حكومة دبي
GOVERNMENT OF DUBAI

هيئة كهرباء ومياه دبي
Dubai Electricity & Water Authority

HANDBOOK ON ENERGY EFFICIENCY MEASURES OF ELECTRICITY AND WATER

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MD & CEO of Dubai Electricity & Water Authority

MD & CEO's MESSAGE

Sustainability has always been an integral part of the culture of the United Arab Emirates. Thanks to our visionary leadership, the UAE has undertaken important steps to reduce global warming, in line with its international responsibility to address climate change. Dubai has been a pioneer in the implementation of programmes and initiatives that contribute to reducing the carbon footprint.

DEWA plays a pivotal role in protecting the environment by increasing the share of clean and renewable energy and launching several programmes and initiatives that encourage the efficient management of electricity and water use. Our efforts consolidate Dubai's position as a global sustainability hub and support international endeavours to achieve sustainable development and address environmental challenges. This supports the Dubai Clean Energy Strategy 2050 and the Dubai Net Zero Carbon Emissions Strategy 2050, which aim to ensure 100% of the emirate's total power capacity comes from clean sources by 2050.

Since its establishment in 2013, Etihad Energy Services Company (Etihad ESCO), a leading energy services company owned by DEWA, has been making Dubai a leading example in energy efficiency for the region and the world. It retrofits buildings, monitors energy consumption and installs solar energy systems.

These efforts align with Dubai's Demand Side Management (DSM) Strategy 2050, which aims to reduce electricity and water consumption by 30% by 2030 and 50% by 2050.

DEWA has developed this Handbook on Efficient Use of Electricity and Water to showcase the available technologies that its customers and the wider society can use to efficiently manage their electricity and water use. I hope it will help you make a positive change and contribute to protecting the environment and natural resources, ensuring their sustainability for generations to come.

Our Purpose

Providing globally leading sustainable, efficient and reliable power and water services and related innovative smart solutions towards a net-zero future.

Our Vision

A globally leading sustainable innovative corporation committed to achieving net zero by 2050.

Our Mission

We are committed and aligned to Dubai's 8 Guiding Principles and 50-Year Charter, supporting the UAE's directions through the delivery of global leading services and innovative energy and potable water solutions, enriching lives and ensuring the happiness of our stakeholders for a sustainable net-zero carbon 2050.

Our Motto

For generations to come.

DISCLAIMER

The handbook informs but does not advertise any particular technology. DEWA does not endorse any of these technologies. This handbook only discusses the technical aspects of efficient water and energy use and does not recommend any specific brand.

This handbook is NOT a replacement for the energy audit process. DEWA recommends that a proper viability study should be carried out on the commercial and technical elements of any property or premises and their suitability for the site in question.

DEWA is not accountable and liable for any failure of operation or any of the measures mentioned in the handbook. Customers should carry out a due diligence and analysis process before implementing any of the measures covered in this handbook.

The potential and maximum savings percentages mentioned in the handbook are representative and indicative; the exact savings for the measures specific to the project can be best estimated by conducting an energy audit of the premises.

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LIST OF ABBREVIATIONS

AHU
Air Handling Unit

BMS
Building Management System

CFL
Compact Fluorescent Light

CHW
Chilled Water

CPM
Chiller Plant Manager

CRI
Colour Rendering Index

DCP
District Cooling Providers

DP
Differential Pressure

DX
Direct Expansion

EEM
Energy Efficiency Measures

ESCO
Energy Services Company

FAHU
Fresh Air Handling Unit

FCU
Fan Coil Unit

HVAC
Heating, Ventilation, and Air Conditioning

IEC
Indirect Evaporative cooling

IDEC
Indirect-Direct Evaporative Cooling/Two-Stage Evaporative Cooling

LPM
Litre per Minute

VFD/VSD
Variable Frequency Drives/Variable Speed Drives

VPS
Variable Pressure System

VRF
Variable Refrigerant Flow

INTRODUCTION

DEWA has published this Handbook on the efficient use of electricity and water to introduce various technologies that might suit its customers' facilities. It intends to help customers better understand typically available technologies that can help them manage their electricity and water usage.

This handbook covers two types of measures: technologies and control systems. Technologies cover retrofitting or replacing existing equipment with more efficient alternatives. Control measures recommend installing devices to optimise the control of existing or new equipment to improve their operation.

The handbook has been colour-coded throughout to make it easy to differentiate and classify the measures and their applications. In addition, the handbook has symbols representing various customer sectors - residential, commercial, governmental and industrial - for which the Energy Efficiency Measures (EEMs) are applicable.

EFFICIENT MEASURES ON ELECTRICITY & WATER USE

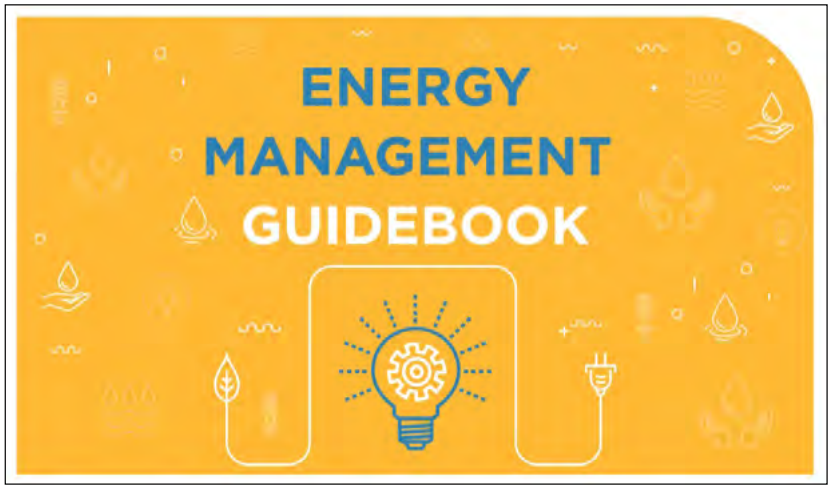
These are projects and technologies to reduce electricity and water use in a building. This handbook covers the measures that require the installation of devices or equipment as a retrofit or a replacement.

Retrofitting is the act of replacing a component of a system to improve efficiency and performance, while replacement refers to completely replacing a system or equipment with a more efficient one.

Measures such as advice, ideal forms of behaviour and best practices in maintenance, design and operations are not included in this handbook.

Please refer to the Energy Management Guidebook issued by the DSCE for more information about implementing measures of efficient electricity and water use and a better understanding of the energy management journey. See the link:

[Supreme Council of Energy Guidebook Link]



WHO SHOULD READ THIS?

This handbook is for:

- Facility Owners
- Facility Management companies
- Engineering and Maintenance Teams
- Individuals and Homeowners.
- Architects

1. SUMMARY

The following table summarises all the efficient management measures in this handbook, with their typical range of savings.

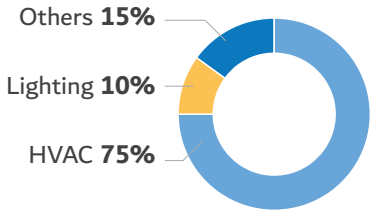
Colour Code	Energy Efficiency Measures	% Savings on End-use Consumption
Lighting	Lighting Replacement	Up to 80%
	Solar Tubes	Up to 80%
	Lighting Control Devices	Up to 20%
HVAC	AC - VRF System	Up to 20%
	AC - Inverter Split	Up to 25%
	AC Compressor Optimisation Retrofit	Up to 12%
	Refrigerant Additive	Up to 10%
	Evaporative Cooling For Chiller	Up to 14%
	DC Motors for FCUs	Up to 25%
	Evaporative Cooling	Up to 20%
	Programmable Thermostats	Up to 15%
	Smart Thermostats	Up to 20%
	Chiller Plant Manager (CPM)	Up to 25%
	VFDs/VSDs for AHUs & FAHUs	Up to 50%
	VFDs/VSDs For Chilled Water Pumps	Up to 50%
	Differential Pressure Optimisation	Up to 15%
	Carbon Monoxide Sensors for Basement Exhaust Fans	Up to 20%
	Timers For Exhaust Fans	Up to 20%
Water	Low-flow Fixtures	Up to 60%
	Sensor-control Faucets	Up to 55%
Building Envelopes	Paint-based Insulation & Coating	NA
	Advanced Window Controls	NA
	Window Film	NA
General	Energy Management Systems	Up to 8%
	Heat Pumps For Swimming Pool	Up to 20%

Please note that the project specific savings and applicability will be different and can only be estimated after an internal assessment or an energy audit.

SECTOR-WISE ANNUAL ELECTRICITY END-USE CONSUMPTION BREAKDOWNS

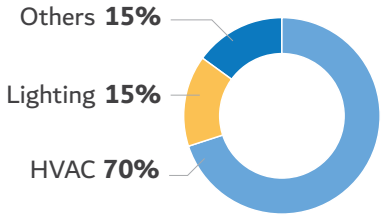
RESIDENTIAL

Homes and dwellings where people live.

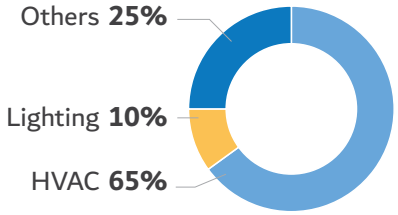


GOVERNMENT & COMMERCIAL

Hotel, restaurants, malls, etc.

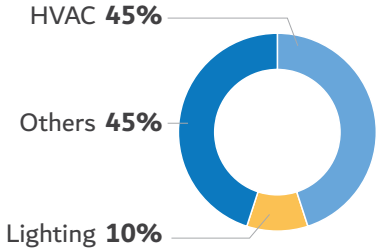


Government and commercial office buildings.

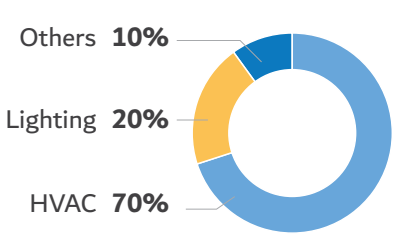


INDUSTRIAL

Factories, workshops, etc.



Industrial warehouses which are air-conditioned



These consumption breakdowns are typical for these types of building. Actual breakdowns may be different for individual buildings.

2. LIGHTING SYSTEMS

This section of the handbook covers different types of lighting systems that save energy.

TECHNOLOGY

Improving the technology used by retrofitting or replacing conventional lighting with energy-efficient ones.

- Lighting replacement
- Solar tubes

CONTROL

Optimising the operation of lighting systems by using lighting-control devices.

- Dimmers
- Timers
- Photocell
- Motion and occupancy sensors

LIGHTING REPLACEMENT

DESCRIPTION

Light-emitting diode (LED) lamps have revolutionised energy-efficient lighting. They are solid-state lighting elements that are extremely energy-efficient. Retrofitting existing lighting such as fluorescent tubes, incandescent lamps and halogen lamps with LED lighting will result in substantial energy savings.

The lighting upgrades can be performed by lamp replacement or fixture replacement. Lighting replacement is the simplest form of lighting upgrade because it is quick, involves minimal disruption and has a relatively low cost.

Advantages of LED Lights

- **Increased lifetime**: LEDs last up to 30,000 hours to 50,000 hours, reducing the need for frequent replacements..
- **Reduced heat generation**: LEDs generate less heat than the conventional light sources, reducing the facility's cooling load.
- **Substantial power reduction**: LEDs require lower power compared to conventional light sources, resulting in savings of up to 80%.
- **Shapes variety**: LEDS comes in different shapes, making them suitable for all applications.

When to apply

The main aspects to consider before proceeding with a lamp replacement are the following:

- The lighting fixtures used for longer operating schedules should be upgraded first as they have more potential for energy savings.
- The greater the technological difference between current and upgraded lighting systems, the greater the overall energy savings. For instance, upgrading to LED lighting from incandescent bulbs results in more energy savings than upgrading from fluorescent bulbs.
- Upgrading lighting in air-conditioned and refrigerated spaces results in two types of savings: a direct reduction in lighting consumption and a reduction in cooling needs, which reduces demand for cooling energy.

Things to consider

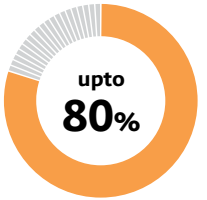
Replacement lamps must also be selected with suitable lighting properties, depending on each application, and they should deliver the following:

- **Illuminance levels**: It should be suitable for the needs of the place, Excessive lighting causes energy waste.
- **Correlated colour temperature (CCT):** The right CCT depends on the functional needs or requirements of occupants. For example, lower CCT values (warm colours) are used to create relaxing environments while high CCT values (cool colours) are used for environments where visibility and awareness are essential, such as sports venues and offices.
- **Adequate colour-rendering index (CRI):** Lamps with high CRIs reveal the colour of the objects, similar to those under natural light. However, they usually have greater costs. Therefore, high-CRI lamps should be used in places where this quality is critical, such as retail shops, museums, art galleries and healthcare facilities.

BUILDINGS OF APPLICATION

INDUSTRIAL | GOVERNMENT & COMMERCIAL | RESIDENTIAL

POTENTIAL SAVINGS



Maximum savings

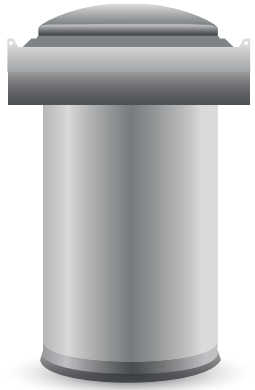
Consumption post-implementation

SOLAR TUBES

DESCRIPTION

Solar tubes are reflector tubes that help capture sunlight and harvest daylight without increasing the thermal load of the building.

The solar tube is a simple device consisting of a collector dome assembly that collects sunlight. Light is then diverted to the required area using a tube made of different reflective materials. The diffuser at the end reduces the glare and helps remove the heat of the light.



Advantages of solar tubes

- They allow artificial lighting to be switched off during the day.
- They offer energy savings, have no glare effect and are low-cost and low maintenance.

When to apply

Solar tubes are more suitable for factories, workshops and warehouses where all areas to be utilised and it is not possible to use other apertures, such as windows and skylights.

Things to consider

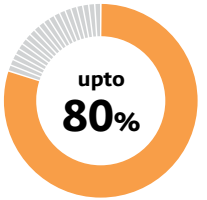
Solar tubes have a few drawbacks that should be considered:

- Periodical cleaning
- Due to high humidity, the insulation of solar tubes is critical to avoid condensation problems.

BUILDINGS WHERE THEY CAN BE APPLIED

INDUSTRIAL

POTENTIAL SAVINGS



Maximum savings

Consumption post-implementation

LIGHTING-CONTROL DEVICES

DESCRIPTION

Lighting-control devices in rooms and areas can optimise their operations, improve efficiency, and make energy savings. Various typical lighting control technologies are summarised here:

Control	Description	Benefits	Drawbacks
Timer	Keeps lights ON for a specific period of time. Once the countdown is complete, the lights turn off.	• Fairly inexpensive • Mechanical or electronic • Electronic types can be programmable and adjust to daylight	• Electronic-type timers may not work with all fluorescent lamps due to incompatibility with their electronic ballasts.
Dimmer	Gives users the ability to vary the intensity of the lights.	• Is fairly easy to install • Provides flexible light levels • Increases lamp life	• Fluorescent dimming can be expensive
Photocell	Senses change in outdoor light (lux) levels so exterior lights turn ON at dusk and OFF at dawn.	• Can be integral to fixtures, switch or stand alone	• For best operation, they must be exposed to bright sunlight. • If not clean, will not sense sunlight and will keep lights switched-on during daytime.
Motion Sensor	Turns lights ON based on motion detection.	• The lighting function and operation times are generally programmable. • Can be integral to fixtures, switch or stand alone	• If aimed improperly, small animals can trigger the sensor to turn ON.
Occupancy Sensor Switch	Detects when a room becomes occupied and turns ON the lights automatically. If no occupancy is detected for a specified time, the lights automatically switch OFF.	• No need to remember to turn the lights OFF • Can be useful if the physical switch is inaccessible	• Typically more costly than timer • False OFFs can occur if sensor placement is not appropriate

Note: It's always recommended to check the compatibility of lamps/lights with the control device before installation.

All the above control devices can be installed in a stand-alone configuration, and they can be integrated with a Building Management System (BMS). The BMS integration will promote better overall integration and monitoring of the operation of field control devices and of lighting equipment.

When to apply

Light-control devices are best suited for spaces with variable occupancy or functions that can lead to lights being used during unnecessary times or at unnecessary levels. Such control devices ensure that light fixtures are used only when needed.

Things to consider

- **To follow correct installation procedure**
- **Dimmers**: Dimmers should be carefully selected based on the type of lighting installed.
- **Photocells**: They turn lights on at dusk and off at dawn, which may not be ideal for every situation, and there are no options for customised scheduling. Additionally, these sensors can be triggered by nonnatural light sources.
- **Motion sensors**: Outdoor motion sensors may be exposed to harsh environmental conditions; over time, they can deteriorate or become less reliable.
- **Occupancy sensor switch**: There might be a slight delay between detecting motion and activating the lights.

BUILDINGS WHERE THEY CAN BE APPLIED

INDUSTRIAL | GOVERNMENT & COMMERCIAL | RESIDENTIAL

POTENTIAL SAVINGS

Maximum savings

Consumption post-implementation

3. HVAC SYSTEMS

HVAC systems are responsible for about 70% of a building's energy consumption, and they are the primary focus of energy efficiency activities.

TECHNOLOGY

Efficient technologies focus on improving system performance.

Measures include:

- AC - VRF System
- AC - Inverter Split
- AC Compressor Optimisation Retrofit
- Refrigerant Additive
- Evaporative Cooling For Chiller
- DC Motors for FCUs
- Evaporative Cooling

CONTROL

Control technologies help manage energy by optimising system controls.

Measures include:

- Programmable thermostats
- Smart Thermostats
- Chiller Plant Manager (CPM)
- VFDs/VSDs for AHUs & FAHUs
- VFDs/VSDs For Chilled Water Pumps
- Differential Pressure Optimisation
- Carbon Monoxide Sensors for Basement Exhaust Fans
- Timers for Exhaust Fans

TYPES OF COOLING SYSTEMS

Primarily, three types of cooling technologies are used:

DIRECT EXPANSION

Also known as DX systems, these use the refrigerant cycle to directly cool air from the evaporator. These include:

- Window-mounted air conditioners
- Split air conditioners
- Inverter Split units
- Variable Refrigerant Flow (VRF) units
- Packaged AC
- Ducted split- air conditioners

CHILLERS

These systems use the refrigerant cycle to cool the water that in turn cools the air via air-side equipment.

Essentially all chillers will produce chilled water that cools the air inside in the building.

The condenser of the chiller itself needs cooling. In case the condenser of the chiller is cooled using air, the chiller is classified as an air-cooled chiller.

In case the condenser of the chiller is cooled by water, the chiller is classified as a water-cooled chiller.

DISTRICT COOLING

District Cooling Providers (DCP) provide chilled water to a group of buildings.

This chilled water, which is transported in insulated underground pipes, cools the buildings through the use of a heat exchanger.

The heat exchangers and secondary pumps are in customers' buildings, which provide chilled water to the local building circuit.

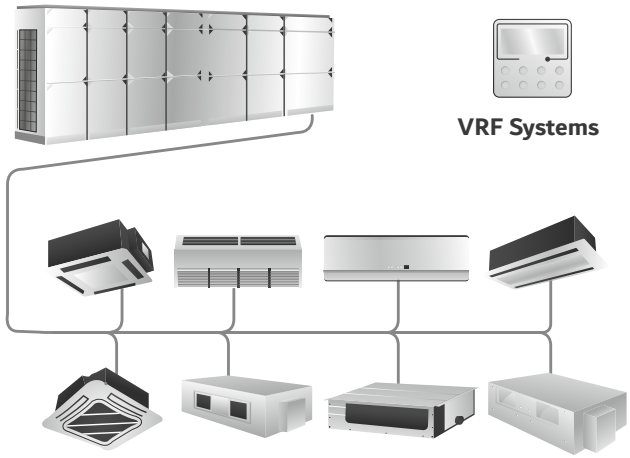
Generally, large water-cooled chillers are used, in district cooling plants.

AC - VRF SYSTEM

DESCRIPTION

Variable Refrigerant Flow (VRF) systems are the latest technological advancement in Direct Expansion (DX) air conditioners. The basic principle of operation is that the compressor operates according to the load requirement, as it is installed with variable speed drive and able to regulate refrigerant flow rather than simply perform ON/OFF operations.

Typically, these units usually have multiple indoor units installed on a single outdoor unit.



When to apply

- In buildings with multiple zones that require different temperatures (such as open offices, hotels, sports arenas, schools).
- In buildings that use roofs for other purposes and cannot accommodate large units.

Things to consider

- Malfunction of the outdoor unit results in failure of complete HVAC operation in all connected zones. A proper maintenance schedule can help to reduce this risk.

BUILDINGS WHERE THEY CAN BE APPLIED

INDUSTRIAL

GOVERNMENT & COMMERCIAL

RESIDENTIAL

POTENTIAL SAVINGS

Maximum savings

Consumption post-implementation

AC - INVERTER SPLIT

DESCRIPTION

Inverter split air-conditioning systems have become increasingly popular due to their energy efficiency and cooling performance

This type of compressor uses a variable speed drive to control the compressor motor speed to modulate cooling capacity, instead of turning the compressor motor ON and OFF. Capacity modulation is a way to match cooling capacity to cooling demand. Such variable control provides the correct amount of cooling at every point in time, resulting in less energy waste and more accurate temperature control.

These types have one indoor unit to every outdoor unit.

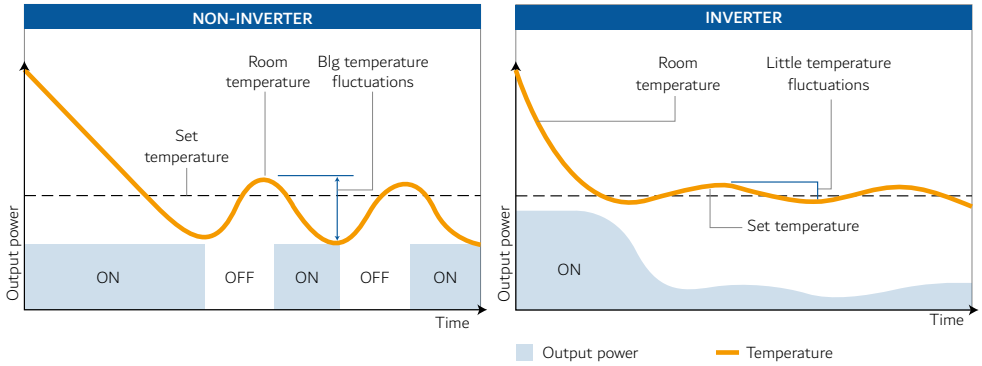
When to apply

- When the current indoor temperature fluctuates considerably due to on/off controls.

Things to consider

- Require regular maintenance to maintain their efficiency.

PERFORMANCE COMPARISON



BUILDINGS WHERE THEY CAN BE APPLIED

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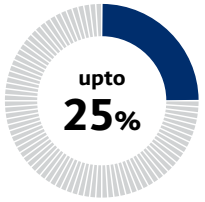


Maximum savings

Consumption post-implementation

AC COMPRESSOR OPTIMISATION RETROFIT

DESCRIPTION

AC compressor optimisation devices are retrofitted to the compressors of existing ACs.

These devices are sensor-driven and have software algorithms designed to optimise compressor operations.

Savings are made by reducing the overall runtime of the compressor, without changes in the comfort conditions of the rooms.

These retrofits are usually installed on split or window air conditioners.

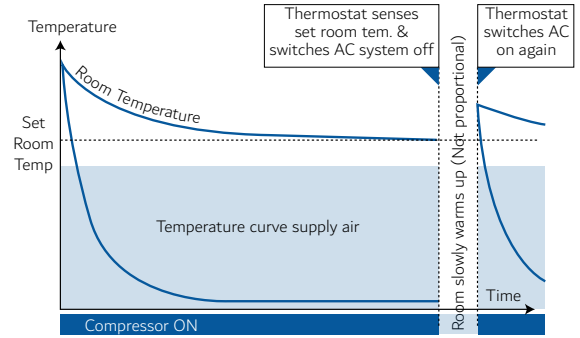
When to apply

- When the DX units with fixed-speed compressors are not old, compressor optimisation is a cost-effective way to increase cooling system efficiency. This approach provides better control over compressor operation and costs less than replacing existing units with new inverter-type units.

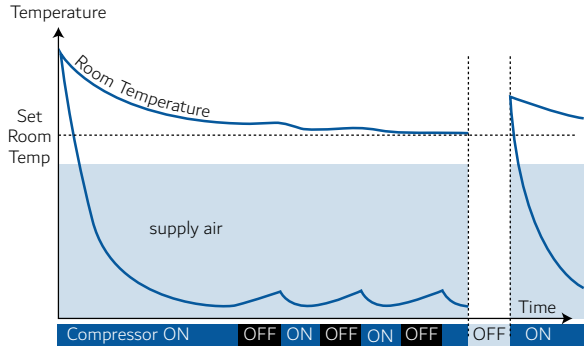
Things to consider

- An expert should install these devices because they interfere with the default logic of the AC units.

BEFORE OPTIMISATION



AFTER OPTIMISATION



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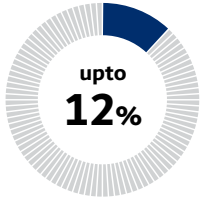


Maximum savings

Consumption post-implementation

REFRIGERANT ADDITIVE

DESCRIPTION

Refrigerant additives are oil additives for the refrigerant cycle in DX systems and chillers. They are chemicals that dislodge the layer of stagnant sludge that builds up inside the refrigerant's pipeline. It then forms a protective coating to reduce the possibility of future build-ups of sludge.

This will enhance the condenser's heat transfer capacity and lead to higher efficiency.

Oil fouling of heat transfer surfaces of air conditioning and refrigeration systems will cause a loss in efficiency of approximately 7% in the first year, 5% in the second year and 2% per year in the following years, up to a peak degradation of between 20% and 30% (ASHRAE Handbook, Refrigeration, Chapter 2.9.).

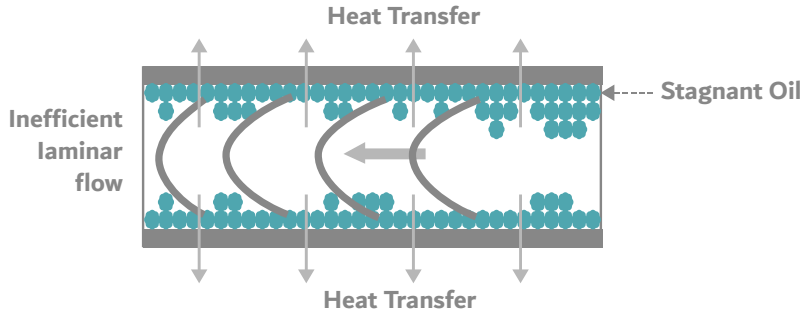
Accordingly, using refrigerant additives will help to avoid the deterioration of the efficiency of cooling equipment – chillers, package units, split units and big refrigerators – and can save up to 10% of their consumption.

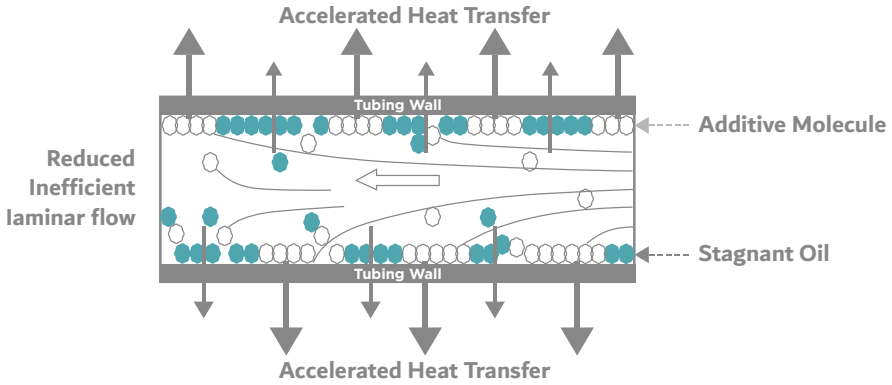
When to apply

- Equipment with a lifetime beyond five years
- Equipment with little maintenance/cleaning in its refrigerant coils
- Equipment with poorly sealed compressor chambers
- Equipment with visible oil sludge layers in its refrigerant coils

Things to consider

- This retrofit is complementary to regular maintenance and does not replace servicing the units in any way.





BUILDINGS WHERE THEY CAN BE APPLIED

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POTENTIAL SAVINGS

Maximum savings

Consumption post-implementation

EVAPORATIVE COOLING FOR CHILLER

DESCRIPTION

Evaporative cooling devices are retrofits for existing air-cooled chillers. These create a cooler micro-climate around the chiller by spraying fine droplets of water in a controlled manner onto specialised material surrounding the unit, resulting in cooler condenser air inlet temperatures. The ideal condition for retrofitting is a high-temperature difference (T) across the evaporation device. This is common in areas with low relative humidity and high-temperature microclimates.

Evaporative cooling systems should be linked to chiller operations and operate under the following conditions:

- Ambient temperature 28°C: start operation
- Relative humidity 70%: stop operation

There are two types of cooling systems:

- **Misters** produce a mist (droplets of water) on to a mesh that cools the air.
- **Wet Walls** are walls made up of special materials. Water passes over these walls, which surround the chillers. As air passes through them, it cools.

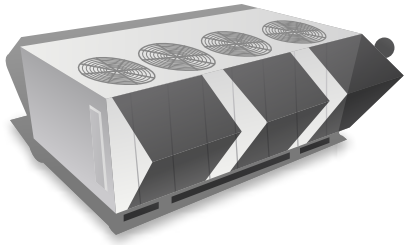
When to apply

On air-cooled chillers, located in microclimates with low relative humidity and high ambient temperatures. This measure performs better inland and in desert areas away from coasts.

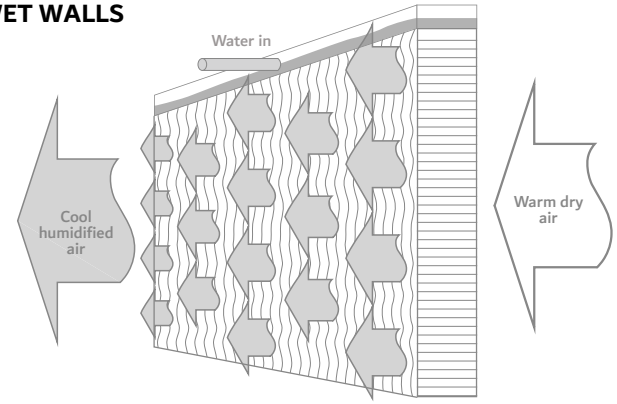
Things to consider

- The electricity savings must outweigh the additional water consumption of the evaporative system (wet wall/mister).
- Due to the wet environment created by evaporative systems, regular maintenance is required to prevent corrosion of the units.

WATER MIST



WET WALLS



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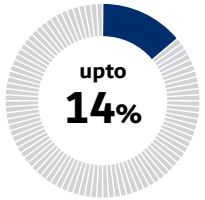
POTENTIAL SAVINGS



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DC MOTORS FOR FCUs

DESCRIPTION

The DC (direct current) motor saves energy in terms of the capacity of the motor, and its control is as follows:

1. For the same airflow output of the FCU (fan coil unit), DC motors use 30% less energy compared to conventional AC motors. DC motors are available with built-in converters and can replace existing AC motors.

2. DC motors can be controlled to a greater degree of precision. They can integrate with Building Management Systems and operate at variable speeds depending on demand and load.

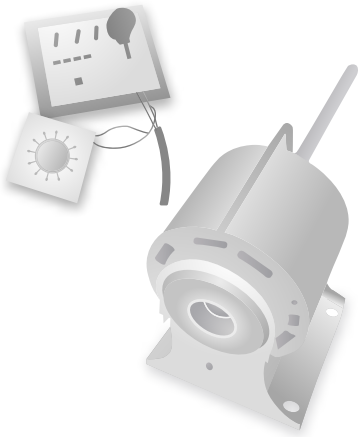
When to apply

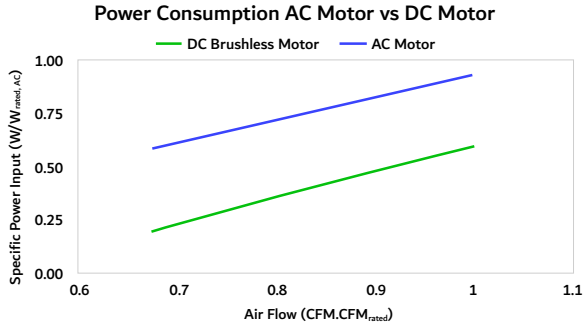
- DC motors are best in applications that require variable speed control since speed control is achieved with a minimal increase in cost compared to that of AC motors.

- DC motors for FCUs are ideal for constant load conditions that require fine speed control. These motors exhibit their best capabilities under such conditions, providing temperature control by modulating the cooling load.

Things to consider

Another benefit of DC motors is that they have a faster response time than do AC motors due to their higher initial power. Thus, it is crucial to consider this trait when designing a system.





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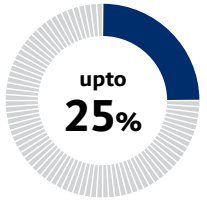

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EVAPORATIVE COOLING

DESCRIPTION

Evaporative cooling is a cooling system that uses water evaporation to cool the air, without the need for refrigerant gas or a compressor as in traditional air conditioners. It draws in outside air and passes it through water-soaked filters. When the water evaporates, the air temperature drops, and then the cool air is pumped inside. It consumes much less electricity, is environmentally friendly (does not use industrial refrigerant gases like Freon), and has a low cost.

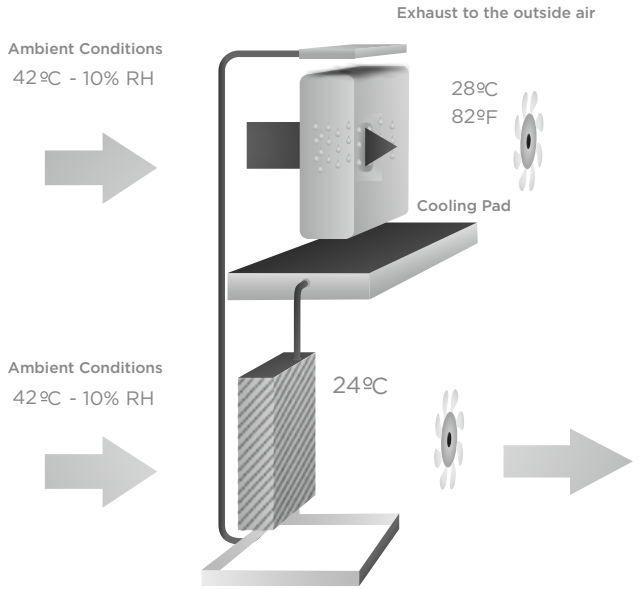
There are three types of evaporative cooling, and they are as follows:

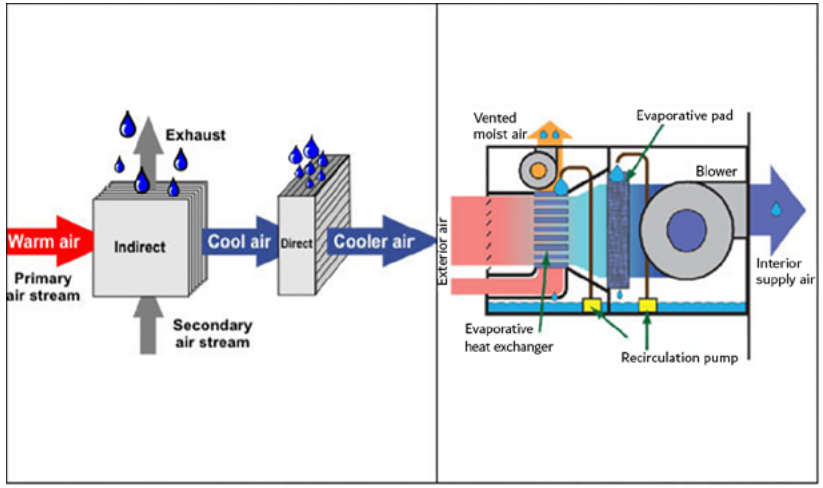
1. **Direct Evaporative Cooling with Auxiliary Refrigeration**

   - **Description**: This system uses a standard evaporative cooler but includes an auxiliary refrigeration component. The refrigeration unit kicks in when additional cooling is needed, such as during very hot or humid periods.
   - **Application**: Suitable for areas with occasional high humidity or extreme heat where traditional evaporative cooling might fall short.

2. **Indirect Evaporative Cooling**

   - **Description**: This system pre-cools the incoming air using evaporative cooling, but it doesn't mix this air directly with the indoor air. Instead, the cooled air is used to cool a secondary air stream that is then introduced into the living space.
   - **Application**: Effective in areas where outdoor humidity is high. It provides better temperature control and can maintain cooler indoor temperatures without introducing excessive humidity.





3. Direct-Indirect Hybrid Systems

- **Description**: Combines both direct and indirect evaporative cooling in one system. It uses indirect evaporative cooling to pre-cool the air and direct evaporative cooling to further cool the air before it is delivered into the space.
- **Application**: Useful in areas with varying climate conditions. It offers versatility and can be adjusted according to the current weather conditions.

When to apply

- In locations with dry summer seasons. However, they can also be utilised in moderately humid, hot conditions. Outdoor areas (workshops, barns, and playgrounds).

Things to consider

- Before selecting an EC for cooling a building, consider the climate conditions, the size of the building, the cooling load and the water requirements.
- IECs are not as effective as traditional air conditioning systems in humid climates. They struggle to maintain indoor humidity levels. Therefore, traditional air conditioning systems may be more suitable in such cases.
- A proper maintenance schedule is essential to overcome the loss in efficiency of evaporative systems due to dust/sand accumulation, corrosion, and other similar environmental issues.

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PROGRAMMABLE THERMOSTATS

DESCRIPTION

Programmable thermostat is a device that replaces the traditional thermostat in air conditioning systems, allowing you to set different temperatures at different times of the day according to a pre-determined schedule to make sure that the temperature is at optimum energy-saving levels.

Some of the products can also allow the customer to centrally monitor all AC operations and consumption over a smartphone or PC.

When to apply

- Timer-based thermostats are suitable for buildings with regular occupancy schedules such as offices. In contrast, occupancy-based thermostats are best for irregular schedule locations.

Things to consider

- It is important to install the thermostat in a location with a representative temperature of the space that is being sensed.
  - It should be away from drafts, windows, doors, vents or direct sunlight.
  - Ensure that the thermostat is not obstructed by furniture, curtains or other objects that may block its ability to sense the space temperature.
- The thermostat should be programmed to have a setpoint and setback according to the cooling needs.
- Not all HVAC systems are compatible with programmable thermostats. It is important to check whether the system can work with the thermostat intended to be purchased.

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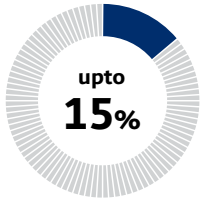

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SMART THERMOSTATS

DESCRIPTION

Smart thermostats help regulate home temperatures, enhance indoor comfort and save energy at home. Unlike programable thermostats, Wi-Fi-enabled devices can be controlled remotely via an app or voice commands with learning and self-programming capabilities. They maintain the temperature according to occupants' preferences, as well as automatically turn down the heat when they are away, and adjust the temperature when they are sleeping.

Smart thermostats optimise the use of air conditioning without user intervention, considering what they have learnt about the occupants' preferences, the house's thermal performance and the weather. They also track and analyse energy usage and provide suggestions to increase cooling energy savings.

Additionally, they can be seamlessly integrated with other smart home devices and share information with them. Depending on the model, they can offer many different features, such as geofencing, which allows them to know when the occupants are on the way home and automatically adjust the temperature to their liking.

When to apply

- When occupants need a control device to learn about their preferences, house thermal preferences and weather conditions.
- When occupants need to track the energy usage of their AC.

Things to consider

- Smart thermostats are generally more expensive than programmable thermostats but offer more features and potential energy savings.
- Before installing smart thermostats in small businesses, it is important to consult with an IT representative about the use of Wi-Fi and Bluetooth devices.

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CHILLER PLANT MANAGERS (CPM)

DESCRIPTION

Chiller Plant Managers (CPM) can be installed independently or with a BMS. They manage the chillers and improve their operational efficiency. Their functions include:

- **Chiller operation scheduling and sequencing**: this is based on run time and loading.
- **Loading management and load balancing**: this maintains equal loading for all operating chillers.
- **Dynamic chilled water supply set-point resetting**: this depends on load, so as to maintain delta T.
- Managing Primary and secondary pump operations.

When to Apply

- This approach works well when the HVAC system's chillers, pumps, and fans are fitted with VFDs/VSDs.
- A higher potential of savings is expected in systems where different-size chillers are installed so that the loading of the chillers is optimised with chiller sequencing.
- Where there is a high variation in cooling load requirements.

Things to consider

- The chiller plant manager (CPM) operator should ensure that all the equipment is operating close to its best efficiency point while considering interactions with other equipment. This approach guarantees that the entire plant is running at its best capacity, as opposed to individual pieces of equipment.
- Chiller plant manager software can be complex, and a learning curve may be required for operators and facility managers to use all its features effectively.
- Before selecting chiller plant manager software, verify that it is compatible with all existing chiller systems and whether retrofitting or upgrading is needed.
- Relying on software for critical operations means that the system may be vulnerable to technology failures, such as software bugs, connectivity issues, or cyberattacks.

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VFD/VSD FOR AHUs & FAHUs

DESCRIPTION

Variable Frequency Drives (VFD) or Variable Speed Drives (VSD) are installed on the supply fan of the Air Handling Units (AHUs) and Fresh Air Handling Units (FAHUs) to operate the fan at variable speeds according to a varying schedule or demand. This helps reduce unnecessary running of AHUs and FAHUs. This reduces consumption. It also indirectly affects/ reduces the chillers' consumption.

The VFD / VSD can be installed with feedback from field temperature sensors or CO_2 sensors to maintain CO_2 concentration in the recommended range of 800 parts per million (ppm).

The VFD / VSD can be installed in a stand-alone configuration or can be installed and managed using a Building Management System.

When to apply

- On fixed-speed AHUs and FAHUs that serve areas with variable modulating flow needs (such as changes in occupancy with time).
- On equipment that was oversized by design and whose current flow exceeded the real needs of the existing occupants.

Things to consider

- As a rule of thumb, VFDs/VSDs should not operate below 40% of the speed of the equipment (20 Hz).

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VFD/VSD FOR CHILLED WATER PUMPS

DESCRIPTION

Installing Variable Frequency Drives (VFD) or Variable Speed Drives (VSD) on Chilled Water Pumps (primary, secondary, etc.) allows them to operate at variable speeds according to a varying schedule or demand. Demand is sensed using a differential pressure sensor between the chilled water supply and the return header. The differential pressure will change according to the demand in the case of a system installed with two-way valves. In other cases with BMS, other feedback inputs like delta T can also be added to govern the VFD / VSD operation.

This helps to reduce both unnecessary running and consumption of the chilled water pumps.

When to apply

Different setups of chillers, pumps, and cooling units can use VFDs (Variable Frequency Drives) to save energy.

Optimized design:

Fixed-speed chiller, fixed-speed primary pumps, and distributed variable-speed pumping will result.

1. Efficient for both chillers and pumps.
2. No low delta T problems.

Things to consider

- When using or adjusting VFDs in chilled water pumps, always consider the chiller's specifications and how it interacts with the pumps to provide variable cooling..
- Changing the flow also changes the pressure. After any changes, make sure the pressure is enough to overcome the water network's pressure loss.
- As a rule of thumb, VFDs/VSDs should not operate below 40% of the speed of the equipment (20 Hz).

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DIFFERENTIAL PRESSURE OPTIMISATION

DESCRIPTION

In cooling systems that rely on pumping cold water, there must be a specific pressure difference/differential pressure (DP) between the start and end of the water line to ensure efficient water flow to all parts of the building.

Differential pressure optimisation slows the operation of chilled water pumps, without any resulting cooling issues, for the best performance and the lowest energy use.

The differential pressure in the line ensures the optimum speed operation of the VFD/VSD. As the load decreases, the Differential Pressure (DP) also decreases. This means that VFD/VSD reduces pump speeds to maintain the set-point of the DP.

DP set points can be over-engineered, so it is necessary to check the DP setting to avoid unnecessary running of the chilled water pumps.

In this case, it is best to install a DP sensor in the line and link the sensor to the chilled water pump VFD/VSD. To optimise the differential pressure, the best thing to do is manually reduce its setting to achieve the lowest possible speed that meets users' cooling requirements. Repeat this process twice a year.

When to apply

- This approach works well in situations where chilled water circuits are transported to larger distances and the cooling load requirement variation is considerable. For example, when the cooling required in the nearest FCU/customer in the chilled water circuit is low or zero, the cooling required at the far end is high.

Things to consider

- Differential pressure optimisation can be complex and may require the expertise of experienced engineers or technicians. Calculating the correct differential pressure, setting up appropriate control systems and ensuring that pressure differentials are maintained within specified tolerances can be challenging.

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CARBON MONOXIDE SENSORS FOR BASEMENT EXHAUST FANS

DESCRIPTION

Carbon monoxide is a toxic and odorless gas produced by vehicls in enclosed parking garages, posing a health risk. Therefore, ventilation fans are used to expel this gas, but running the fans all the time consumes a lot of energy.

Exhaust fan automation systems based on carbon monoxide (CO) sensors modulate their operation depending upon CO concentration inside the basement car park and only run the fan when required. These systems are available as stand-alone systems or can be integrated with the existing BMS system.

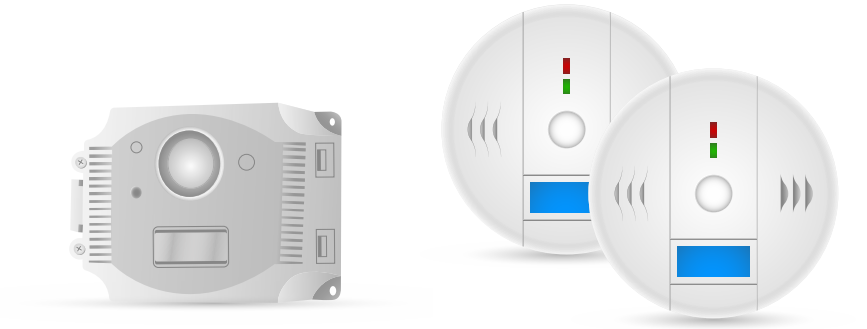
CO concentration should be maintained within the limitation of the applicable building regulations.

When to apply

- Car park exhaust fans with little control over their operation
- CO sensors enable compliance with health and safety regulations in the most efficient way.

Things to consider

- Users should not turn off fans to save energy, which puts occupants at risk and is against regulations. Automating the operations of exhaust fans based on CO sensors enables the reduction of energy waste, as well as supports compliance with required CO levels and the maintenance of healthy and safe basements.
- To check and recalibrate the CO monitoring equipment in line with the manufacturer's specifications.
- CO monitoring equipment must be installed, with at least one CO sensor per 400 square metres of parking area.
- An audible alarm should be triggered when the CO concentration reaches or exceeds 75ppm in at least 5% of the monitored locations.



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Consumption post-implementation

TIMERS FOR EXHAUST FANS

DESCRIPTION

Timers are a very low cost and effective solution to control the operation of exhaust fans. The exhaust fans can be switched off when not in use, such as at night or early morning.

When to apply

- On fans that need to be operated during specific hours, such as those serving industry processes.
- Control based on present CO sensors is more effective for exhaust fans with variable time and duration requirements.

Things to consider

- With dangerous fumes, timers for exhaust fans should be complemented with other kinds of sensors that ensure safe operation at all times

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4. WATER SYSTEMS

This section presents techniques of efficient water systems.

TECHNOLOGY

Efficient water management measures use the following technologies.

- Low-flow fixtures
- Sensor-controlled faucets

LOW-FLOW FIXTURES

DESCRIPTION

Most water-flow reducers are aerators. They mix air and water to maintain the pressure and to reduce water consumption. They can be installed on the faucet. Inline aerators can be installed directly in the water supply line. Currently, aerators with flow rates as low as 2 litres per minute (LPM) are available.

Water flow reducers can be installed in faucets, showerheads, and toilets.

Water flow rate values as per Dubai Building Code are as follow:

Fixture Type	Maximum flow rate permitted by Dubai Building Code
Showerheads	8 litres/min
Hand washbasins	6 litres/min
Kitchen sinks	7 litres/min
Dual flush toilets	6 litres/full flush
	3 litres/part flush
Urinal	2.4 litres per flush in non-public facilities
	1 litre per flush or waterless in public facilities

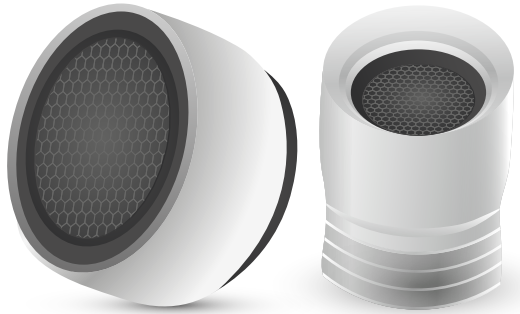
The flow rates identified in the table are the maximum recommended flow rates. In practice, it is recommended to use further efficient (minimum) market available flow rates, as applicable.

When to apply

- Low-flow fixtures should be installed in all daily sanitary fixtures while prioritising those with the highest operating demand.

Things to consider

- Low-flow fixtures should be maintained regularly to avoid debris accumulation that can lead to clogging.



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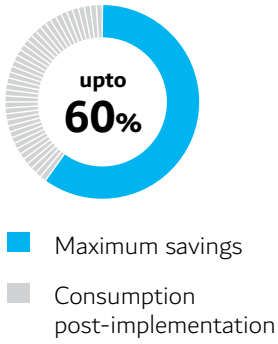

SENSOR-CONTROLLED FAUCETS

DESCRIPTION

Sensor-controlled water faucets are an efficient way of limiting the overuse of faucets. These devices automatically cut off the water flow from the faucet, either after a lack of motion or a set time.

Sensor-controlled faucets optimise operation times and reduce water consumption by up to 30%. However, if these faucets are combined with an aerator (low-flow device), the savings can reach 55%.

Sensor-controlled faucets offer additional advantages, such as reducing the spread of bacteria and viruses and facilitating handwashing for people of determination.

When to apply

- Sensor faucets are especially practical for highly populated buildings.

Things to consider

- Sensor faucets can be more expensive than traditional models upfront.
- Some models require electrical connections to other batteries, which might require occasional replacement or maintenance.
- Improperly adjusted sensors can be overly sensitive or unresponsive, leading to frustration.

BUILDINGS WHERE THEY CAN BE APPLIED

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5. BUILDING ENVELOPES

This section presents technological measures for building envelopes - the elements of the outer shell that maintain proper isolated indoor environment and facilitate its climate control.

TECHNOLOGY

There are three technological measures for building envelopes:

- Paint-based insulation and coatings
- Advanced window control
- Window film

PAINT-BASED INSULATION & COATING

DESCRIPTION

Paint-based insulation and coatings are sprayed or painted on to walls and the roofs of buildings to improve their thermal performance. With increased wall insulation, the heat load of the building reduces and leads to savings on HVAC loads.

Insulation coating:

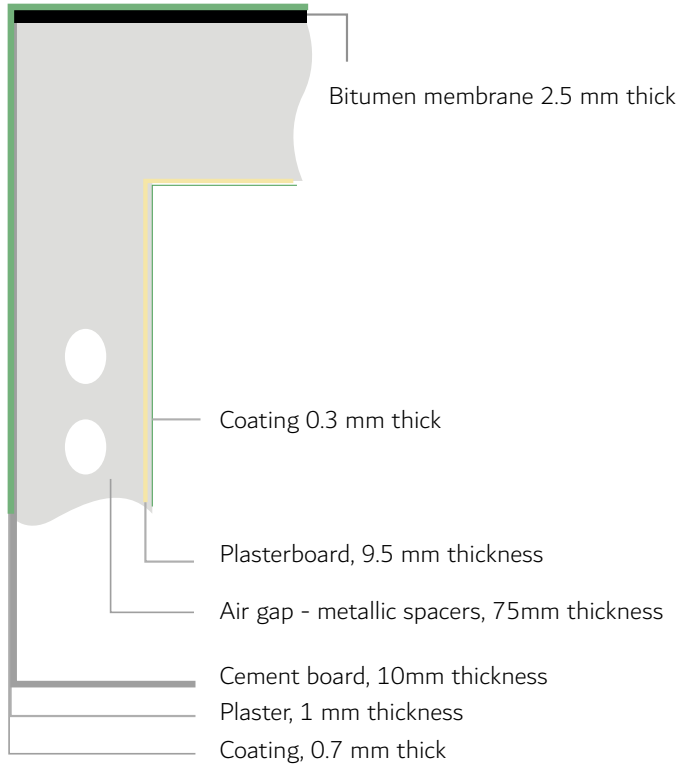
- Increases wall insulation
- Reduces degradation of building elements resulting from excessive heat
- Protects against moisture, thermal bridging and conduction

When to apply

- This solution is best for surfaces that create a barrier between the outdoor environment and temperature-controlled indoor spaces. Their most common application is roofs and external walls.
- They are especially helpful on surfaces that receive a high amount of solar radiation due to their high reflectivity.

Things to consider

- Paint-based insulation and coatings were not designed to replace traditional insulation, and they cannot. However, they can complement and enhance the thermal resistance of walls and roofs.
- Soiling and ageing reduce their reflectivity.
- The longevity of paint-based insulation and coatings depends on their exposure to wear and tear due to the environment or activities around them.



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ADVANCED WINDOW CONTROLS

DESCRIPTION

These new highly insulated windows use sensors and microprocessors to automatically adjust shade based on available sunlight and the time of day. This provides the proper lighting and comfort, and saves energy and money.

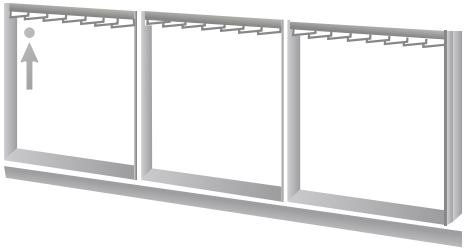
When to apply

There are multiple types of dynamic glazing. The choice will depend on the project budget and requirements.

- Electrochromic glazing is recommended when a colour change is needed. It can take 15 minutes for tinting to occur. Nevertheless, this approach is the most energy-efficient because the voltage needed for tinting is minimal.
- Gasochromic glazing is also recommended when a colour change is needed. This type of glazing responds very quickly. However, it is a complex and expensive multilayer design.
- Liquid-crystal glazing (LCG) can also be used to change the glazing from transparent to opaque. Therefore, this technology is recommended for controlling privacy. LCG is also an expensive option. It may appear slightly hazy when opaque and have less clarity than regular glass when transparent.

Things to consider

- Retrofitting using dynamic glazing has a high cost and might require the replacement of the whole window.



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WINDOW FILM

DESCRIPTION

Window film is a thin laminate installed on the interior or exterior of glass in buildings. It is a thermoplastic polymer resin made from polyester. It is used because of its clarity, tensile strength, dimensional stability, and ability to accept a variety of surface-applied or embedded treatments.

Films applied to the interior of flat glass windows reduce heat and the amount of infrared and visible light and ultraviolet radiation entering through the windows.

Due to their heat-insulating properties, window films reduce the thermal load of the building and minimize energy. The savings potential depends on the window-to-wall ratio of the building and the orientation of the application window.

When to apply

- Recommended when there is a need to improve thermal insulation, increase occupant comfort and improve building aesthetics.
- The application of window films should be prioritised based on window exposure to sunlight. For instance, windows at the south and west facades should be a priority compared to the northern facade given the lower solar exposure throughout the year.

Things to consider

- The longevity of the window film depends on its application (interior or exterior); whether the glazing is vertical (such as regular windows) or horizontal (such as skylights or atriums); window orientation, which allows films applied in east-facing windows to last longer than those in the south of the building; and the quality of application of the film, as well as the methods and sealants used.

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6. OTHER MEASURES ON EFFICIENT USE OF ELECTRICITY

This section covers general technologies for reducing electricity use.

TECHNOLOGY

- Energy management systems
- Heat pumps for swimming pool

OTHER MEASURES ON EFFICIENT ELECTRICITY USE

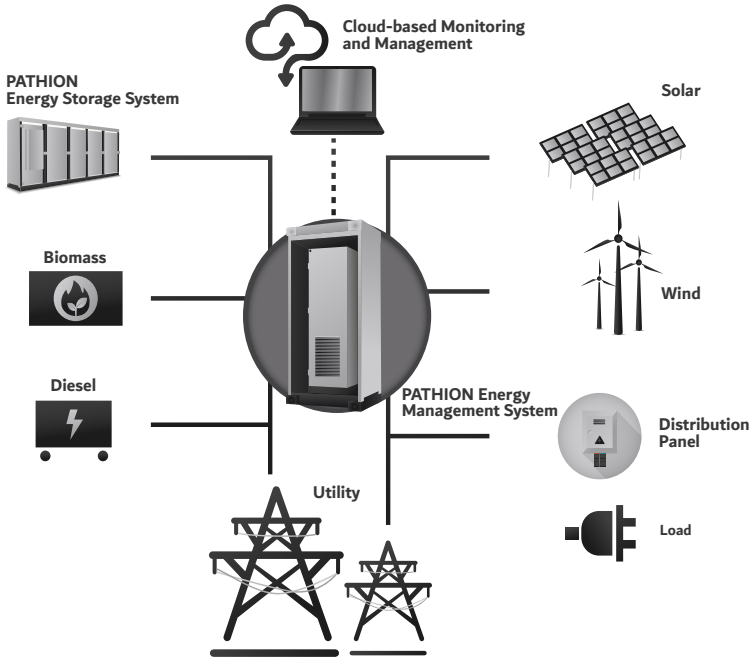
ENERGY MANAGEMENT SYSTEMS

DESCRIPTION

Energy Management Systems are comprehensive integrated energy-management software that are web-based with some peripheral hardware, such as non-invasive transducers. They measure electrical use and help to establish best practices across all energy functions, including energy monitoring, scrutiny and surveillance. Some EMS do not come with equipment controls. This means they require a building management system to operate them.

The EMS software collects data from the electricity used in buildings to analyse operational consumption patterns and identifies ways to reduce it when used inefficiently, or unnecessarily. As well as reducing electricity bills, a BMS can help prolong the life of electrical equipment in buildings.

This system can be installed independently or integrated with existing BMS.



When to apply

- Energy management systems are often employed in Government, Commercial, Industrial and Educational institutions buildings for energy savings.
- Energy management is vital in data centres to maintain optimal temperature and humidity levels while minimising energy use to keep servers and IT equipment functioning efficiently.

Things to consider

- Implementing an energy management system, particularly for smaller businesses or homeowners, can be expensive. The cost includes hardware, software, installation and training.
- Energy management systems can be complex, and their set-up and operation may require technical expertise. This can be a barrier for some users.
- Ensure to select an energy management system compatible with the existing equipment.
- **Maintenance**: Energy management systems require regular maintenance and updates to ensure that they function optimally.
- **Limited control**: In some cases, an EMS may not provide the desired level of control, particularly when fine-tuned adjustments are necessary.

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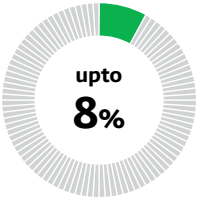

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OTHER MEASURES ON EFFICIENT ELECTRICITY USE

HEAT PUMPS FOR SWIMMING POOL

DESCRIPTION

Pool heat pumps can cool as well as heat water. When heating water, pool heat pumps transfer the heat from the ambient air surrounding the unit to the water. When cooling it, the pumps remove the heat from the water.

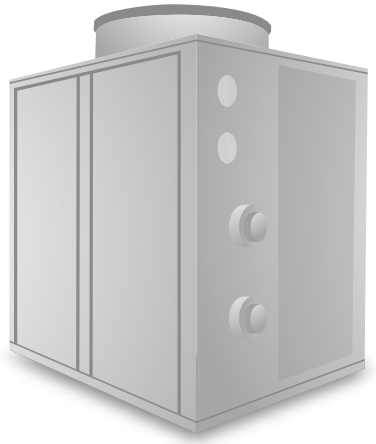
Generally, heat pumps are more expensive than normal gas or resistance electric heaters. However, the cost to run a heat pump is dramatically lower than the gas or electric heater.

When to apply

- Heat pumps are an excellent option for replacing electric resistance-based heaters due to their high energy efficiency.
- They are preferrable when both cooling and heating capabilities are desired.

Things to consider

- Heat pumps are generally more energy-efficient than electrical and gas heaters.
- They can be combined with a solar pool heating system to further optimise its energy efficiency and provide consistent heating under varying conditions.
- Heat pumps typically heat pool water more slowly than gas heaters.
- Heat pumps can be relatively large and may require more space for installation than other cooling and heating methods.



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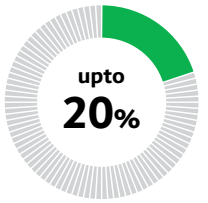
POTENTIAL SAVINGS



Maximum savings

Consumption post-implementation

7. NEXT STEPS

We hope that you have found these explanations of the various efficient electricity and water management measures useful and informative.

If you are considering installing or implementing any of these measures, we do recommend that you arrange for a feasibility study for your premises.

If you need a comprehensive solution starting from energy auditing to performance contracting, such as financing, implementation, operation, maintenance and saving guarantee, you should approach specialised energy service companies like **Etihad ESCO.**

الاتحاد
Etihad
لخدمات الطاقة
Energy Services

CONTACT DETAILS OF ETIHAD ESCO

Address

Etihad Energy Services Company (Etihad ESCO)
PO Box. 37578, Dubai, United Arab Emirates.

TEL: +971 (0) 4 820 9066
https://etihadesco.ae

Additional tips

You can also find low and no-cost energy efficiency tips on our website, which outlines the sustainable habits and best practices, at:

https://www.dewa.gov.ae/en/consumer/Sustainability/sustainability-and-conservation

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