

Water use efficiency in buildings

Measures that commonly help improve water efficiency in buildings:

- Leak detection
- Water efficient fixtures and systems in toilets, wash basins, and showers
- Appliances with high water efficiency rating
- Sectioning of different water-using areas
- Encouraging behavioral changes in institutional and commercial buildings and in residential homes
- Optimizing heating and cooling systems
- Greywater recycling
- Water-smart landscaping and irrigation.

This section provides tips on water use efficiency relevant to most types of buildings including residential buildings as well as institutional and commercial buildings such as schools, hospitals, shopping centers, office buildings, mosques, hotels, and restaurants. Buildings are places where significant amounts of water are consumed and where considerable savings can be captured. Water use in buildings is also projected to increase due to further urbanization, rising living standards, and the growing service sector in national economies.

Traditionally, water efficiency received little or no attention in building design and operation. This fact combined with wasteful use patterns has resulted in water being used rather inefficiently in buildings. In light of growing water scarcity and increasing costs of water supply and effluent discharge, building operators and owners are starting to realize benefits linked to improved water efficiency.



Typically encountered inefficient fixtures in buildings and facilities in the region.

Fortunately, there is a wide range of opportunities for improving water efficiency in buildings. A number of approaches are suggested including installations that can be integrated into the building during the design phase, technological retrofits to existing installations, and behavioural changes. In this chapter we look at these opportunities across different water uses in buildings.

WATER USE BREAKDOWN IN BUILDINGS

As would be familiar from our residential settings, water in buildings is commonly used for cleaning, for personal hygiene, for heat transfer, and for landscaping.

Primary water use purposes in buildings

- Toilets
- Showers
- Wash basins
- Kitchens
- Laundry
- Heating, ventilation, and air conditioning (HVAC) systems
- Landscaping.

Although water-consuming activities often remain similar, the sophistication of water infrastructure as well as the quantities and use patterns can vary significantly depending on the primary purpose of the building. For example, while showers and toilets are particularly important in residences, schools, hotels, and office buildings, HVAC systems and landscaping can be major users of water for shopping center and other large commercial and institutional buildings.

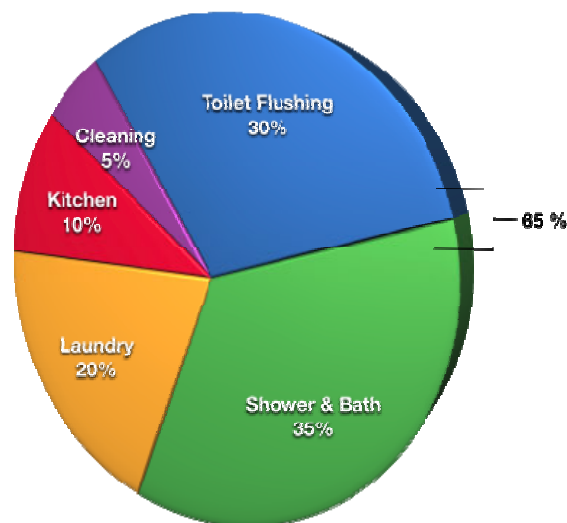


Figure 4.1: Typical water use breakdown in a residential building

SYSTEMICALLY IMPROVING WATER EFFICIENCY IN BUILDINGS

In order to improve water efficiency in buildings, a systematic approach should be adopted, as outlined in Chapter 2. However, as mentioned earlier, buildings can show significant differences in their water use characteristics and in the utilization of their water-related infrastructure. Buildings also have different service life spans. A major difference can be observed between residential buildings on one hand and commercial and institutional buildings on the other hand, in terms of water systems complexity, the lifetime of fixtures and equipments, and the resources and organisational capabilities of their owners, users, or operators. Consequently, monitoring strategies and improvement options have to be adjusted and tailored to these variations. This guide tries to remain cognizant of these differences.



Water sectioning system used in a shopping center.

PREPARATION AND PLANNING

As in industrial facilities, water efficiency programs in buildings require preparation and planning including conducting a facility survey, monitoring use, determining performance targets, identifying saving options, informing and engaging building users, and allocating resources. In single-family homes or apartments, the steps can be organised informally and the process logic remains the same. In addition to the Data Form for Buildings, provided as part of Support Sheet A in Chapter 2, the following checklist of questions can be helpful during a site survey for an institutional or commercial building.

CHECKLIST

Planning questions in an institutional/commercial building site survey

- How much water is consumed in different functions of the building?
- Which functions are the main consumers: HVAC, toilet facilities, technical areas, irrigation, others?
- What are the direct and indirect costs of water use in the building?
- What type of maintenance routines (such as leak inspections or equipment maintenance) are in place today?
- What water reuse and recycling systems are in use or have been considered?

UNDERSTANDING WATER USE DYNAMICS

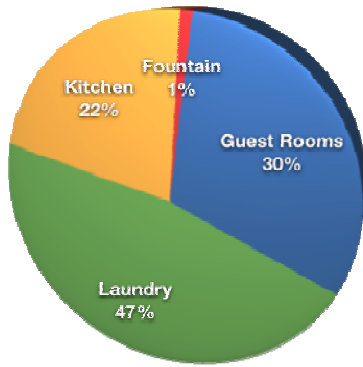
Residential buildings often have a relatively simple distribution structure with limited number of outlets and relatively lower consumption volumes. In these settings, performing a detailed monitoring would neither be feasible nor necessary. An awareness of the overall water consumption of the building together with an average water use breakdown benchmark (**Figure 4.1**) would be sufficient to kick start an effort to identify water-saving opportunities.

In commercial and institutional buildings, the monitoring activities will have to become more detailed to match the growing size and complexity of the water system. A more thorough and exhaustive effort is needed in order to develop a more useful level of understanding.

CHECKLIST

Required sub-metering in a shopping mall in order to develop sufficient understanding of the water use dynamics

- Cold water supply & hot water supply
- Toilets and urinals
- Cooling towers
- Food courts and restaurants
- Outdoor areas and water features
- Retail shops
- Sewage discharge.



The next step after monitoring is to develop water balances – for the entire building or for key water using activities – and usage patterns over time. **Figure 4.2** shows an example of water use breakdown in a hotel.

Figure 4.2: Water use breakdown in a five-star hotel in Hong Kong.

IDENTIFYING IMPROVEMENT OPTIONS

Improvement measures need to be investigated with an eye on selecting from a set of areas or activities those that have the greatest potential for improvement. This will be a function of the type of building in question. **Table 4.1** provides a summary of key areas for different building types.

Building Type	Areas with main improvement potential								
	Toilets	Showers	Sinks	Laundry	Kitchen	Heating/Cooling	Landscaping	Pools	Sterilization
Residential	X	X	X						
Hotels	X	X	X	X	X	X	X	X	
Hospitals	X	X	X	X		X	X		X
Schools	X		X		X		X		
Offices	X		X			X	X		
Shopping centres	X		X		X	X	X	X	

Table 4.1: Areas of main improvement potential in different types of buildings

PRIORITISATION AND IMPLEMENTATION

Once they are identified, the improvement possibilities need to be assessed based on their lifetime benefits and costs. For such assessments, knowledge of the true cost of water is

needed. This step requires the quantification of both direct and hidden costs, as described by the following checklist.

CHECKLIST

Hidden water use costs in buildings can often be linked to:

- Costs for heating and cooling the water
- Pumping costs for transporting water
- Treatment costs
- Cost of chemicals.

In addition to a benefit-cost analysis, the effect of identified options on the service quality, applicability, suitability, and availability of support need to be assessed.

Experience from European and North American countries shows that residential users are often better positioned to change water use patterns but may not have the resources for detailed monitoring or for replacing existing fixtures or equipment with more efficient ones, thereby limiting their options primarily to retrofits.

ASSURING CONTINUATION

One of the key virtues of a systematic water efficiency program is to assure that the process of improvement does not halt following the first set of gains, but instead becomes embedded as an integral part of normal routines. At a minimum, this entails continuous monitoring of water use patterns in key areas and taking corrective actions to handle irregularities or to meet defined targets. It also includes continuously looking for new approaches that can reduce water consumption in the building and swiftly adopting those that prove to be feasible.

COMMON WATER EFFICIENCY MEASURES FOR BUILDINGS

There are numerous measures that can successfully improve water use efficiency in buildings. The improvements can be achieved through a combination of behavioral changes and technological fixes. A description of some common measures follows.

USE-BASED CHARGING

A common problem hindering water efficiency improvements in buildings is linked to the tariff system. In many parts of the world, considerable segments of water users – whether they are house owners, occupants of flats in apartment buildings, or tenants at a commercial center – are still not charged for water according to their actual consumption. Instead, their water tariffs are based on a fixed cost, sometimes incorporated as part of a set monthly rent. This practice is a major hurdle to water efficiency because it removes incentives for lowering water consumption. Therefore, a key step in water efficiency in buildings requires installing water meters for individual users and introducing a fee accounting system based on actual consumption. The incentive for cost savings can only be realised by making water users aware of their consuming habits and linking their water bills to actual rates of consumption.

DETECTING LEAKS

Water leakage from toilets, faucets, or plumbing fixtures can be responsible for as much as 10 to 30% of water losses.¹ Therefore, detecting and repairing leaking fixtures forms a good starting point for efficiency improvements. By conducting regular checks and routine maintenance, considerable amounts of water can potentially be saved.

Detecting leaks in residential buildings, where the number of outlets and water users is limited and concentrated, can be accomplished relatively easy as demonstrated by the tips box below. In commercial and institutional buildings, more complex measures such as continuous monitoring, overnight monitoring, and water balances may need to be used to determine the extent of leakage.

¹Environment Canada. <http://www.ec.gc.ca/eau-water/default.asp?lang=en&n=E85F9FC8-1> and Sydney Water.

TIPS

Quick way to detect water leakage

In order to verify whether your house is leak-free, read your water meter before and after a two-hour period when no water is being used. If the meter does not read exactly the same, this indicates the presence of leaks.

Detecting Water Leakage in Toilets

Leaks with slow flows can be difficult to detect by ordinary observation. To be sure, add some food-dye to the cistern. After 30 minutes, check your toilet bowl for any coloring, which will indicate leakage. Make sure to rinse the bowl to avoid permanent coloring.

Once the magnitude of leakage is determined, the leaking fixture must be located and identified. A description of common leaking areas or fixtures that are relatively easy to identify and fix follows.

Dripping taps, faucets, and shower heads

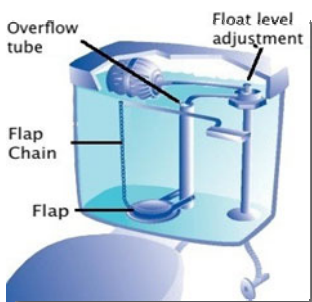
A dripping tap can waste between 4,000 to 10,000 liters of water every year. This is enough water for 40 to 100 showers. Worn out plastic seals often cause leakage in taps. Damaged seals can be easily and inexpensively replaced, thereby saving thousands of liters of water.

Leakage in toilet flushes

A toilet flush system that leaks water in the form of a constant flow can result in the loss of substantial amounts of water. Leaks from toilets can also be harder to detect. Two of the problems that are common and that can be fixed relatively easily are:

A misplaced or broken flap causes water to continuously flow into the toilet bowl. A quick inspection of the flap mechanism to ensure that the flap is well-aligned with the flush-gate and that there are no obstructions can fix the problem. If the flap, or its seal, is damaged, it will need to be replaced.

Continuous overflow happens when the shut-off level is not properly adjusted or when the movement of the float arm is obstructed. By adjusting the shut-off level correctly and making sure that the float arm moves freely, overflow can be avoided.



Components that can lead to leaks in a typical

Storage tanks

In commercial and institutional buildings, water supplied by the main is often stored in tanks prior to its use. The structural stability of storage tanks can deteriorate over time due to various reasons leading to leaks. This can be detected by monitoring the water level in the tank during a period when no water is being extracted from the tank. A drop in water level will indicate leakage.

Cooling towers

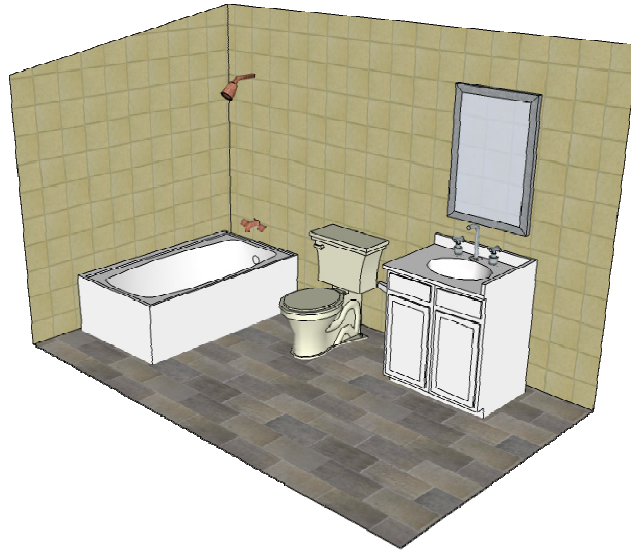
Overflow from cooling tower basins, as covered in Chapter 3, can also be seen as a form of leakage in institutional and commercial buildings and can lead to considerable wastage. Measures discussed earlier will also be applicable to buildings.

Pipes, joints, and valves

Old pipes, junctions, and valves with worn-out sealing are potential sources of water losses in buildings. These can be more difficult to detect, particularly if the leaking water is finding its way to effluent discharge channels. Leakage in the piping system may be indicated if leakage persists after all the visible leakage points have been repaired. In these cases, assistance from a professional may be necessary.

TOILETS AND URINALS

In many buildings, toilets account for one-third of water use, making them an attractive target for water efficiency improvements. These can be achieved through behavioral changes, low cost retrofits, or replacing older toilets with newer and more water-efficient models. In this section we present several of those options. It is important to examine closely the payback period when considering replacement options.



Changing behavior

Behavioral change towards avoiding the use of toilet flush unnecessarily forms a sensible starting point for reducing water consumption in toilets. Users should be encouraged not to use the toilet as a garbage bin and not to dispose of, for example, tissues, dead insects, or similar waste. In private homes such changes can be relatively easy to implement. In institutional and commercial buildings, on the other hand, more formal training as well as the use of educational signs may be necessary to stimulate a change in user behavior.

Volume displacement objects

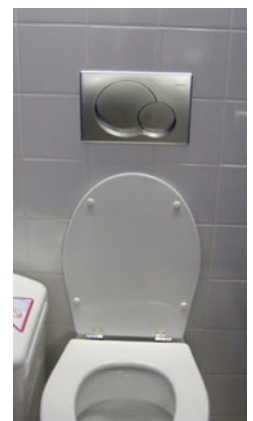


A volume displacement object can save up to 30%

If the toilet is of an older model, a simple and effective measure to conserve water is to place a displacement object inside the toilet cistern. These are objects that sit inside the cistern permanently occupying a reasonable volume without interfering with the operational mechanism of the flush system. Plastic bottles filled with water and carefully placed inside the cistern can serve this purpose. There are also commercial products that can be used as cistern displacement. Another possibility is to use the so-called toilet dams. These are barriers placed inside the cistern, creating dry compartments and thereby reducing the amount of water used in each flush. These devices can save 1 to 3 liters of water per flush.

Low-volume or dual-mode flush systems

While conventional flush systems use more than 11 liters of water per flush, modern low-volume, dual-mode flush systems can reduce this amount to 4.5 liters per full flush and 3 liters per partial flush. Such a conversion may translate into



A dual-mode flush system.

thousands of liters of water being saved annually. However, these systems usually require the replacement of not only the cistern and the flushing mechanism, but also the toilet bowl. Therefore, they should be considered when replacing old models or installing new toilets. It should also be noted that low-flow toilets are more prone to clogging and may require the elimination of certain grades of toilet paper.

Vacuum-toilets

Toilets can be connected to a vacuum source to employ for flushing. These systems operate with the help of a pump that creates a vacuum to help flush the contents of a toilet with minimal water use. With such systems water consumption can be reduced to as low as 0.5 liters per flush.



A composting toilet.

Composting toilets

More suited to rural areas, these toilets eliminate the use of water and do not create black effluents. If properly managed, they can also produce sterile humus that is free from unwanted smells. These units have, however, larger space requirements and demand appropriate handling from users.

URINALS

Urinals are often used in public amenities and are conventionally fitted with cyclic flushing systems. Because they waste considerable amount of water, their use should be eliminated. The following are examples of more efficient alternatives.

Urinals with on-demand sensors

Infrared sensor operated urinals work by detecting the presence of a user within the detection zone for more than a certain time threshold. The user's departure from the detection zone activates flushing. These units use no more than 1 to 1.5 litres of water per flush. Such sensor can be prone to malfunctioning leading to water wastage. It is therefore important to fit them with manual shut off valves. The continual monitoring and maintenance of the sensors is also essential for sustained efficiency.

Waterless urinals

Waterless urinals have a drain trap insert siphon that collects the urine and discharges it into the sewage system, without




Example of a waterless urinal.

using water. These urinals have hydrophobic inner surface and are also equipped with a hydrostatic float, which seals the discharge opening of the urinal and does not allow smells to be released.

Use of greywater in flushing

Alternative sources of water can be used to flush toilets and urinals. In particular, water consumed in showers, wash basins, and laundry operations – so-called greywater – can be reused. Greywater reuse in toilets, however, requires the installation of extra pipes, pumps, a storage unit, and a simple treatment unit. It can be costly to retrofit existing toilets and urinals with a greywater collection system. It is much more feasible to introduce a system for collecting and treating greywater for reuse during the design phase.



The Aqua™

The Aqua™ catches the water flowing down your sink drain. The collected water is filtered, disinfected, and stored to ready it for the next toilet flush. The system is designed to be easily retrofitted into existing fixtures and boasts low maintenance. A small electric pump transports the water from the 21-liter (5.5 gallon) holding tank installed under the sink. A device in the toilet tank prevents fresh water inflow as long as sufficient water is available in the Aqua to do the job.

Source: www.thetreehugger.com

BATHS AND SHOWERS

Baths and showers can account for up to 30% of total domestic water use. Through a combination of behavioral and technical approaches, up to 50% reduction in water use can be achieved in baths and showers without compromising hygiene or comfort requirements.

Giving a preference to showers over baths

Making changes in usage patterns is again one of the most effective ways of improving water efficiency in baths and showers. Naturally, when baths can be used for therapeutic and relaxation purposes, they can be difficult to substitute. However, when the purpose is solely personal hygiene, showers should be preferred over baths. Showers not only use

less water – provided that they are reasonably short – but also offer better hygienic results.

Controlling water flow and time in showers



Example of a shower timer.

Staying under running water can be tempting but results in wasteful use of water. By reducing the average length of a shower by two minutes, a family of four can save up to 60 m³ of water in a year. Simple and inexpensive timers are available to alert users of the time spent in a shower. In an ordinary shower cycle, as much as 50% savings can be achieved by turning the water off while shampooing your hair or washing your body.

Tips

Implementing behavioral changes can be easier in residential homes than, for instance, in hotels, where excessive water use in showers and baths can be seen as part of an exclusive service offering. To trigger changes among hotel guests, awareness raising using leaflets and informational campaigns can be linked to the social responsibility mission associated with a hotel brand.

Water efficient shower heads

Efficient shower heads operate by mixing water flow with an air jet. These units provide satisfactory contact with water and achieve effective rinsing with much less water. Whereas a five-minute shower with a normal shower head can use around 100 liters of water, a water efficient shower head consumes a modest 35 liters.



Example of a shower head with an air jet.

Source:
www.showerheadstor.com

Showers with automatic shut-off systems

Showers with shut-off systems automatically cut the water flow once a predetermined amount of water has been used and require user input to re-activate the water flow. Such systems are particularly well-suited for schools, offices, and sports facilities but their use is also becoming common in motels and guest houses.

Use of easily adjustable mixers

More than 10% of the total amount of water used in a shower cycle can be wasted while trying to adjust for a comfortable temperature. With the use of easily adjustable water mixers with temperature indicators, desired water temperatures can be more easily achieved, thereby wasting less water.

Water used in showers and baths can be suitable for alternative uses. Therefore, instead of letting it drain, it can be captured, treated, and reused (see section on greywater use).

FAUCETS, TAPS, AND WASH BASINS

Water efficiency in these areas can also start with some behavioral changes, such as not letting the water run straight to the drain while teeth brushing, hand-washing, or shaving. Washing razor blades in a container with hot water instead of under running water can also improve water efficiency. With regards to technical installations, the following options should be considered.

Water efficient faucets and tap adaptors

Simple devices that mix water and air can reduce both water flow rates and splashing while increasing areas of coverage and wetting efficiency. For example, faucet aerators can save water use by up to 50% during hand-washing. Modern faucets come with integrated aerators and should be preferred for new installations. Effective aerating adaptors are also available inexpensively and can be easily installed.



Easy to fit and inexpensive, aerators can save water by up



A tap with an infrared on-demand sensor.

Faucets with on-demand sensors

On-demand faucet units rely on infrared sensors to trigger water flow. With the use of such systems, water use in wash basins can be reduced considerably. It is essential that such units have a quick response time in order to avoid user dissatisfaction. In addition, such units provide improved results if used in combination with aerators (see above).

Faucets with automatic shut-off systems

Faucets with automatic shut-off systems will cut the flow of water once a predetermined amount of water has been discharged. These units can use mechanical triggers or infrared sensors to control water flow. These units need to be used in combination with water saving aerators. In cases where the shut-off limit is not properly matched to the needs of the users, these units may result in wasteful use of water. **Figure 4.3** depicts how water consumption varies with different types of faucets.



A push-button automatic shut-off tap system.

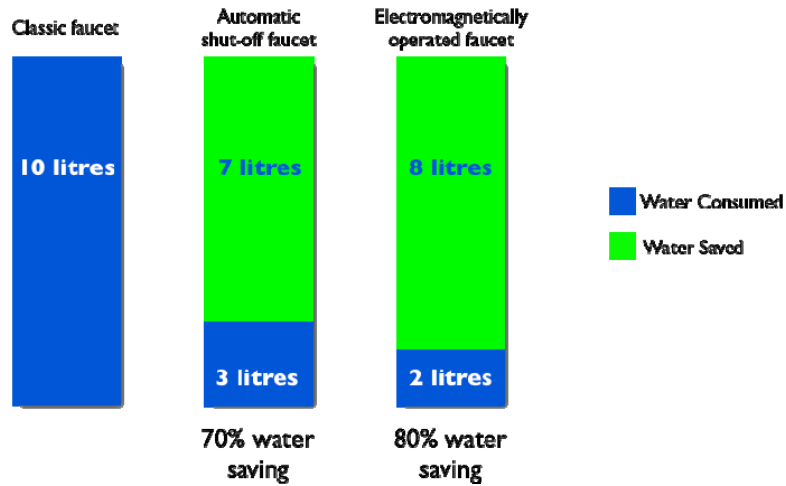


Figure 4.3: Water consumption and savings using different types of faucets

LAUNDRIES

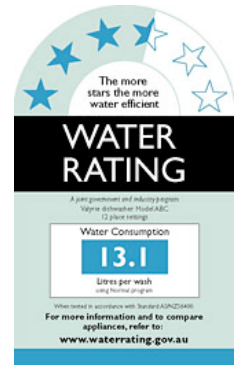
Laundry operations are another high water-use area, especially for homes, hospitals, hotels, and commercial linen services.

For residential homes, clothes machine washing is much more water efficient than doing laundry by hand. Consequently, use of washing machines should be prioritized. In addition, front-loading washing machines with high efficiency ratings should be selected when outfitting new buildings or replacing old equipment.

Behavioral approaches can have a significant impact on water use in laundry operations. For example, laundry cycles should be adjusted so that washing machines are run at full loads rather than partial loads.

Overall water consumption in laundry for a given setting can also be reduced significantly by performing the washing when it is necessary rather than according to a pre-set schedule. This is particularly relevant in hotels where traditionally all towels and bed sheets are replaced and laundered on a daily basis. An increasing number of hotels today allow their customers to decide if they want their towels and sheets replaced, thereby eliminating unnecessary laundry.

Greywater from laundry operations can be subjected to basic treatment and made suitable for reuse. It can be reused to flush toilets. It can also be used for outdoor irrigation.



Water-rating labels help consumers choose more efficient washing machines. *Source: Water Efficiency Labeling and Standards, Australia.*

Therefore, plans to capture and reuse greywater from laundry operations should be considered during the design phase of new buildings.

KITCHENS

Kitchens in different settings are another high-water use area, particularly in commercial and institutional buildings, such as hotels, schools, restaurants, and shopping centres. Once again, with a combination of behavioral and technical changes, water use in the kitchens can be reduced considerably.



Eliminate using running water for food preparation

Both in domestic and commercial kitchens vegetables and fruits need to be washed prior to being used in food preparation. Instead of washing under running water, using a water container can be equally effective. Additionally, avoid using running water for defrosting. This practice wastes large quantities of water. Instead, defrosting can be achieved by placing frozen food items in a refrigerator or in a room environment for a reasonable amount of time (beware of time to avoid food spoilage). Microwave ovens can also be used for defrosting.

Using a dishwasher

Whenever possible, dishes and utensils should be washed using dishwashing machines because they are far more water efficient than manual washing. For commercial applications, and also for households, preference should be given to machines that have higher water efficiency. Such dishwashers should be run once fully loaded, rather than at partial loads. It should be noted that modern domestic dishwashers that utilize

high-pressure steam can easily handle a great majority of the dirt found on dishes and DO NOT require pre-rinsing.

Mechanical pre-rinse for manual washing

Where manual washing is the only option, priority should be given to removing food residues from dishes by mechanical means, such as with the help of a used napkin or a brush, over using running water. If necessary, dishes could be soaked in a container to allow the residues to soften. Actual washing and rinsing should also be performed using batches of water placed in containers instead of running water.

Triggered spray nozzles

In commercial kitchens, pre-rinsing of the dishes is common in order to reduce water and chemical consumption in quick-cycle dishwashers. In such activities, use of high-pressure nozzles with a hand-held trigger can result in substantial water savings.

Use of hot water

Hot water is much more effective in removing food remains from dishes and therefore provides equal or better cleaning with much lower volumes than cold water. However, the energy costs of water heating need to be taken into consideration.

Ice makers

Commonly found in restaurants and hotels, ice makers can use considerable amounts of water. Air cooled machines, which require only about 1.9 liters of water per kilogram of ice, should be preferred over water cooled machines, which may use as high as seven times more water.

Space cleaning

Commercial kitchens need to be frequently cleaned for hygienic purposes. A number of measures can be adopted to reduce water use. Sectioning the areas according to cleaning needs, utilizing mechanical cleaning to the extent possible, and using high-pressure, low-volume systems can collectively help reduce water consumption for space cleaning.



A tap with a triggered spray nozzle can save a lot of water in kitchens.
Picture: Superb Lifestyle products.

LANDSCAPING

Water use for landscaping can consume considerable amounts of water and usually holds a good potential for efficiency gains. Three main approaches are effective in reducing the amount of water used in landscaping:

Selecting the right plant species

Plant species hold the most important promise for reducing water consumption. Unfortunately, exotic plant species that are not native to the local environment are commonly used in gardens, which demand excessive quantities of water and additional maintenance. In semi-arid areas, characteristic of most MENA countries, drought-tolerant varieties should be the preferred option. Drought-tolerant plants are an essential part of water efficient landscapes. They are adapted to water-scarce environments and therefore require minimal supplemental irrigation. They also require less maintenance than their water-needy counterparts.

Water conserving landscapes project in Jordan

The Center for the Study of the Built Environment (CSBE) project on water conserving landscapes is concerned with the development of aesthetically pleasing landscapes that also conserve the use of water. These goals are achieved through a variety of means, which include using native and drought-tolerant vegetation, making maximum use of rainfall runoff, and incorporating hard-covered ground surfaces (consisting of materials such as pebbles, stones, bricks, and concrete) in landscape designs, rather than relying exclusively on surfaces covered with vegetation.

The project generates informative educational leaflets and manuals in both Arabic and English on water conserving landscapes, featuring a list of drought-tolerant plants adapted to the region. Available for free at:

Optimization of irrigation systems

Irrigation can be performed by hand or through a dedicated installation. When choosing an irrigation set-up, below ground irrigation systems should be prioritized over above ground systems, thus minimizing evaporation losses. In addition, synchronizing irrigation to changes in soil moisture content is more efficient than relying on pre-set frequencies. When managed properly, an automatic irrigation controller can pay for itself in reduced water usage, cost, and labour. By using a simple device to monitor the soil moisture content continuously, significant efficiencies can be gained.



A hand-held soil moisture meter.

Irrigation equipment needs to be properly maintained on a regular basis, including making adjustments to the sprinkler heads or drip nozzles as needed.

Use of harvested rainwater and greywater

Landscape irrigation is often well-suited to using alternative sources of water, such as greywater, harvested rainwater, or even treated wastewater that can be sourced from municipal water works in some contexts. **Figure 4.4** depicts a water harvesting system.

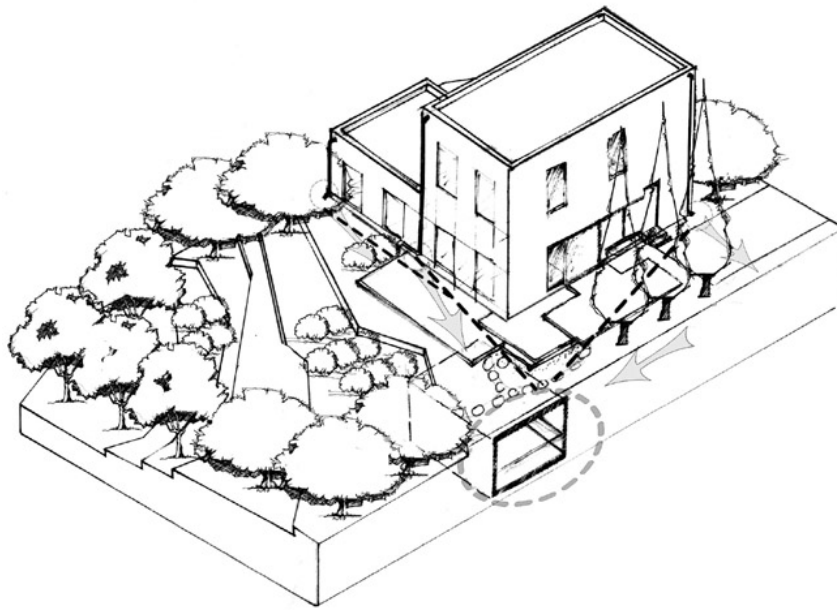


Figure 4.4: An active water harvesting system²

HEATING AND COOLING

In commercial and institutional buildings with large floor areas, centralised heating, ventilation, and air conditioning (HVAC) systems are frequently used. These systems are highly similar to heating and cooling systems described in chapter 3 (Water efficiency in industrial facilities), and can benefit from the same efficiency measures.

² Source: CSBE, Water Conserving Landscapes Manual

Checklist

Water efficiency measures for HVAC systems

- Adjusting the heating and cooling loads to actual demand
- Replacing once-through systems with re-circulating systems
- Reducing bleeding through close monitoring of impurities and use of appropriate chemicals
- Properly maintaining the system components
- Reducing drift and splash losses from cooling towers
- Reducing excessive overflow by properly adjusting the level of float valves in cooling tower storage tanks
- Consider use of alternative water sources.

EARLY DESIGN MEASURES

Water efficiency should be integrated early on in the design and construction phase of buildings. The feasibility of certain efficiency measures can be enhanced by re-considering certain design features related to the water distribution network, water storage tanks, and other water supporting systems. In the following are examples of three systems.

Water storage tanks

Commercial and institutional buildings are usually equipped with water storage tanks, which serve two functions. It is an available, if temporary, source of water when regular supply from the water distribution network is interrupted. Stored water can also be used for fire-fighting purposes. For maintenance reasons, these tanks need to be emptied at certain intervals and their contents are usually drained.

To save water, the water storage tank should be designed with two independent cells, each occupying a 50% capacity of the total tank volume. With a two-compartment tank, water from one cell can be circulated to the other cell during maintenance, precluding the need to drain the entire water content of the tank. Therefore, the two water cells should be connected to each other, allowing water circulation and ensuring water quality maintenance. Water cells should also be designed to allow them to be emptied independently (for washing or maintenance purposes).

Water distribution networks

Another approach that can result in water efficiency gains in commercial and institutional buildings is to design the internal water distribution network with clearly independent sectors, defined by both the area of the building and the type of water consumption. In the following box are examples of independent water sectors that can be considered for commercial buildings. Each sector should be equipped with a water flow meter measuring the specific water consumption in that sector independent of others.

Checklist

Independent water sectors in a commercial building

- One sector per floor
- One sector for the common areas (corridors, technical areas, others)
- One sector for the HVAC system
- One sector for the irrigation system
- One sector for ornamental fountains, when available.

Independent monitoring of the sectors helps gain an understanding of water use patterns in different sectors as well as identify and isolate possible water leaks in the building.

Infrastructure for water re-use

As mentioned earlier, greywater produced by certain uses in buildings – such as showers, wash basins, and laundry rooms – can be suited for use in toilet systems or in landscaping. To facilitate the use of greywater, it is key to include in the early design phase a system for collecting, treating, and storing treated greywater. This system may include a separate drainage network, an on-site simple treatment unit – e.g. using sand filters or ultra-filtration –, a storage tank, and a dedicated distribution network.

Similarly with rainwater harvesting, a collection, treatment and storage and distribution infrastructure is needed.

Rainwater Harvesting

Rainwater collected primarily from roofs or other suitable paved areas – such as parking lots – can reach considerable amounts and can be used for a variety of purposes, such as:

- 💧 Landscape irrigation;
- 💧 Toilet flushing;
- 💧 Laundry;
- 💧 General cleaning;
- 💧 Cooling and heating;
- 💧 Hygienic use and drinking.

A rainwater harvesting and re-use system includes the following components.

CATCHMENT AREA: An impermeable surface, like roof or parking lot, is needed to capture the rainfall.

CONVEYANCE SYSTEM: Appropriate piping and drainage needs to be in place in order to transfer the captured rainwater first to the treatment units and then to the storage tank.

FILTRATION/TREATMENT: Captured rainwater often needs to be treated. The extent of treatment needed depends both on the characteristics of the catchment area and the intended use of the collected water. Usually water collected from roofs has lower amounts of pollutants than those collected from pavements or parking lots and therefore require less treatment. Generally, the first part of the collected runoff is flushed away, as it tends to be rich in impurities. The water is then passed through a filtration unit to retain organic and other impurities. While a coarse filtration – such as one that can be achieved with a simple grate filter or sand filter – may be sufficient for relatively clean harvests, finer filtration –such as micro-filtration– may be needed for others – particularly if the intended use for the water requires higher quality.

STORAGE: The filtered water is then placed into a storage tank. The dimensioning of the tank is an important consideration, and requires an estimation of the amount that can be harvested. The amount of rainwater that can be harvested on a specific site can be calculated using the following formula:

$$V_{\text{Rain}} = \frac{A \times P \times 0.8}{1000}$$

where:

V_{Rain} = Volume of rainwater (in m^3/year)

A = Collection area (m^2)

P = Average annual precipitation³ (in mm)

0.8 = Collection factor to account for filtering losses and small rainfall that does not generate runoff.

Storage tanks need to be fitted with an overflow system. Moreover, if the tank will need to be topped up with water from the main, a backflow prevention device will need to be fitted.

DELIVERY SYSTEM: Pumps, valves and pipes may be needed to transfer the collected rainwater to the point of use. Depending on the design of the system, if a pump is needed to transfer the collected water to the point of use, this can be placed inside the tank. If the rainwater needs to meet higher hygienic requirements or will be used for drinking, additional treatment units, such as granulated activated carbon filtration and UV disinfection may need to be integrated to the distribution system.

An alternative design for a simple rainwater harvesting system is depicted in **Figure 4.5**.

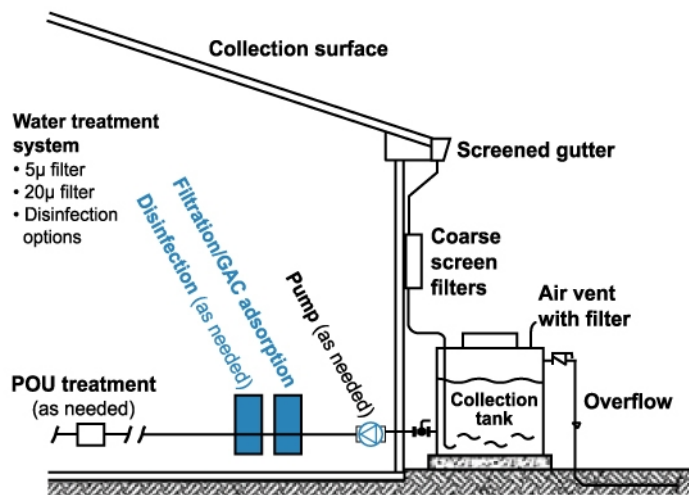


Figure 4.5: Rainwater harvesting system for buildings⁴

³ Annual precipitation values can often be obtained from national or local meteorological departments.

⁴ Source: Home Water Purification Systems (<http://www.cleanairpurewater.com/>).

CARE NEEDED: The storage tanks of rainwater harvesting systems need to be cleaned in frequent intervals – the frequency is dependent on the tank design and level of filtration.

Particularly in warmer climates, the storage tanks can easily turn into breeding grounds for mosquitos and other nuisance insects. In order to prevent this from happening, all non-frequently used orifices need to be properly closed and sealed. Orifices that are commonly used – like input and overflow pipes, on the other hand need to be covered with a mesh.