



# RENEWABLE ENERGY SERIES



HOTEL  
ENERGY  
SOLUTIONS



## Key Renewable Energy (RE) Solutions for SME Hotels

Hotel Energy Solutions Official Partners



Supported by





# KEY RENEWABLE ENERGY (RE) SOLUTIONS FOR SME HOTELS



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## Hotel Energy Solutions (HES) Project Basics

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## Hotel Energy Official Partners



## Project Supported by





# KEY RENEWABLE ENERGY (RE) SOLUTIONS FOR SME HOTELS



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## Introduction to the database

The purpose of this report is to give a detailed description of the renewable energy solutions that have been identified for application in SME hotels. The resulting 11 datasheets constitute the database of renewable energy solutions that is to be provided by the HES (Hotel Energy Solutions) project.

### *Renewable Energy solutions identified*

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11 key renewable energy solutions have been identified for application in SME hotels. To avoid being redundant, different technologies with a same approach (e.g. wood pellet and wood chip) have been included under a same datasheet. They are listed below.

- *Key RE solution n°I* Biomass
- *Key RE solution n°II* Combined Heating and Power (CHP)
- *Key RE solution n°III* Geothermal Energy
- *Key RE solution n°IV* Solar photovoltaic electricity systems
- *Key RE solution n°V* Solar thermal energy – Solar COMBI systems
- *Key RE solution n°VI* Solar thermal energy – Solar COMBI+ systems
- *Key RE solution n°VII* Solar thermal energy – Domestic Hot Water Systems (DHWS)
- *Key RE solution n°VIII* Swimming Pools
- *Key RE solution n°IX* Wind energy
- *Key RE solution n°X* Micro Hydro Power
- *Key RE solution n°XI* Deep Water Cooling

## About investment costs and return on investment estimates

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### a) Investment costs

Assessing the investment costs of EE and RE solutions is difficult because they depend on many parameters, including the following:

Equipment *prices* vary among suppliers and among countries, they are not always available (not all suppliers wish to give their prices) and they need to be updated regularly as they evolve quickly.

*Installation costs* vary greatly between countries (due, for example, to differences in labour costs). Those costs also depend greatly on whether the installation work requires shutting down the hotel or not.

The *legal framework* also affects investment costs significantly, depending on whether there are any national/local grants, tax credits or subsidy schemes (for example, in France, there are tax credits when implementing RE and EE technologies provided the system is installed by a professional). Legal frameworks are often complex, very different from one country to another, and evolve quickly with time. Also, advantageous incentives may sometimes introduce variation in prices, in particular for non-mature markets.

### b) Return on investment

Return on investment is also difficult to estimate because it depends on the following parameters:

*investment costs*: as seen previously, investment costs depend very much on the local context,

*maintenance costs*: like installation costs, maintenance costs vary greatly between countries, due to differences in labour costs.

*cost savings induced by energy savings*: these cost savings are directly dependent on energy prices. Energy prices fluctuate greatly with time (as shown by the volatility of oil prices since 2007) and are very different from one country to another. Moreover, energy savings are themselves rough estimates – they depend greatly on the hotel's initial situation and on the behaviour of its users.

For all these reasons, it was decided not to focus on presenting *investment costs* and *return on investment*: even though some information is provided on these two data (in the form of an approximate cost and an approximate number of years), it is explicitly written for each solution that: "*costs and return on investment may vary greatly depending on the local context and on the hotel's initial situation*".

in any case, the prices may be considered as closely linked to the ease of implementation ranking from "easy" to "difficult" [equivalent to cheap (\*), medium (\*\*), expensive (\*\*\*)]. We therefore recommend stressing the *ease of implementation ranking* in the solution provider that is to be developed.

We also recommend presenting as priority the *end-use* the solution relates to (space heating, hot water production, lighting...) as this type of information may be quite relevant to the hotelier for prioritizing the solutions.

The hotelier can then refer to the information on the *potential energy savings* to estimate roughly the costs savings that can be obtained by implementing the solution (based on the energy price that applies to his hotel).

He can also read about the rough estimate of *carbon emission reduction* (expressed in teq CO<sub>2</sub>) resulting from the solution (this information is provided in order to raise his awareness of the environmental benefits provided by the solution).

## Assumptions underlying the evaluation of carbon emissions reduction

Carbon emissions reduction resulting from the implementation of the solutions has been evaluated roughly from the data on energy savings, given some hypotheses on the size of the hotel and certain annual energy consumption and according to French carbon emission factors.

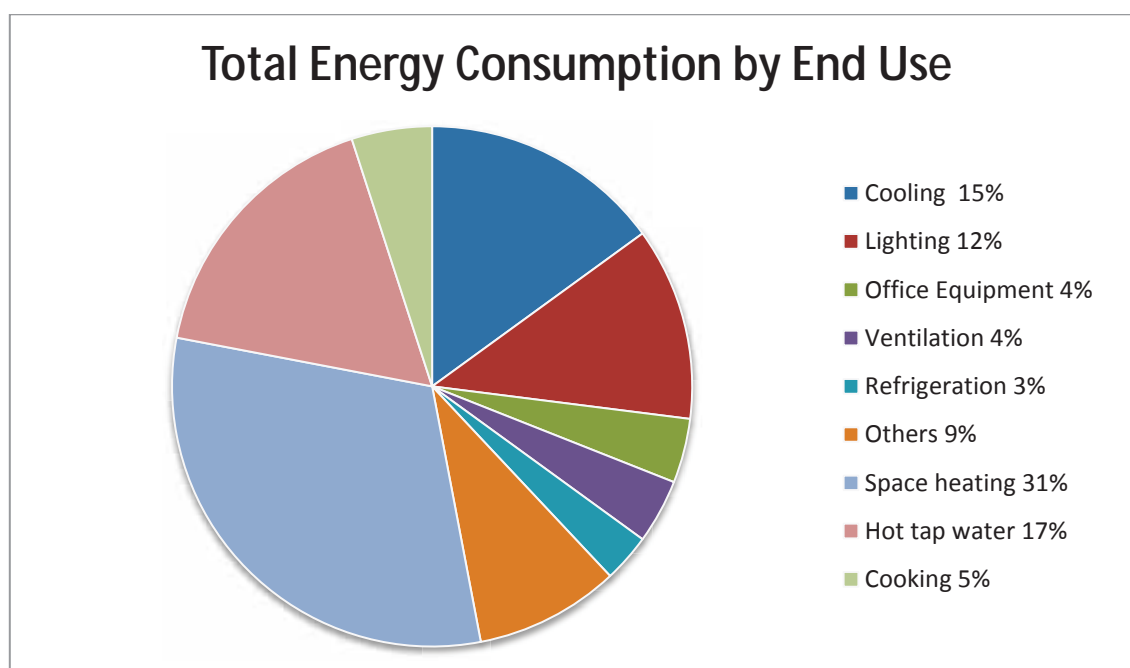
### a) Hypothesis on the hotel size and on its total energy consumption

A hotel with a 1,000 m<sup>2</sup> surface and with an annual energy consumption of 250 kWh/m<sup>2</sup> has been assumed. This energy consumption is representative of small hotels (<50 bedrooms) in Europe (*IMPIVA, 1994*).

The hotelier may make a comparison with this —reference case— by converting his annual energy bills (in euros) into annual energy consumption (in kWh) and by comparing this to the reference case (250,000 kWh/year).

### b) Hypothesis on energy consumption by end-use

A typical breakdown of energy consumption by end-use has been assumed (see Figure below).



*Typical total energy consumption by end-use in hotels (Leonardo ENERGY, 2008)*



The energy carriers considered for the reference case are: electricity (47% of total energy consumption) and gas (53%). The energy carrier considered for each end–use is indicated in the following table:

End-uses involving electricity consumption (assumption)	Total Energy Consumption by end-use (%)	Annual energy consumption by end use (kWh)
Cooling	15	37 500
Lighting	12	30 000
Office Equipment	4	10 000
Ventilation	4	10 000
Refrigeration	3	7 500
Others	9	22 500
Total	47	117 500
End-uses involving gas consumption (assumption)	Percentage of total energy consumption by end-use	Annual energy consumption by end use
Space heating	31	77 500
Hot tap water	17	42 500
Cooking	5	12 500
Total	53	132 500

Percentages of energy savings induced by the solutions on a specific use are then used to calculate annual energy savings (in kWh). The French carbon emission factors for electricity and gas (expressed in  $\text{teq CO}_2/\text{kWh}$ ) are then applied to annual energy savings (expressed in kWh) to obtain an estimate of carbon emission reduction (in  $\text{teq CO}_2$ ). Note that French carbon emission factor for electricity may not be representative on the European scale due to the specificities of electricity production in France (dominated by nuclear production). The values of  $\text{CO}_2$  savings presented in this report can thus be considered as conservative.

## Datasheets of the 9 key renewable energy solutions identified for SME hotels





# Renewable Energy Solutions

## Biomass - wood chips and wood pellets- heating systems

### 1. General Information

*Since people first learned to control fire, we have used wood for heating. Today, heating with wood has become even cleaner, safer and more efficient than before.*



#### For what can my hotel use a biomass - wood chip and wood pellet- heating system for?

Biomass - wood chip and wood pellet- heating systems can provide efficient automated space heating. Wood chip and wood pellet boilers can now fill the same role as traditional fossil fuel boilers, and provide competitively priced heat for central heating or hot water needs.

#### What are wood chips?

Wood chips are small pieces of wood that can be made from a broad variety of raw material such as wood residues (i.e. logging residues, wood from forest thinning operations, stumps and roots, wood waste)

#### What are wood pellets?

Wood pellets are small cylindrical pieces produced from dried sawdust and wood shavings (and also other biomass products such as straw and biomass crops) compressed under high pressure.

#### What are the advantages of wood pellets over woodchips or other forms of wood as heating fuel?

Wood pellets can be produced to very uniform specifications – typically short pellets of 6mm-10mm in diameter, very similar to animal feed. These pellets can be produced to a much greater density than wood chip, and therefore take up less space. The moisture content of pellet fuel is lower and more uniform, and it produces more heat per unit of weight, making it a more efficient fuel. It also burns cleaner, and takes less space to store, about four to five times less than that of woodchips for example. Their uniformity of size and their ability to flow makes wood pellets ideally suited to automated machines.

#### Can I use wood chips and wood pellets for the same boiler?

Yes, but only in the case of those boilers that are manufactured to burn either pellets or wood chips.

## What is the cost of heating with pellet/chip fuels?

Like determining the cost of any space heating fuel, one needs to factor in the energy efficiency of the hotel, the level of heating required and the seasonal climate where the hotel is located. With pellet fuel, the actual price will depend upon the user's distance from the manufacturer, pellet availability and the time of year pellets are purchased. Many hotels save money by buying pellets off season or signing a pre-season agreement with a supplier

## How efficient are wood pellet/chip heating boilers?

Traditionally wood fuel has been used to heat hotels, either in open fires or in primitive wood burning stoves. These methods of burning fuel are usually quite inefficient, with most of the heat produced going up the chimney. This traditional image of wood heating involving smoky open fires is no longer valid. Modern wood heating, as a result of new wood-burning technology, is clean, efficient and cost effective. When used properly, today's pellet/chip boilers burn wood efficiently, producing little pollution and wasted energy. The cycle of burning and regrowth produces no net increase of carbon dioxide in the atmosphere.

## Where do I store the wood pellets/chips in my hotel?

The storage of wood fuel requires a lot more storage space than fossil fuels, and this can be a problem. Wood pellets will require 3 times, and wood chips 10 times, the storage volume of oil to provide similar amounts of heat.

## How much maintenance does a biomass - wood chip and wood pellet- heating system need?

Without proper use and maintenance, a wood burning system becomes a fire hazard. To prevent fires, the boiler must be properly installed and operated.

## How do I know if a wood pellet heating system is a good choice for my hotel?

- Determine the current heating requirements and annual fuel costs
- Check if there is enough space in your hotel to storage the pellets
- Verify the availability and price of wood pellets/chips in the area
- Check if there is a reliable local supplier of wood pellets/chips
- Compare the cost of heating with wood pellets/chips to the existing heating costs
- Determine if any financial incentives are available for the proposed project

## How can I finance a biomass - wood chip and wood pellet- heating system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your biomass system.

Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There also banks promoting the use of biomass systems by granting long-term, low interest loans. Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).

## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over of the application paperwork to receive an incentive. Local energy agencies may also help you.

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a biomass - wood chip and wood pellet- heating system is in your best interest, because it will help to make your hotel as energy efficient as possible. The size of your new wood boiler and the time it takes for operation can be minimized by a well-insulated and weatherized hotel.

## Who can install a biomass - wood chip and wood pellet- heating system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduce the hotel energy costs, by taking care of the investments involved of installing biomass system and sharing the resulting future cost savings with you by letting the ESCO install the biomass system in your hotel.

### Follow the next steps to make your biomass - wood chip and wood pellet- heating system a reality:



- Learn as much as you can about biomass - wood chip and wood pellet- heating system before you make a decision.
- Schedule an on-site energy audit
- Call an installer and obtain estimates
- Check zoning, permit and utility requirements, insurance, and other legalities
- Look for financing options
- Install and learn how to safely maintain your system
- Enjoy producing your own heat



## Renewable Energy Solutions

### Biomass - wood chips and wood pellets- heating systems

#### 2. Technical Information

*Since people first learned to control fire, we have used wood for heating. Today, heating with wood has become even cleaner, safer and more efficient than before*

#### How does a biomass system work?

By using the term “biomass” we refer to “the biodegradable fraction of products, wastes and residues from biological origin from agriculture (including vegetable and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste”(RES Directive). The most common way for transforming biomass in heating is to burn it during a process called “combustion”. Combustion of solid biomass of wood for heat production is the main bioenergy route in the world, with a constant drive for improved efficiency and reduced pollutant emissions. Depending on their size, different systems can be used: small-scale heating systems for households typically use firewood or pellets; medium-scale users typically burn wood chips in grate boilers.

**Pellets:** they are small cylindrical pieces produced from saw dust and wood shavings compressed under high pressure Wood chips: they are small pieces of wood that can be made from a broad variety of raw material such as wood residues (i.e. logging residues, small trees from forest thinning operations, stumps and roots, wood waste) or dedicated energy crops such as miscanthus, willow, poplar, reed canary grass, etc.

#### Pellet boiler for hot water and space heating

Pellet boilers tend to be physically smaller than chip fired equivalents as less robust feed and burning systems are needed. Installations are available from around 15kW upwards, there is no significant technological upper limit to installation size (there are a number of power stations in Europe that run exclusively on pellets). Pellet boilers are available with either a built in hopper, filled manually from bags, or with a separate, bulk storage hopper. The latter allows pellets to be delivered by tanker, down a long pipe, typically just once a year, with the minimum of disruption.

Buying in bulk is also cheaper, provided a minimum order size can be achieved, but the additional cost of a bulk hopper, and pellet feed to the boiler may not be justified.

It is very important to ensure that pellet fuel stores are well sealed and do not allow dust to enter the boiler room or other parts of the building.



## Chip boiler for hot water and space heating

Wood chip boilers are most appropriate for medium and large scale installations. Buildings that currently use wood chip boilers include blocks of flats, visitor centers, office buildings and even airport terminals. It is very important to ensure that wood chip boilers are supplied with the appropriate type of fuel. This will vary between boiler types and sizes. The two most important variables are particle size and moisture content.

Wood chips can be produced from round wood by using specialized wood chippers. These are designed to produce a uniform size of chip that works well in automated fuel feed systems. There is a large number of wood chip suppliers in Europe, alternatively if the boiler is going to be installed on a farm or other site with its own woodland it may be possible to use this resource to provide at least part of the fuel requirement. The use of a specialist, contract chipper service can avoid the need to buy a chipper.

Since wood chips require less processing than pellets and less manual handling than logs, they can be an extremely energy efficient use of biomass. Country estates, farms and other sites where there is woodland near to the point of end use are particularly well suited to wood chip systems. Many of these sites also find that they are able to offset forestry and heating costs within the organization.



Wood chips

## Link with other solutions

Easy combination with Solar thermal – decentralized energy units like “energy cabin” – using solar thermal & biomass - also available on the market.

## How Pellets Are Made

### Raw Material

The production of wood pellets begins with the generation of the raw material. In most cases this raw material is a byproduct of some other wood processing operation. Hardwood flooring mills are one example: They produce large quantities of clean (no bark or dirt), dry sawdust and small scrap blocks in their operations. This byproduct makes an ideal raw material for pellet production; however, as the interest in pellet production grows, some mills are generating pellet-making raw materials directly from trees (i.e. “roundwood”).

### Drying

The pellet raw material must be uniformly dried to a low moisture content feedstock (below 4 percent on a dry-weight basis). Because of the high temperatures and pressures in the manufacturing process, excess moisture can cause problems – for example, poor consolidation of the pellet (resulting in dust in the final product). However, this low moisture content is also the main reason that wood pellets burn so well.



Wood pellets

## Processing Material

Once the feedstock has been dried, it is fed into a hammer mill to produce wood particles that are a consistent size. This process helps make the pellets a uniform density so that they provide a consistent heating value.

## Formation of the Pellets

Pellets are extruded using special dies. High pressure and temperatures are generated in this process, which softens lignin in the wood and binds the material in the pellet together. No additional adhesives are required, although sometimes small amounts of lubricants may be added to improve processing.

## BENEFITS FOR THE HOTEL



### STAFF INVOLVEMENT

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Train your staff as guides to show guests the biomass system you have installed and explain them how it is warming up your hotel, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!



### GUEST INVOLVEMENT

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Install a demonstration diagram to show your guests how your biomass boiler is producing warm/hot water for your hotel. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

## BENEFITS FOR THE ENVIRONMENT



### CARBON EMISSIONS REDUCTION

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Biomass used in biomass boilers are a carbon neutral form of fuel.





# Renewable Energy Solutions

## Combined Heat and Power (CHP)

### 1. General Information

*Three-quarters of the hotels total energy use is used for heating water and guest rooms, air conditioning, and lighting—all of which can be supplied cost effectively by Combined Heat and Power (CHP). Hotels are perfect for the application of CHP technology as they have a high electrical and heat requirement. CHP provides a reliable source of energy to keep hotel guests comfortable and safe by producing simultaneous power and heat 24 hours a day, seven days a week.*



#### What does CHP mean?



CHP means Combined Heat and Power. CHP systems are typically run as heating appliances, providing space heating and warm water in hotel buildings like conventional boilers. But unlike a boiler, micro-CHP systems generate electricity together with the heat at very high-efficiencies and therefore help to save fuel, cut greenhouse gas emissions and reduce electricity costs.

#### How does a CHP system work?

A CHP system works on the principle of combined heat and power generation. An internal combustion engine drives a generator which, in turn, produces electrical energy and the heat generated is then used rather than wasted. Most CHP systems operate in grid-parallel mode, so that the hotel continues to receive some of its electrical needs from the electrical network, but it may also export some electricity to the grid. Around 100% of the heat that is produced by the engine and generator during this process is recovered and is fed directly into the hotels centralized heating and hot water system.

In addition, CHP systems provide high-quality power that can stabilize voltage and current sags, spikes, transients, and phase voltage imbalances.

#### What can my hotel use a CHP for?

The use of CHP would allow your hotel to produce electricity onsite at a lower cost and benefit from the heat produced as a byproduct of the generation process. CHP technologies generate electricity and meet thermal energy needs (direct heat, hot water, steam, process heating) simultaneously, at your hotel. Space heating, water heating, laundry, restaurant, and pool heating loads can be met by an appropriately sized CHP system.

#### How can heat and power be produced at the same time?

Combined Heat and Power (CHP) technologies utilize both electricity and heat generated from a single source. These systems recover heat that normally would be wasted in an electricity generator, and utilize it to produce one or more of the following: hot water, space heating and steam. Through the use of CHP systems, the fuel that would otherwise be used to produce heat or steam in a separate unit is saved.

## How efficient can a CHP be?

A CHP system makes better use of the fuel you put into them, saving up to 40 percent of the energy in total. A CHP system can provide all the hot water and space heating required by your hotel and reduces dependence on electricity from the grid supply thereby proving more efficiency than conventional boiler systems.

## Which fuels does CHP use?

Just like conventional hotel emergency power plants, CHP plants can run off virtually any fuel from oil or gas. Gas and oil are not renewable energy sources (they are fossil fuels) but the technology is still considered to be a 'low carbon technology' because it is more efficient than just burning the fossil fuel for heat and getting electricity from the national grid.

## Is a CHP a renewable energy system?

Strictly speaking CHP is only renewable if the fuel it uses is renewable (such as biofuel for example). However all CHP uses fuel more efficiently than most typical thermal power generating stations, so it can be classified as a 'energy efficient' technology.

## How noisy is a CHP system?

CHP systems are housed in a sound-proofed and thermally insulated enclosure which guarantees low noise.

## Is a micro CHP system suitable for my hotel?

CHP systems are flexible, providing a wide range of sizing options. The right CHP system for your hotel will be determined through a site-specific evaluation of your hotel's electricity and thermal loads.

To find out if a micro CHP system is suitable for your hotel you will need to check the following:

- Simultaneous base load requirement for electricity and heat
- Suitable fuel supply, preferably biofuels

- Suitable access and space for the micro CHP unit
- Suitable location with respect to other site functions (e.g. noise and exhaust)
- Fuel and electricity consumption records available on a monthly or more frequent basis.

## Which are the main CHP system characteristics?

Micro CHP are designed as small, compact combined heat-power cogenerating facilities which are ready for connection and correspond with the following demands:

- Small compact system
- Fits through the heating cellar door without problems directly installed by craftsmen and partially also maintained by them
- Low maintenance costs and long lifespan of the motor

## Will I need any permits or inspections to install a micro CHP system?

Air pollution permits could be required before the micro CHP system can be installed.

## How long does a CHP last?

A CHP can last up to 20 years, depending on the annual operating hours and providing the unit is serviced according to servicing schedule and maintenance instructions.

## How can I finance a CHP system?

You may fund your energy efficiency system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your CHP systems.

Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There are also banks promoting the use of CHP systems by granting long-term, low-interest loans.

Visit: [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a CHP system is in your best interest, because it will help make the existing energy consumption as efficient as possible and will lower your energy consumption and monthly energy bills. By reducing your energy consumption you will need to pay much less for a CHP system that's capable of meeting your lowered-new electricity and heat demand.

## Who can install a CHP system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives and loans for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduces the hotel energy costs, by taking care of the investments involved in installing a CHP system and sharing the resulting future cost savings with you, by letting it install the CHP system in your hotel.

## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over the application paperwork to receive an incentive. Local energy agencies may also help you.

### Follow the next steps to make your CHP system a reality:

- Learn as much as you can about CHP systems before you make a decision
- Schedule an on-site energy audit
- Call an installer and obtain estimates
- Check permit and utility requirements, insurance, and other legalities
- Look for financing options
- Install and learn how to safely maintain your system
- Enjoy generating your own energy and saving money





# Renewable Energy Solutions

## Combined Heat and Power (CHP)

### 2. Technical Information

*Three-quarters of the hotels total energy use is used for heating water and guest rooms, air conditioning, and lighting—all of which can be supplied cost effectively by Combined Heat and Power (CHP). Hotels are perfect for the application of CHP technology as they have a high electrical and heat requirement. CHP provides a reliable source of energy to keep hotel guests comfortable and safe by producing simultaneous power and heat 24 hours a day, seven days a week.*



#### How does a CHP system work?

Cogeneration (also called combined heat and power, CHP) is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat. It is one of the most common forms of energy recycling. Micro CHP is simply CHP on a small scale, with the prime mover generating less than 50 kW of electricity (kWe). The main difference to a standard boiler is that they are able to generate electricity while they are heating water (the main output of a micro CHP system is heat with some electricity generation).

Any electricity generated and not used in the hotel can be exported back to the grid. Most micro CHP systems today use gas as a heating fuel, although they can also be powered by oil or bio fuels. Cogeneration using biomass is one of the best means of converting a renewable energy source into heat and power coupled with the CO<sub>2</sub> reduction potential when compared with fossil fuels. Gas and oil are not renewable energy sources (they are fossil fuels) but the technology is still considered to be a 'low carbon technology' because it is more efficient than just burning the fossil fuel for heat and getting electricity from the national grid.

#### Which CHP systems are available?

There are 3 main CHP technologies available. The difference is the way in which they generate electricity. These three main engine technologies are normally used:

1. Stirling engine
2. Fuel cell
3. Internal combustion engine



#### Is a CHP system suitable for my hotel?

CHP systems are used wherever there is demand for heat and power. The system provides all the hot water and space heating required and reduces dependence on electricity from the grid supply thereby proving more efficient than conventional boiler systems. To find out if a micro CHP system is suitable for your hotel you will need:

- o Simultaneous base load requirement for electricity and heat
- o Suitable fuel supply, preferably biofuels
- o Suitable access and space for the micro CHP unit
- o Suitable location with respect to other site functions (e.g. noise and exhaust)
- o Fuel and electricity consumption records available on a monthly or more frequent basis

## Designing your CHP system

Micro CHPs in Europe are understood as cogeneration facilities in the small performance range of up to 50 kW<sub>el</sub>. They are designed as small, compact combined heat-power cogenerating facilities which are ready for connection and correspond with the following demands:

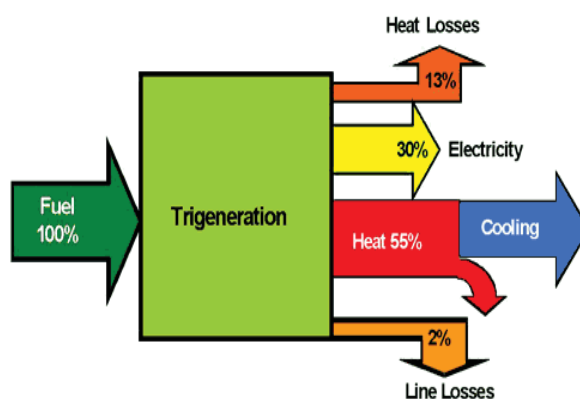
- Small compact system
- Fits through the heating cellar door without problems
- Is directly installed by craftsmen and partially also maintained by them
- Low maintenance costs and long lifespan of the motor

## Micro-combined heat and power units

Powered through the existing gas network, micro-combined heat and power units are easily installed. They operate similarly to conventional gas boilers and it is therefore unlikely that your radiators will need to be replaced. As with fitting a new boiler, it may be necessary to inspect and make improvements to the central heating system to optimize performance. Available systems vary between those that can be wall hung, and those that must be sited on the floor.

## Link to other technologies

Trigeneration systems are used wherever there is demand for heat, cooling and power (CHCP Combined Heat & Cooling Power). Trigeneration is a specific field of cogeneration. It not only allows you to produce your own electricity, but recovers heat generated by your plant to produce cooling energy too. For the economic viability of CHP systems it is important that they are used as much as possible. Therefore, other uses of the waste heat are awakening more interest. One of the possible uses of waste heat during the non-heating season is cooling. The demand for summer air-conditioning of buildings in Europe is increasing due to enhanced comfort expectations, architectural trends using large glass façades and also due to climate change.



## BENEFITS FOR THE HOTEL



## BENEFITS FOR THE ENVIRONMENT



### COST REDUCTION

CHP is the measure that offers the most significant single opportunity to reduce energy costs and to improve environmental performance with typical savings around 20% of their energy costs. The viability of micro CHP depends upon a good base load of operation, both in terms of an on-site electrical demand and heat demand. In practice, an exact match between the heat and electricity needs rarely exists. The viability can be greatly increased where opportunities for trigeneration exist. In such cases the heat from the micro CHP is also used as a primary energy source to deliver cooling by means of a thermally driven chiller.

### STAFF INVOLVEMENT

Train your staff as guides to show guests micro CHP system you have applied and explain them how it works, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!

### GUEST INVOLVEMENT

Install a demonstration diagram in your hotel to show your guests how the micro CHP system is producing the heat and electricity of your hotel. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

### CARBON EMISSIONS REDUCTION

Cogeneration using biomass is one of the best means of converting a renewable energy source into heat and power coupled with the CO2 reduction potential when compared with fossil fuels.



# Renewable Energy Solutions

## Geothermal Energy

### 1. General Information

*Geothermal energy systems work by using the Earth's constant temperature as a heating and cooling source. The biggest prerequisite in utilizing geothermal energy is the availability of a lake, wells or digging into the earth to cool or heat the water used in heat pumps.*



#### What are ground and groundwater heat pump systems?

The ground is a very good store of heat energy, and this heat can be harnessed and used to heat or cool hotel buildings. The ground has a high thermal mass, and because of this the earth in Europe ground stays at a constant 11-12°C at a depth of 1-2m. Geothermal heat pumps are systems able to draw the heat contained in the underground so that it can be used to heat your hotel building and/or to produce domestic hot water. When they are 'reversible', they can also be used to draw heat from the building and put it back into the ground/groundwater, therefore cooling the hotel. Aerothermal or air source heat pumps also exist. They draw the heat from the outside air or from the inside air that is vented out by the ventilation system.

#### How does a geothermal heat pump system work?

The principle of a heat pump is exactly the same as the principle of a refrigerator: a refrigerating fluid is expanded, heated by the ground/ground water (or outside air), then is compressed and gives its heat to the hotel building, before being expanded again. Whereas the refrigerator takes the heat from the inside of the appliance to the

outside, a heat pump in heating mode takes the heat from the ground/ground water (or outside air) to the inside of the hotel. In cooling mode, the heat pump acts as a refrigerator.

#### What are the basic components of a geothermal heat pump system?

All heat pumps comprise three parts: the circuit that takes the heat from the ground/ground water (or air) through heat exchangers, the heat pump itself that compresses the refrigerant fluid, and the distribution system that delivers the heat to the indoor spaces.

The heat from the ground/ground water (or air) is absorbed by the refrigerating fluid through heat exchangers or heat collectors. In geothermal heat pumps, the heat collectors are pipes that are buried in the ground. Depending on the location of the hotel, those pipes can either be installed horizontally (in that case lengths of pipe are laid in rows about 1 m deep) or vertically (the so-called 'borehole heat exchangers' are a pipe in U shape that go up to 80 m deep in the ground). When the heat source is ground water, it is possible to pump it and bring it directly to the heat pump heat exchanger, then re-inject it further into the groundwater body.



## Is a geothermal heat pump system suitable for my hotel?

To install a geothermal heat pump with horizontal collector pipes, it is necessary to have a sufficient ground area. To install a geothermal heat pump with vertical collectors, it is necessary to check with the municipal authorities if the underground structure is compatible. To install a groundwater heat pump, a groundwater body with sufficient flow all over the year must be present near or under the hotel. The choice of heat source and heat collectors will depend on the situation of the hotel. If sufficient outdoor area is available, a geothermal heat pump with horizontal collectors is a good choice. For smaller available areas, vertical collectors are more expensive but will allow heating a larger floor area.

## How much maintenance does a geothermal heat pump system need?

A heat pump system requires little maintenance by the hotelier but needs to be inspected by a professional yearly.

## Will I need any permits or inspections to install a geothermal heat pump system?

For geothermal heat pumps with vertical collectors or groundwater wells, you may need a permit before drilling. Check this with your local authority.

## How can I finance a geothermal heat pump system?

You may fund your geothermal heat pump system in several ways. Many financial incentives which can benefit your hotel are available. However, these have not been used to their maximum potential. Incentives can in some cases save you more than 50% of the cost of your geothermal heat pump system. Check for national incentives and don't forget that your local utility company or other local organizations may also provide additional support. There are also banks promoting the use of geothermal

heat pump system by granting long-term, low interest loans.

Visit: [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).



## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a geothermal heat pump system is in your best interest, because it will help make the existing energy consumption as efficient as possible and will lower your energy consumption and monthly energy bills. By reducing your energy consumption you will need to pay much less for a geothermal heat pump system that's capable of meeting your lowered-new energy demand.

## Who can install a geothermal heat pump system for my hotel?

Installation of a geothermal heat pump system is a complex operation that should be handled only by qualified professionals. In particular, drilling requires very specific precautions and is regulated in many countries. A qualified installer or an Energy Service Company (ESCO) will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduces the hotel energy costs, by taking care of the investments involved in installing a geothermal heat pump system and sharing the resulting future cost savings with you by letting it install the geothermal heat pump system in your hotel.



### Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over of the application paperwork to receive an incentive. Local energy agencies may also help you. Follow the next steps to make your geothermal heat pump system a reality:

- Learn as much as you can about geothermal heat pump systems before you make a decision
- Schedule an on-site energy audit
- Call an installer and obtain estimates
- Check zoning, permit and utility requirements, insurance, and other legalities
- Look for financing options
- Install and learn how to safely maintain your system

Enjoy saving energy and money!



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# Renewable Energy Solutions

## Geothermal Energy – Ground Source Heat Pumps

### 2. Technical Information

*Earth stores lots of solar energy that reaches us, making it a natural heat source for hotels. Geothermal heating and cooling systems move the heat from the ground into your hotel using the same technology your refrigerator uses to remove heat from food.*



#### How efficient is a GSHP Ground Source Heat Pump? How long will my GSHP system last?

GSHPs are durable and highly reliable. The GSHP contains few mechanical components, and all components are either buried in the ground or located inside the hotel, which protects them from outdoor conditions.

#### What are the key elements of a ground source heat pump?

1. The ground loop – this comprises lengths of pipe buried in the ground, either in a borehole or a horizontal trench. The pipe is filled with a mixture of water and antifreeze, which is then pumped around the pipe and absorbs (winter) or releases (summer) the heat from the ground.
2. The heat pump – a heat pump works by using the evaporation and condensing of a refrigerant to move heat from one place to another. Heat pumps are a very familiar and widely used technology in freezers and air conditioning units.

3. Ground Source Heat Pumps are one of the most efficient systems available today, with heating efficiencies up to 70% higher than other heating systems and cooling efficiencies up to 40% higher than available air conditioners.

#### Can the installed system provide both space heating and cooling for my hotel?

Yes. A GSHP can provide a combination of heating and cooling

#### And what about heating hot water?

Yes. A GSHP can be used for heating your hotel water.

#### How does a GSHP system heat water for my hotel?

During the summer your hotel hot water is produced free as a byproduct of the thermal process. In winter the GSHP system heats a portion of your hot water.

#### How much space does a GSHP unit require?

Most of a GSHP installation is underground. Inside the hotel, the heat pump units are about the same size as a traditional heating or cooling unit.

The heat distribution system –GSHPs work with under floor heating systems or traditional wall mounted radiators. The hot water produced can also be stored in conventional hot water cylinders to reduce additional energy input for hot water supply.

## How do I get the heat from the ground into my hotel?

There are several types of systems that gather the heat from the ground. The most commonly used are horizontal and vertical systems. Using trenchers or backhoes digging trenches below the ground, you then lay a series of parallel pipes. The trench is then back filled, taking care not to allow sharp rocks or debris to damage the pipe.

## What is a vertical-loop system?

Vertical loops are preferred in many installations where yard space is insufficient and where preservation of existing landscaping is desirable. Each hole contains a single loop of pipe with a U-bend at the bottom. The hole is then backfilled or grouted to improve the thermal conductivity. Each vertical pipe is then connected to a horizontal pipe underground to and from the heat pump. Vertical loops are generally more expensive to install, but require less piping than horizontal loops.

## What is a horizontal-loop system?

A horizontal loop is usually the most cost effective when adequate yard space is available and trenches are easy to dig.

## How far apart are trenches and vertical boreholes spaced?

Trenches are spaced one to two meters apart while boreholes are spaced three to five meters apart.

## What are the advantages and disadvantages of the horizontal and vertical installations, respectively?

Horizontal installations are simpler, requiring lower-cost equipment. However, they require longer lengths of pipe. Since a horizontal heat exchanger is laid out in trenches, a larger area is usually required than for a vertical system. Where land is limited, vertical installations can be ideal. If regional soil conditions include extensive hard rock, a vertical installation may be the only available choice. Vertical installations tend to be more expensive due to the increased cost of drilling versus trenching, but since the heat exchanger is buried deeper than with a horizontal system, vertical systems are usually more efficient and can require fewer pipelines.

## Does my hotel need an additional heat source?

Although GSHPs can provide all the heat necessary even in the coldest weather, all systems require an emergency backup.

- The heat pump itself (here with hot water tank) takes no more space than a conventional boiler.





## Renewable Energy Solutions

# Solar photovoltaic electricity systems

### 1. General Information

*With energy costs always increasing, it's no surprise that hotels are looking for new ways to reduce their energy consumption. Renewable energy technologies such as photovoltaic (PV) systems are a good solution that is becoming more cost effective as fuel prices rise and will help hotels stay competitive and profitable.*

#### What does Photovoltaic (PV) mean?

Photo means light. Voltaic means electricity. Photovoltaic means getting electricity from light.

#### How well developed is PV technology?

PV is a proven technology that has been used for decades; solar PV systems are well suited for use in Europe all year round.

#### What can my hotel use a PV system for?

Hotels can install PV panels to reduce or eliminate their monthly electricity bills and provide pollution-free electricity to their guests. The electricity produced can then be used to power your hotel, or be fed back into the grid.

#### How is electricity produced?

Photovoltaic materials have the ability to generate a current of electricity when exposed to light. Photons, which make up light, knock electrons of the photovoltaic material, creating an electrical current. Solar panels produce direct current (DC) electricity. The electricity the hotel uses for most applications is at 240 volt alternating current (AC), so the electricity produced from panels will be transformed by an inverter to AC (or alternating current) power, which is the standard hotel current.

#### How do I know if a solar PV system is a good choice for my hotel?

If your hotel is in an area where the sun shines, free from shading of trees, nearby buildings, or other obstructions, your hotel roof or property contain a large enough area and electricity is costly, chances are that PV solar panels will make financial sense for you, especially if there are tax credits, rebates or other incentives available. Contact an installer to get assistance in evaluating your situation.

## PV SYSTEMS



**Off grid:** If your hotel is not grid connected, the electricity will be used to charge a bank of batteries connected to an inverter. This converts the DC into 240 volt AC, providing usable current for most hotel applications.

**Grid connected:** If your hotel is connected to the grid you can sell the electricity to the grid when the panels are producing more energy than needed and to import energy from the grid when the panels are not producing enough electricity. Therefore there will be a constant supply of electricity and the solar electricity produced will not be wasted.

### Where do I mount the PV panels in my hotel?

On hotels the PV panels are ideally erected on a south facing roof where they receive the maximum amount of sunlight. Solar PV panels can also be installed on the side of a building, on the ground or on a pole.

### Do installed solar PV panels have to face a southerly direction?

In Europe, facing south at the correct angle of elevation will provide the best performance however solar panels can also be installed facing towards the east or west as long as proper considerations are made. Solar PV panels should never face north.

Solar power systems should hence be oriented towards the South and inclined in order to generate the maximum amount of electricity from the sun. A certified installer will be able to advise you on the best way to integrate a PV system into the space available in your hotel.

### Do I need any planning permissions in order to install a PV system?

Most solar PV systems generally do not require permission. Nevertheless, it is worth checking with your local administration or authorities to find out about any local laws that may restrict solar PV systems placement, especially if your hotel is located in a listed building or conservation area.



## What about cloudy days?

PV solar panels will generally produce electricity at a reduced rate under cloudy conditions. A large amount of clouds will interrupt the production of power.

## How long will a solar PV panel system last?

Solar panels are known to last 40 years or longer. Modules are generally warrantied for 25 years and inverters for 10 years. Solar panels are designed to withstand hail, severe wind and weather conditions assuming proper installation.

## How much maintenance does a PV system needs?

As solar photovoltaic panels have no moving parts they are virtually maintenance free. For a grid-tied system where no batteries need be replaced, there is typically little or no maintenance required. Other than that, unless there is an equipment failure there should be no maintenance required.

## Do I need to clean the PV panels periodically?

In most areas of Europe, there is sufficient rain to clean the panels. However, if you are in a dusty area (very near a busy dirt road, very urban area, etc.) you may see a performance gain from cleaning the panels monthly. If necessary, a hose stream is usually sufficient for cleaning. You might consider a periodic inspection to ensure that the panels remain clear of leaves, dirt, bird droppings etc.

## How do solar PV panels resist hail, strong wind, storms etc.?

Solar panels are built using tempered glass for durability and safety and are designed to withstand hail and high winds. Depending on the wind-load requirements in your area, heavier mounting hardware may be required.

## How can I integrate a PV system to my hotel building?

Building-integrated photovoltaics (BIPV) are dual-purpose: they serve as both the outer layer of a structure and generate electricity for use or export to the grid. BIPV systems can provide savings in materials and electricity costs, reduce pollution, and add to the architectural appeal of your hotel.

Though they can be added to a structure as a retrofit, the greatest value for BIPV systems is realized by including them in the initial building design. BIPV is used in facades, rooftops and glazing.



## What is the payback time of a PV system?

This will vary depending on the local cost of electricity, state and local rebates or incentives, and the installed cost of the solar panel system. The range can be from 3-4 years up to 20 years depending on these factors.

## How can I finance a PV system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example - financial incentives through solar rebates and other programs. Some utilities also have net metering programs, which further enhance the economics of PV. However, these have not been used to their maximum potential. Incentives can in some cases save you more than 50% of the cost of your PV systems. Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There are also banks promoting the use of PV systems by granting long-term, low interest loans.

Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a PV system is in your best interest, because it will help make the existing energy consumption as efficient as possible and will lower your energy consumption and monthly energy bills. By reducing your energy consumption you will need to pay much less for a PV system which is capable of meeting your lowered-new energy demand.

## Who can install a solar PV system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduces the hotel energy costs, by taking care of the investments involved of installing a PV system and sharing the resulting future cost savings with you by letting it install the PV system in your hotel.

## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over of the application paperwork to receive an incentive. Local energy agencies may also help you.

### Follow the next steps to make your solar PV system a reality:

- Learn as much as you can about solar PV systems before you make a decision
  - Schedule an on-site energy audit
  - Call an installer and obtain estimates
  - Check zoning, permit and utility requirements, insurance, and other legalities
  - Look for financing options
  - Install and learn how to safely maintain your system
- Enjoy generating your own energy and saving money!







## Renewable Energy Solutions

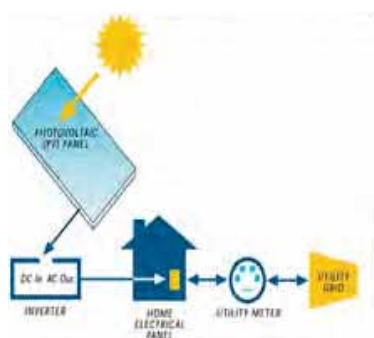
# Solar photovoltaic electricity systems

## 2. Technical Information

With energy costs always increasing, it's no surprise that hotels are looking for new ways to reduce their energy consumption. Renewable energy technologies such as photovoltaic (PV) systems are a good solution that is becoming more cost effective as fuel prices rise and will help hotels stay competitive and profitable.

### How does PV electricity power system work?

Photovoltaic cells are made of very pure semiconductor grade silicon similar to the one used in computer chips. Silicon is the most common element in the Earth's crust. Electricity is produced as photons of sunlight penetrate the element, bumping electrons into a flow.



©Energy Trust Org

PV cells are connected together to make a module. Modules are the building blocks connected together to make an array. Through a PV cell, solar radiation is converted into electricity: when sunlight shines on the semi-conducting materials, the cell creates an electric field across them, making electricity flow.

This is called —the photovoltaic effect and produces DC (Direct Current) electricity. This DC power is converted to AC (Alternating Current) electricity to match the standards of AC frequency and voltage. The conversion is made by an important system component called the inverter. The array and inverter are engineered for efficiency and compatibility. PV allows you to produce electricity—without noise or air pollution—from a clean, renewable resource the sun.

PV systems for hotels are becoming more affordable all the time. Modules range in power output from about 10 watts to 300 watts. The capacity of an PV array is given in terms of its peak power production (kWp).

### What are the basic components of a PV electricity power system?

A PV system connected or tied to the utility grid has these components: one or more PV modules, which are connected to an inverter.



The inverter, which converts the system's direct-current (DC) electricity to alternating current (AC).

Batteries (optional) to provide energy storage or backup power in case of a power interruption or outage on the grid and a special utility meter to let the hotel sell and/or buy electricity to and from the national grid and a consumption meter to displaying the electric power consumed by the appliance and the time period of consumption.



## RECOMMENDATIONS

### Designing your PV electricity power system

As a rule, the cost per kilowatt-hour goes down as you increase the size of the system. For example, many inverters are sized for systems up to 5 kilowatts, so even if your PV array is smaller (say, 3 kilowatts), you may have to buy the same size of inverter. Labor costs for a small system may be nearly as much as those for a large system, so you are likely to get a better price for installing a 2-kilowatt system all at once, rather than installing 1 kilowatt each year for two years.

### Chose the perfect orientation to maximize energy generation!

The best way is to install your PV tilted and oriented towards the South. Nevertheless, you are allowed some shifts without losing too much of your production.

For instance, considering the mean latitude value for central Europe, a +/- 15° tilt shift can involve a slight 2% loss, while the same shift from the southern direction is merely capable of reducing a system's performance by 3% (*Source: PVSunrise project*).

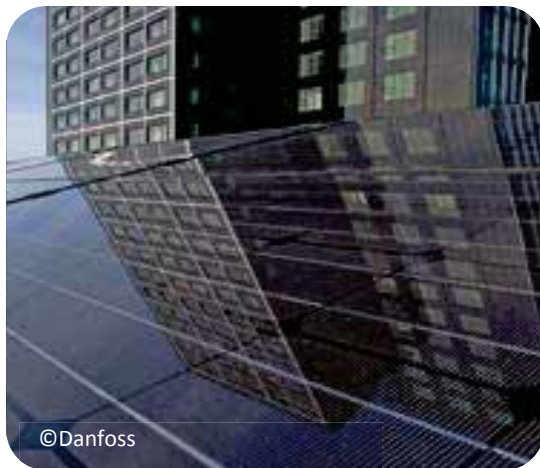
### Ways to install and/or integrate PV systems in your hotel roof:

In order to install a PV system on a roof it is possible to either fix the array over the roof covering, so it sits above the tiles or slates, or to integrate the tiles into the finished roof. When the PV arrays are fitted over the roof covering, the arrays are fixed to the roof structure by drilling through the roof covering (tile, slate) directly into the rafters. Careful planning is required. Holes must also be made for cabling to and from the PV array to the inverters. These holes should be weather-sealed with roofing sealant.

**Integrated roof:** To integrate an array into the roof finish, PV tiles are used to replace individual ordinary roofing tiles or slates. Either a part of the roof can be replaced with PV tiles or the whole covering. The PV tiles are anchored onto the roofing battens and are screwed in place. The tiles overlay like single-lap roof tiles and are connected electrically together with the cabling taken back to the electrical inverter.



**Façades integration:** PV systems that are integrated into the façade of a building are called —Building Integrated PV – BIPV . BIPV can be used in many different ways in the building envelope. In order to exploit the maximum of the PV system, though, it is advisable this has a good exposure (i.e. it is tilted and south oriented, no core or half shadows). In these kinds of applications, different types of modules can be used such as classic (framed) modules, flexible crystalline or thin-film on metal substrate, roof-tiles with solar cells, transparent monocrystalline modules, modules with colored solar cells, semitransparent micro perforated amorphous etc. For this reason, BIPV can be applied on both new and existing buildings and can allow a variety of different designs. A building façade with good design and structure is the first requirement to have a good BIPV system installed. Once this prerequisite is fulfilled, BIPV can be used in a broad array of ways, other than for producing electricity. (Weather protection, heat insulation, sun protection, noise reduction, modulation of daylight).



**Window integration:** Glass PV laminates can be applied to windows providing a semi-transparent façade. The transparency is normally achieved using either of the following methods: The PV cell can be so thin or laser grooved that it is possible to see through. This will provide a filtered vision to the outside. Semitransparent thin-film modules are especially appropriate for this application. Another option is to use semi-transparent crystalline solar cells. Crystalline solar cells on the laminate are spaced so that partial light filters through the PV module and illuminates the room. Light effects from these panels lead to an ever changing pattern of shades in the building itself. The room remains shaded, yet not constrained.

## PV combined with other solutions

Solar garden lights can be used in your hotel. These lights use a small photovoltaic panel at the top of the light. This panel draws the sunlight in, and then charges and stores the energy it makes into the battery under the PV panel in the light. As it charges throughout the day, it stores enough energy to light a walk way or a garden path throughout the night, repeating the cycle again when the sun rises.

Photovoltaic panels can be combined with biomass generators or a wind turbine, as far as RES technologies are concerned.



## BENEFITS FOR THE HOTELS



### **COST REDUCTION**

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- The sun doesn't send monthly bills!!!
- PV can produce energy!

PV modules, unlike any other building materials, produce energy and therefore allow a hotel to recover the initial cost of their investment. More in particular, all electricity generated can be injected and sold to the electricity provider at higher price than the price paid in your monthly electricity bill. This mechanism, called —feed-in tariff , enables you to pay-back your investment in a short time. Some other systems exist to develop renewables (green certificates, tendering, tax credit).



### **GUEST INVOLVEMENT**

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Install a demonstration diagram to show your guests how the sun is generating electricity for your hotel. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

## BENEFITS FOR THE ENVIRONMENT



### **CARBON EMISSIONS REDUCTION**

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The amount of CO<sub>2</sub> a solar roof can save will depend on many factors, including: - the energy source that the solar production is replacing (coal, gas, hydro-electric, nuclear...); - the quantity of energy produced by the solar roof (depending on the roof's location, orientation, inclination and shading); - the "energy habits" of the solar roof owner (does the solar roof owner use less energy now that he/she is aware of the cost of producing electricity? Or does he/she see production as a "bonus" so that they can use more electricity than before?).

The first point is the most important - if your electricity comes from a coal fired power station, each kWh you use will release around 1 000g of equivalent carbon (various greenhouse gases converted into 'equivalent carbon units' for comparison). However, if your original electricity comes from a hydro-electric power station, it is producing much less carbon equivalent emissions (less than 10g). So clearly the amount of CO<sub>2</sub> you will be saving is very dependent on the source of your 'normal' electricity.

(Source: PVSunrise project: <http://www.pvsunrise.eu/about-pv/faq.html#c56>)

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# Renewable Energy Solutions

## Solar thermal energy – Solar COMBI systems

### 1.General Information

*One of the most energy intensive (and therefore costly) processes in any hotel is the heating of domestic hot water and space heating. With energy costs always increasing, it's no surprise that hotels are looking for new ways to reduce their energy consumption. Renewable energy technologies such as solar combi systems are a good solution that is becoming more cost effective as fuel prices rise and will help hotels stay competitive and profitable.*



#### How does a solar combi system work?

Solar combi systems are solar heating installations providing space heating as well as domestic hot water in hotels. The primary energy sources are solar energy as well as an auxiliary source such as biomass, gas, oil and electricity, either direct or with a heat pump.

In a solar combi system cool water is pumped through pipes in a collector usually located on the roof of your hotel which has to be exposed to the sun. Glass on the front of the collector allows sunlight to pass into the collector, but prevents it from escaping, like a greenhouse. The hot water returns then to an insulated storage tank, similar to a regular hot water tank and is ready then to be used by your hotel for domestic hot water and space heating.

#### How well developed is solar combi technology?

Solar combi is a mature and established technology.

Manufacturers have produced and sold solar domestic hot water and space heating systems for decades already and due to continuous innovation, they can supply products that work effectively. To compare product quality there are certificates that apply throughout Europe, as well as national commendations that test and confirm the efficiency and quality of solar combi systems.

#### What can my hotel use a solar combi system for?

Solar combi systems can heat water for guest rooms, housekeeping, laundry facilities, food services and space heating.

#### Is there enough sun in my region to install a solar combi system?

A solar combi system can be installed anywhere in Europe; just the size of the solar system must be changed to achieve enough solar yield.

#### Do the solar combi systems still operate when it's cloudy?

On a cloudy day when there is little or no direct sunlight, there is still enough solar radiation to be usefully collected by solar collectors. While the highest amounts of monthly solar radiation are obviously experienced in the summer months, there is enough radiation coming from the sun in spring, autumn and winter to make a very useful contribution to your hotel's energy needs for both space heating and domestic hot water.

#### If the sun isn't shining, will I only have cold water and no space heating in my hotel?

No.

The storage tank holds the hot water until it is required and ensures that hot water for domestic hot water and space heating use is still available even when there is not enough sunlight. All solar combi system tanks have a backup water heater (e.g., electricity, oil, pellets or natural gas), so there is always hot water when needed.

## Where do I mount the solar collectors in my hotel?

Solar collectors are most of the time installed either on the roof of your hotel, or on a freestanding installation in your hotel yard. There are also facade collectors or installations for balconies. When choosing a location for the installation the primary consideration should be the amount of sun exposure the collectors will get. For maximum daily output the collectors should face south, be in the direct sun (no shading at all), and be mounted at an angle to the sun that will maximize their performance. A certified installer will be able to advise you on the best way to integrate a system into the space available in your hotel.

## How many collectors do I need for my hotel?

The number of solar collectors you'll need for your hotel will depend on the number of guestrooms, the amount of water used, your local climate and the location of the collectors (whether they're facing south or in a shaded area). For an accurate assessment of how many collectors your hotel needs consult a qualified installer for specific size and model specifications.

## Do I need any planning permissions in order to install a solar combi system?

Most solar collectors generally do not require permission. Nevertheless, it is worth checking with your local administration or authorities to find out about any local laws that may restrict solar collector placement, especially if you live in a listed building or conservation area.

Solar obligations have also been adopted in Spain for example, where the new Spanish Technical Buildings Code (CTE Código Técnico de la Edificación) was adopted in March 2006, and its solar thermal section came into force in September 2006 where an obligation to provide 30-70% of the domestic hot water demand with solar thermal energy has to be complied with. This applies to all new hotel buildings as well as those undergoing major refurbishment.

## How much does it cost to install a solar combi system, and how much can my hotel save?

The cost varies based on the size of the solar collector surface, the storage volume, the heat load and the climate. Total savings depend on the amount of hot water and space heating and the type of fuel your hotel uses for it. Savings are the greatest for electricity users, and less for natural gas users. A certified installer will be able to estimate the output of the solar combi system and to give you a general cost/saving estimate for the system.

## What is the lifetime of a solar combi system?

Well maintained systems will usually last over 20 years so they should pay for themselves many times over in energy savings.

## How much maintenance does a solar combi system need?

A solar combi system is almost maintenance-free. However, the system should be checked periodically by a qualified service technician. Every three years the solar system should be tested to make sure it is frost-proof. The circulating pump, the tank, the non-toxic antifreeze mixture and other minor components are subject to wear and tear and may need to be replaced eventually.



## What is the payback time of a solar combi system?

The payback time for solar combi systems can be relatively short. In very favorable cases (closely related to good solar radiation) 3 or 4 years paybacks are possible. Average paybacks of 5 to 6 years are also common.

Climate is important when calculating the payback of an investment in a solar combi system, since it also determines the type of collectors, system, needs, etc. To minimize payback period and maximize savings you need to aim for the biggest possible running capacity for the minimal possible investment in solar collectors. Installers should be able to work out the optimal size and type needed in respect to your hotel hot water and space heating needs and usage.

## How can I finance a solar combi system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your solar hot water system. Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There also banks promoting the use of solar hot water systems by granting long-term, low interest loans.

Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).



## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over of the application paperwork to receive an incentive. Local energy agencies may also help you.

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a solar hot water system is in your best interest, because it will help make the existing hot water system as efficient as possible and will lower your hot water consumption and monthly energy bills. By reducing your hot water consumption you will need to pay much less for a solar hot water system that's capable of meeting your lowered-new hot water demand.

You can improve the performance of your solar combi system and reduce the energy requirements of your hotel by for example:

- Installing low-flow showerheads and faucets
- Installing body shaped bathtubs
- Installing new more efficient water pumps
- Insulating all hot water pipes
- Installing ozone laundry systems
- Insulating your hotel building
- Insulating your hotel windows
- Preventing air infiltration and unnecessary outdoor air supply
- Installing automatic control systems to switch heating systems on and off in guestrooms.
- Installing a good thermal insulation around boilers, water systems, domestic hot water tanks and water pipes



## Who can install a solar combi system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduces the hotel energy costs, by taking care of the investments involved in installing a solar hot water system and sharing the resulting future cost savings with you, by letting it install the solar hot water system in your hotel.

### Follow the next steps to make your solar combi system a reality:

- Learn as much as you can about solar combi systems before you make a decision
- Schedule an on-site energy audit
- Call an installer and obtain estimates
- Check zoning, permit and utility requirements, insurance, and other legalities
- Look for financing options
- Install and learn how to safely maintain your system





## Renewable Energy Solutions

### Solar thermal energy – Solar COMBI systems

#### 2. Technical Information

*One of the most energy intensive (and therefore costly) processes in any hotel is the heating of domestic hot water and space heating. With energy costs always increasing, it's no surprise that hotels are looking for new ways to reduce their energy consumption. Renewable energy technologies such as solar combi systems are a good solution that is becoming more cost effective as fuel prices rise and will help hotels stay competitive and profitable.*



#### How do solar combi systems work?

Solar combi systems use heat from solar thermal collectors to provide solar space heating in winter and domestic hot water (DHW) all year round. An auxiliary heat, additional boiler, is used as a back-up of the solar energy. The solar fraction is the percentage of a building's seasonal energy requirements that can be met by a solar energy device(s) or system(s). This fraction will be optimized through the sizing of the system so as to reach a few percents to more than 100%.

#### What are the basic components of a solar combi system?

A solar combi system includes the following main parts:

Solar thermal collectors: either flat plate collectors and evacuated tube collectors are suitable. Typically vacuum tube collectors have better properties in the transition- and winter periods, but the investment costs are higher than for flat plate collectors.

- Flat-plate collector: glazed flat-plate collectors are insulated, weather proofed boxes that contain a dark absorber plate under a glass.
- Evacuated-tube collectors: they feature parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin.

**Hot water storage tanks:** As solar radiation represents an intermittent energy source: the heat produced by the solar thermal collectors needs to be stored into a water storage tank to be used in any time. Volume in the average of 800-2000 litres for a 12-25 m<sup>2</sup> solar collectors surface. The domestic hot water (DHW) preparation can be performed with an immersed heat exchanger or in an internal/immersed storage tank (tank in tank).

**Auxiliary heating system:** the auxiliary heating required by the hotel can be provided in different ways according to the features and the needs of the building. Several types of auxiliary heating are available to be used in solar combi systems: biomass boilers, heat pumps, district heating, oil, gas burners or electricity.

**Control system:** this is aimed at coordinating all the components of the solar thermal system and the back-up from the auxiliary heating system so as to meet the heating demand.

#### Link with other solutions

#### Solar Combi Plus System



A solar combi system plus provides both solar space heating and cooling as well as hot water from a common array of solar thermal collectors. These systems are most suitable for buildings with both heating and cooling demand. This depends most importantly on the climatic conditions.



Decreasing investment cost: due to the combination of solar cooling and heating, solar collectors which are only used for heating purposes would become more economical since the time of year when cooling is needed is when the sun offers the most energy. The potential to use the sun's radiation for cooling will make use of the energy which otherwise goes unused.

One of the biggest advantages of using solar energy as energy source for cooling is that the maximum energy is obtained when the cooling load is at its peak. An increasing demand for small capacity air-conditioning appliances is being observed throughout Europe.

Today this market is almost entirely covered by compression chillers. This technology produces a growing electricity peak-demand during the summer, especially in the sunny and hot southern countries. Solar energy is one of the possible alternative energy sources for cooling systems.

## Swimming pools

The surplus heat produced in the warm season can be used for heating the hotel swimming pool

## BENEFITS FOR THE HOTEL



### COST REDUCTION

- The sun doesn't send monthly bills!!!

Solar heating is the most cost-effective use of solar energy in many climates. Solar combi systems will insulate your hotel from rising fossil fuel costs and protect you from fuel-price inflation over time since your hotel will not receive any more monthly energy bills for heating your water and your hotel.



### STAFF INVOLVEMENT

Train your staff as guides to show guests the solar combi system you have applied and explain them how it works, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!



### GUEST INVOLVEMENT

Install a demonstration diagram to show your guests how the sun is heating your hotel and the hot water that is consumed. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

## BENEFITS FOR THE ENVIRONMENT



### CARBON EMISSIONS REDUCTION

The energy produced is clean and emission-free. Solar water and space heating systems do not require fuel and produce no waste.



## Renewable Energy Solutions

### Solar thermal energy – Solar COMBI + systems

#### 1. General Information

*The demand for air conditioning in the hotel sector is increasing due to a demand for improved comfort, but also because of the higher temperatures that have occurred during the last decade. Solar Combi Plus systems can supply energy for solar cooling, and combined solar space heating-cooling and domestic hot water systems.*



#### How does a solar combi plus system work?

Solar combi plus systems use heat from solar thermal collectors to provide heating in winter, cooling in summer and domestic hot water all the year round. A solar combi plus installation consists of a typical solar thermal system made up of solar collectors, storage tank, control unit, pipes and pumps and a thermally driven cooling machine.

#### How well developed are thermally driven cooling machines?

As strange as this may sound, thermal powered air conditioning is a well-established technology used for decades in air conditioning for office buildings, hotels, hospitals, and many other applications. All components of a solar combi plus system are now market available.

#### What can my hotel use a solar combi plus system for?

Solar combi plus systems can cover all hotel building thermal demands (domestic hot water, space heating and cooling), this can lead to better annual utilization of the solar collector field, resulting in higher solar fractions and more economical systems.

#### Why use solar combi plus systems for cooling / air-conditioning?

- Coincidence of solar gains and cooling loads
- Reduce Electric Peak loads created by air-conditioning
- High use of solar gains during the entire year
- Reduce summer surplus solar gains in solar systems designed for heating application (solar combi systems).

#### Is there enough sun in my region to install a solar combi plus system?

A solar combi plus system can be installed anywhere in Europe; just the size of the solar system must be changed to achieve enough solar yield. There is a large potential, in particular in Mediterranean countries.

#### Do the solar combi plus systems still operate when it's cloudy?

On a cloudy day when there is little or no direct sunlight, there is still solar radiation sufficiently enough to be usefully collected by solar collectors. While the highest amounts of monthly solar radiation are obviously experienced in the summer months, there is enough radiation coming from the sun in spring, autumn and winter to make a very useful contribution to your hotel's energy needs for both space heating and domestic hot water.

## If the sun isn't shining, will I only have cold water and no space heating or cooling in my hotel?

No. Storage tanks can hold cold water (for cooling) or hot water (for space heating and domestic hot water). The tanks hold the cold/hot water produced until it is required for air/conditioning or space heating and ensures that the solar combi system covers the demand for domestic hot water, space heating and cooling even when there is not enough sunlight. All hot water tanks for solar combi plus system have a backup water heater (e.g., electricity, oil, pellets or natural gas), so there is always hot water when needed.

## Where do I mount the solar collectors in my hotel?

Solar collectors are most of the times installed either on the roof of your hotel, or on a freestanding installation in your hotel yard. There are also facade collectors or installations for balconies.

When choosing a location for the installation the primary consideration should be the amount of sun exposure the collectors will get. For maximum daily output the collectors should face due south, be in the direct sun (no shading at all), and be mounted at an angle to the sun that will maximize their performance. A certified installer will be able to advise you on the best way to integrate a system into the space available in your hotel.

## How many collectors do I need for my hotel?

The number of solar collectors you'll need for your hotel will depend on the number of guestrooms, the heating/cooling demand, the amount of water used, your local climate and the location of the collectors (whether they're facing south or in a shaded area). For an accurate assessment of how many collectors your hotel needs consult a qualified installer for specific size and model specifications.

## Do I need any planning permissions in order to install a solar combi system?

Most solar collectors generally not require permission. Nevertheless, it is worth checking with your local administration or authorities to find out about any local laws that may restrict solar collector placement, especially if you live in a listed building or conservation area.

Also solar obligations have now been adopted in Spain for example, where the new Spanish Technical Buildings Code (CTE Código Técnico de la Edificación) was adopted in March 2006, and its solar thermal section came into force in September 2006 where an obligation to provide 30-70% of the domestic hot water demand with solar thermal energy has to be complied with. This applies to all new hotel buildings as well as those undergoing major refurbishment.

## How much does it cost to install a solar combi plus system, and how much can my hotel save?

The cost varies based on the size of a system, and how it fits into your hotel existing plumbing. You may find cheap and efficient solar hot water systems for warm regions (thermosiphon systems), but more complex systems for colder regions (with vacuum tube collectors, pumps, heat exchangers, antifreeze mixtures, controls...).

Total savings depend on the amount of hot water and the type of fuel your hotel uses to heat water. Savings are the greatest for electricity users, and less for natural gas users. Typically in Europe, solar hot water systems are sized to provide approximately 50-70 percent of the heating load per year. On sunny summer days the system may provide nearly 100 percent of the heat required, while during extended cloudy periods, the output may drop to 20-30 percent. A certified installer will be able to estimate the output of the solar hot water system and to give you a general cost/saving estimate for the system.

## What is the lifetime of a solar combi plus system?

Well maintained systems will usually last over 20 years so they should pay for themselves many times over in energy savings.

## How much maintenance does a solar combi plus system need?

A solar combi plus system is almost maintenance-free. However, the system should be checked periodically by a qualified service technician. Every three years the solar system should be tested to make sure it is frost-proof. The circulating pump, the tank, the non-toxic antifreeze mixture and other minor components are subject to wear and tear and may need to be replaced eventually. The thermally driven cooling machines will need also a special maintenance plan.

## What is the payback time of a solar combi plus system?

The payback time for solar combi plus systems can be relatively short. In very favorable cases (closely related to good solar radiation). Average paybacks of 10 years are common.

Climate is important when calculating the payback of an investment in a solar combi plus system, since it also determines the type of collectors, system, needs, etc



To minimize payback period and maximize savings you need to aim for the biggest possible running capacity for the minimal possible investment in solar collectors. Installers should be able to work out the optimal size and type needed in respect to your hotel hot water, space heating and cooling needs and usage.

## How can I finance a solar combi plus system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your solar combi plus system. Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There also banks promoting the use of solar hot water systems by granting long-term, low interest loans.

Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only)



## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over of the application paperwork to receive an incentive. Local energy agencies may also help you.

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a solar combi plus system is in your best interest, because it will help make the existing system as efficient as possible and will lower your energy consumption and monthly energy bills. By reducing your hot water, space heating and cooling demand you will need to pay much less for a solar combi plus system that's capable of meeting your lowered-new hot water, heating and cooling demand.

You can improve the performance of your solar combi plus system and reduce the energy requirements of your hotel by for example:

- Installing low-flow showerheads and faucets
- Installing body shaped bathtubs
- Installing new more efficient water pumps
- Insulating all hot water pipes
- Installing ozone laundry systems
- Insulating your hotel building
- Insulating your hotel windows
- Preventing air infiltration and unnecessary outdoor air supply
- Installing automatic control systems to switch Heating/cooling systems on and off in guestrooms
- Installing a good thermal insulation around boilers, water systems, domestic hot /cold water tanks and water pipes

## Who can install a solar combi plus system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduces the hotel energy costs, by taking care of the investments involved in installing a solar combi plus system and sharing the resulting future cost savings with you by letting it install the system in your hotel.

### Follow the next steps to make your solar combi plus system a reality:

- Learn as much as you can about solar combi plus systems before you make a decision.
- Schedule an on-site energy audit
- Call an installer and obtain estimates
- Check zoning, permit and utility requirements, insurance, and other legalities
- Look for financing options
- Install and learn how to safely maintain your system





# Renewable Energy Solutions

## Solar Thermal Combi Plus Systems

### 2. Technical Information

*The demand for air conditioning in the hotel sector is increasing due to a demand for improved comfort, but also because of the higher temperatures that have occurred during the last decade. Solar Combi Plus systems can supply energy for solar cooling, and combined solar space heating-cooling and domestic hot water systems.*



#### How does a solar combi plus system work?

Solar combi plus systems use heat from solar thermal collectors to provide heating in winter, cooling in summer and domestic hot water (DHW) all year round. The cold is produced by a thermally driven cooling machine, a **sorption chiller** which is fed with heat (hot water 70-100°C). The main benefit of using the solar thermal energy to feed the chiller is that, in general, the demand for cooling is the highest when the levels of solar radiation are high. Solar thermal cooling systems have then a high potential to replace conventional cooling machines based on electricity.

#### What are the basic components of a solar combi system?

A solar combi system includes the following main parts:

- **Solar thermal collectors:** to provide the heat, usually backed up by an **auxiliary heat source**, both flat plate collectors and evacuated tube collectors are suitable. Typically vacuum tube collectors have better properties in the transition- and winter periods, but the investment costs are higher than for flat plate collectors.



Source: Austria Solar/ESTIF

- **Flat-plate collector:** glazed flat-plate collectors are insulated, weatherproofed boxes that contain a dark absorber plate under a glass.
- **Evacuated-tube collectors:** they feature parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin
- **Hot water storage tank:** As solar radiation represents an intermittent energy source: the heat
- produced by the solar thermal collectors needs to be stored into a water storage tank to be used in any time.
- **Domestic hot water preparation (DHW) unit:** The domestic hot water preparation can be performed with an immersed heat exchanger or in an internal/immersed storage tank (tank in tank).
- **Auxiliary heating system:** the auxiliary heating required by the building can be provided in different ways according to the features and the needs of the building. Several types of auxiliary heating are available to be used in solar combi systems: biomass boilers, heat pumps district heating, oil, gas burners or electricity.



- **Sorption chiller:** is fed with hot water (70-100°C) so as to produce cold by using a thermo-chemical process. From this process, the heat rejection at intermediate temperature (30-40°C) needs to be dissipated through a cooling tower (dry or wet) or another heat sink (e.g. a swimming pool).

The Solar Combi Plus system can be connected to the existing heat distribution (preferably a low or medium temperature system) or cold distribution system (e.g. a chilled ceiling, fan-coils or air handling units)

**Closed systems:** thermally driven chillers provide chilled water, that is either used in air handling units to supply conditioned air (cooled, dehumidified), or that is distributed via a chilled water network to the designated rooms to operate decentralized room installations, e.g. fan coils. Market-available machines for this purpose are absorption chillers (most common) and adsorption chillers

**Open systems:** allowing complete air conditioning by supplying cooled and dehumidified air according to comfort conditions. The “refrigerant” is always water, since it is in direct contact with the atmosphere. Most common systems are desiccant cooling systems using a rotating dehumidification wheel with solid sorbent.

As the application uses a renewable energy source it offers environmental benefits: a reduction in conventional energy use, as well as lower levels of harmful emissions. The use of solar thermal energy also reduces the need for electrical energy, especially at midday during summer, which is a peak time for electricity use.

## Is a solar cooling system suitable for my hotel?

A solar cooling system will work for you if:

- Your hotel is located in a high solar radiation area like in the Mediterranean.

- Your hotel has big demand for space cooling (summer), space heating (winter), domestic hot water, swimming water heating, etc.
- Your hotel has the space available for a storage tank and for the equipment to dissipate the exceeding warm (i.e. cooling tower).

**Combi+ Systems** are gaining market share where space heating and space cooling is required in addition to domestic hot water. These systems are larger and save more energy. System performance depends on both the integrated control of system’s components and their respective sizing, with respect to the building and each component with regard to the other. In particular the following ratios have to be respected:

- Collector’s area/chiller rated power
- Storage tank
- Volume/collectors area. The systems are controlled electronically and require a yearly maintenance, as most of the heating system.

## Link with other technologies Swimming pools

The surplus heat produced can be used by the swimming pool. Using the heat rejection at intermediate temperature (30-40°C), as any heat sink or cooling tower. This heat is generated when transforming the heat into cold in the cooling machine; It is then a waste which can be valorized by heating the swimming pool.

## Solar Combi System

A thermally driven cooling machine can be combined to an existing solar thermal combi system so as to make a Solar Combi Plus system.



## BENEFITS FOR THE HOTELS



### COST REDUCTION

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In comparison with a conventional air conditioning system the investment costs for a solar-powered cooling system are around twice as high. However, the monthly energy savings are significantly higher than the monthly repayment costs, resulting in monthly savings, making the extra investment worthwhile. The balance looks even better if the cost savings for pool heating and domestic hot water are included.



### STAFF INVOLVEMENT

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Train your staff as guides to show guests the solar cooling machine you have installed and explain them how it is cooling down your hotel, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!



### GUEST INVOLVEMENT

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Install a demonstration diagram to show your guests how a your thermally driven solar cooling machine is producing cooling for your hotel. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

## BENEFITS FOR THE ENVIRONMENT



### CARBON EMISSIONS REDUCTION

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Slash carbon emissions, significantly reduce power grid load, and make full use of additional summer energy available from solar collectors.



## Renewable Energy Solutions

# Solar Thermal - Domestic Hot Water systems (DHWS)

## 1. General Information

*One of the most energy intensive (and therefore costly) processes in any hotel is the heating of domestic hot water. With energy costs always increasing, it's no surprise that hotels are looking for new ways to reduce their energy consumption. Renewable energy technologies such as solar domestic hot water systems are a good solution that is becoming more cost effective as fuel prices rise and will help hotels stay competitive and profitable.*



### How well developed is solar domestic hot water technology?

Solar domestic hot water is a mature and established technology. Manufacturers have produced and sold solar domestic hot water systems for decades already and due to continuous innovation, they can supply products that work effectively. To compare product quality there are certificates that apply throughout Europe, as well as national commendations that test and confirm the efficiency and quality of solar domestic hot water systems.

### What can my hotel use a solar domestic hot water system for?

Solar domestic hot water systems can heat water for guest rooms, housekeeping, laundry facilities, food services and more.

### How does a solar domestic hot water system work?

There are several types of solar hot water systems, but most pump cool water through pipes in a collector usually located on the roof of your hotel which has to be exposed to the sun. Glass on the front of the collector allows sunlight to pass into the collector, but prevents it from escaping, like a greenhouse.

The hot water returns then to an insulated storage tank, similar to a regular hot water tank and is ready then to be used by your hotel.

### Is there enough sun in my region to install a solar hot water system?

A solar domestic hot water system can be installed anywhere in Europe; just the size of the solar system must be changed to achieve enough solar yield.

### Do the solar domestic hot water systems still operate when it's cloudy?

On a cloudy day when there is little or no direct sunlight, there is still enough solar radiation to be usefully collected by solar collectors. While the highest amounts of monthly solar radiation are obviously experienced in the summer months, there is enough radiation coming from the sun in spring, autumn and winter to make a very useful contribution to your hotel's energy needs.

### And if the sun isn't shining, will I only have cold water in my hotel?

No. The storage tank holds the hot water until it is required and ensures that hot water is still available even when there is not enough sunlight. Most solar domestic hot water tanks also have a backup water heater (e.g., electricity, oil, pellets or natural gas), so there is always hot water when needed.

## Where do I mount the solar collectors in my hotel?

Solar collectors are most of the times installed either on the roof of your hotel, or on a freestanding installation in your hotel yard. There are also facade collectors or installations for balconies. When choosing a location for the installation the primary consideration should be the amount of sun exposure the collectors will get. For maximum daily output the collectors should face due south, be in the direct sun (no shading at all), and be mounted at an angle to the sun that will maximize their performance. A certified installer will be able to advise you on the best way to integrate a system into the space available in your hotel.

## How many collectors do I need for my hotel?

The number of solar collectors you'll need for your hotel will depend on the number of guestrooms, the amount of water used, your local climate and the location of the collectors (whether they're facing south or in a shaded area). For an accurate assessment of how many collectors your hotel needs consult a qualified installer for specific size and model specifications.

As a very general example, for a 20 guestrooms hotel located in the Mediterranean a solar domestic hot water system consisting of 7 glazed flat plate solar collectors with a total area of around 15 m<sup>2</sup> would cover most of the hotel's hot water demand.

## Do I need a planning permission in order to install a solar domestic hot water system?

Most solar collectors generally not require permission. Nevertheless, it is worth checking with your local administration or authorities to find out about any local laws that may restrict solar collector placement, especially if you live in a listed building or conservation area. Also solar obligations have now been adopted in Spain for example, where the new Spanish Technical Buildings Code (CTE Código Técnico de la Edificación) was adopted in March 2006, and its solar thermal section came into force in

September 2006 where an obligation to provide 30-70% of the domestic hot water demand with solar thermal energy has to be complied with. This applies to all new hotel buildings as well as those undergoing major refurbishment.

## How much does it cost to install a solar domestic hot water system, and how much can my hotel save?

The cost varies based on the size of a system, and how it fits into your hotel existing plumbing. You may find cheap and efficient solar hot water systems for warm regions (thermosyphon systems), but more complex systems for colder regions (with vacuum tube collectors, pumps, heat exchangers, antifreeze mixtures, controls...) Total savings depend on the amount of hot water and the type of fuel your hotel uses to heat water. Savings are the greatest for electricity users, and less for natural gas users. Typically in Europe, solar domestic hot water systems are sized to provide approximately 50-70 percent of the heating load per year.

On sunny summer days the system may provide nearly 100 percent of the heat required, while during extended cloudy periods, the output may drop to 20-30 percent. A certified installer will be able to estimate the output of the solar domestic hot water system and to give you a general cost/saving estimate for the system.



## What is the lifetime of a solar domestic hot water system?

Well maintained systems will usually last over 20 years so they should pay for themselves many times over in energy savings.

## How much maintenance does a solar domestic hot water system need?

A solar domestic hot water system is almost maintenance-free. However, the system should be checked periodically by a qualified service technician. Every three years the solar system should be tested to make sure it is frost-proof. The circulating pump, the tank, the non-toxic antifreeze mixture and other minor components are subject to wear and tear and may need to be replaced eventually.

## What is the payback time of a solar domestic hot water system?

The payback time for solar hot water systems can be relatively short. In very favorable cases (closely related to good solar radiation) 3 or 4 years paybacks are possible. Average paybacks of 5 to 6 years are also common.

Climate is important when calculating the payback of an investment in a solar system, since it also determines the type of collectors, system, needs, etc. To minimize payback period and maximize savings you need to aim for the biggest possible running capacity for the minimal possible investment in solar collectors. Installers should be able to work out the optimal size and type needed in respect to your hotel hot water needs and usage.

## How can I finance a solar domestic hot water system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your solar hot water system. Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There also banks promoting the use of solar hot water systems by granting long-term, low interest loans. Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).



## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over of the application paperwork to receive an incentive. Local energy agencies may also help you.

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a solar hot water system is in your best interest, because it will help make the existing hot water system as efficient as possible and will lower your hot water consumption and monthly energy bills. By reducing your hot water consumption you will need to pay much less for a solar hot water system that's capable of meeting your lowered-new hot water demand.

You can improve the performance of your hot water system and reduce the hot water requirements of your hotel by for example:

- Installing low-flow showerheads and faucets
- Installing body shaped bathtubs

- Installing new more efficient water pumps
- Insulating all hot water pipes
- Installing ozone laundry systems

## Who can install a solar domestic hot water system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduce the hotel energy costs, by taking care of the investments involved of installing a solar hot water system and sharing the resulting future cost savings with you by letting the ESCO install the solar hot water system in your hotel.

## Follow the next steps to make your solar domestic hot water system

- Learn as much as you can about solar domestic hot water systems before you make a decision.
- Schedule an on-site energy audit
- Call an installer and obtain estimates
- Check zoning, permit and utility requirements, insurance, and other legalities
- Look for financing options
- Install and learn how to safely maintain your system





## Renewable Energy Solutions

### Solar Thermal - Domestic Hot Water systems (DHWS)

#### 2. Technical Information

*One of the most energy intensive (and therefore costly) processes in any hotel is the heating of domestic hot water. With energy costs always increasing, it's no surprise that hotels are looking for new ways to reduce their energy consumption. Renewable energy technologies such as solar domestic hot water systems are a good solution that is becoming more cost effective as fuel prices rise and will help hotels stay competitive and profitable.*



#### How does a solar domestic hot water heating system work?

Solar water heating systems use free heat from the sun to warm domestic hot water. An auxiliary heat, additional boiler or immersion heater, is then used to make the water hotter, or to provide hot water when solar radiation is not sufficient. The solar fraction is the percentage of a building's seasonal energy requirements that can be met by a solar energy device or system. This fraction will be optimized through the sizing of the system so as to reach 50% to 100% or even more to be used in other features like swimming pools.

#### What are the basic components of a solar hot water heating system?

Solar water heating systems include the solar thermal collectors and a hot water storage tank. An auxiliary heat source is used as a back-up of the solar energy. Either conventional or renewable energy sources can provide any backup needed and may already be part of the solar system.

The collector has the role of "collecting" radiant energy and converting it into heat. Two types of solar collectors are used for SME hotel applications: flat plate collectors and evacuated tube collectors (also called vacuum tubes). Typically vacuum tube collectors have better properties in the transition- and winter periods, but the investment costs are higher than for flat plate collectors.

**Flat-plate collector:** glazed flat-plate collectors are insulated, weatherproofed boxes that contain a dark absorber plate under a glass.

**Evacuated-tube collectors:** they feature parallel rows of transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin. As solar radiation represents an intermittent energy source: the heat produced by the solar thermal collectors needs to be driven into a water storage tank to be used in any time.

There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't: **Active Solar Water Heating Systems:** These systems use pumps to drive the heat from the collectors to the hot water storage tank, and a heat exchanger which can be immersed (small size applications) or external (bigger applications). In areas with low risk of freezing, it's sometimes possible to have the potable water circulate directly through the collector, thus avoiding the commonly used closed primary circuit and the heat exchanger.

**Passive Solar Water Heating Systems:** Thermo syphon systems rely on the natural convection of warm water rising to circulate water through the collectors and to the tank (located above the collector). As water in the solar collector heats, it becomes lighter and rises naturally into the tank above. Meanwhile, the cooler water flows down the pipes to the bottom of the collector, enhancing the circulation.



These systems are widely implemented in Mediterranean areas (very popular in Greece, Cyprus) where both the heat needs and risks of freezing are reduced.

Collective solar domestic hot water systems are being installed into multi-family houses, hotels, office buildings etc. These collective systems have a collector surface ranging from ten to several hundred square meters.

Most of the larger systems used for collective solar thermal domestic hot water are designed as forced-circulation systems – using a pump, but multiple thermo syphon systems are also used where appropriate. Further information about collective solar thermal DHW can be found on the SOLARGE project's website.

<http://www.solarge.org/>



### TIPS:

- Passive solar water heating systems are typically less expensive than active systems, but they're usually not as efficient. However, passive systems can be more reliable and may last longer.
- Solar water heating systems require a backup system for cloudy days and times of increased demand. Conventional storage water heaters usually provide backup and may already be part of the solar system.

### Link with other solutions Solar Combi and Solar Combi Plus Systems

Solar domestic hot water technology is used both by the **solar combi systems** for space heating and the **solar combi+ systems** for space heating and cooling.

### Swimming pools

The Solar domestic hot water technology can also be combined with **swimming-pool heating**. The surplus heat produced in the warm season is sometimes used for heating the swimming pool.



## BENEFITS FOR THE HOTEL



## BENEFITS FOR THE ENVIRONMENT



### COST REDUCTION

- The sun doesn't send monthly bills!!!

Solar water heating is the most cost-effective use of solar energy in many climates. A solar hot water heating system will insulate your hotel from rising fossil fuel costs and protect you from fuel-price inflation over time since your hotel will not receive any more monthly energy bills for heating water.

### STAFF INVOLVEMENT

Train your staff as guides to show guests the solar hot water heating system you have applied and explain them how it works, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!

### GUEST INVOLVEMENT

Install a demonstration diagram or to show your guests how the sun is heating the water that is consumed in your hotel. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

### CARBON EMISSIONS REDUCTION

The energy produced is clean and emission-free. Solar water systems do not require fuel and produce no waste.



# Renewable Energy Solutions

## Solar heated swimming pools

### 1. General information

Do your guests wish to swim in your swimming pool for a much longer season than you are now able to offer them? Have you been dismayed by the running costs and environmental impact of conventional pool heating methods? Then take a look at the alternative, a solar swimming pool heating system that will bring your hotel swimming pool up to a comfortable swimming temperature for an extended season. Get ahead of the competition and advertise the fact that your hotel comes with a solar heated swimming pool.

#### How well developed are solar swimming pool heating systems?

Solar heated swimming pool systems are a mature and established technology. Manufacturers have produced and sold solar heated swimming pool systems for decades already and due to continuous innovation, they can supply products that work effectively. To compare product quality there are certificates that apply throughout Europe, as well as national commendations that test and confirm the efficiency and quality of solar heated swimming pool systems.

#### What can my hotel use a solar swimming pool heating system for?

Solar heated swimming pool systems can heat water for swimming pools, spas, jacuzzis and more.

#### How does a solar heated swimming pool system work?

A solar swimming pool heating system heats water in solar water collectors.

The solar water collectors are placed in an area that receives a lot of daily sun. The swimming pool water pump sucks water out of the pool, pushes it into the solar water collector, and brings it back into the pool. The water that runs through the collector picks up the heat from the collector, which warms up the water.

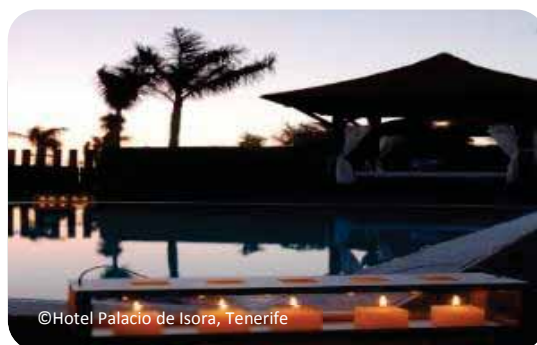
#### How difficult is it to install a solar swimming pool heating system?

It is relatively simple to integrate a solar water heater since most pools require a pump, filter, and plumbing.

With a solar energy system, the pool's water is pumped through the filter and then through solar thermal collectors instead of directly back to the pool. The sun heats the water in the collectors before it returns to the pool.

#### Do I have to change the existing pumps?

If you add a solar heater, you may need a pump larger than your present one, or a separate, smaller pump to pump the pool's water to and through the solar collectors. Adding any heater, solar or otherwise, will preclude selecting the smallest pump. Nevertheless, you may also reduce pumping time to help cut costs. A pump driven by a solar photovoltaic panel is also a good idea.



©Hotel Palacio de Isora, Tenerife

## For what else can I use my solar swimming pool heating system?

Solar collectors can also be used to cool the pool in hot climates or during peak summer months by circulating the water through the collectors at night. The collectors lose heat by radiation to the night sky.

## Should I install pool covers?

A pool cover or blanket reduces heat loss and helps maintain warm temperatures for a longer period. Uncovered swimming pools lose heat during the cool nighttime hours. A pool cover helps to keep the heat in the pool during the cool hours.

## Is there enough sun in my region to install a solar swimming pool heating system?

A solar swimming pool heating system can be installed anywhere in Europe; just the size of the solar system must be changed to achieve enough solar yield.

## Does a solar swimming pool heating system still operate when it's cloudy?

On a cloudy day when there is little or no direct sunlight, there is still enough solar radiation to be usefully collected by solar collectors. While the highest amounts of monthly solar radiation are obviously experienced in the summer months, there is enough radiation coming from the sun in spring, autumn and winter to make a very useful contribution to your hotel's energy needs.

## Are there special collectors used for solar swimming pool systems?

Collectors for heating a pool normally do not require glazing or insulation because they operate during warmer months when solar radiation and ambient temperatures are relatively high. This allows for a simpler design that is usually less expensive than collectors for domestic hot water.

Many pool collectors are made of heavy duty rubber or plastic treated with a UV light inhibitor to extend the life of the panels. The advantages of plastic collectors are that they're usually less expensive and weigh less than metal collectors.

## Where do I mount the solar collectors in my hotel?

Collectors can be mounted on roofs or anywhere near the pool that provides the proper exposure, orientation, and tilt toward the sun. For maximum daily output the collectors should face due south, be in the direct sun (no shading at all), and be mounted at an angle to the sun that will maximize their performance. A certified installer will be able to advise you on the best way to integrate a system into the space available in your hotel.

## How many collectors do I need for my swimming pool?

The area needed for collectors to heat your pool depends on many factors. A general rule of thumb is that the collector surface area should equal at least one half of the pool's surface area. In a relatively sunny climate, this additional heating helps extend the swimming season into spring and autumn. In cooler and cloudier areas, you may need to increase the collectors' surface area to equal the entire surface area of the pool.

## Do I need any planning permissions in order to install a solar swimming pool system?

Most solar collectors generally do not require permission.

Nevertheless, it is worth checking with your local administration or authorities to find out about any local laws that may restrict solar collector placement, especially if your hotel is located in a listed building or conservation area.

## How can I finance a solar swimming pool system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your solar swimming pool system. Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There also banks promoting the use of solar hot water systems by granting long-term, low interest loans.

Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).



## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are more and more taking over of the application paperwork to receive an incentive. Local energy agencies may also help you.

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a solar swimming pool system is in your best interest, because it will help make the existing swimming pool hot water system as efficient as possible and if possible a solar swimming pool system can be recommended which will lower your monthly energy bills.

## Who can install a solar swimming pool heating system for my hotel?

The proper installation of a solar swimming pool heating system depends on many factors. These factors include solar resource, climate, local building code requirements, and safety issues. A qualified installer or an Energy Service Company (ESCO) will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduces the hotel energy costs, by taking care of the investments involved of installing a solar swimming pool heating system and sharing the resulting future cost savings with you, by letting it install the system in your hotel.

### Follow the next steps to make your solar swimming pool heating system a reality:

- Learn as much as you can about solar swimming pool heating systems before you make a decision.
- Schedule an on-site energy audit<sup>5</sup>
- Call an installer and obtain estimates
- Check zoning, permit and utility requirements, insurance, and other legalities
- Look for financing options
- Install and learn how to safely maintain your system



# Renewable Energy Solutions

## Solar heated swimming pools

### 2. Technical Information

*Do your guests wish to swim in your swimming pool for a much longer season than you are now able to offer them? Have you been dismayed by the running costs and environmental impact of conventional pool heating methods? Then take a look at the alternative, a solar swimming pool heating system that will bring your hotel swimming pool up to a comfortable swimming temperature for an extended season. Get ahead of the competition and advertise the fact that your hotel comes with a solar heated swimming pool.*



#### What are the basic components of a swimming pool solar water system?

Most solar pool heating systems include the following: solar thermal systems, unglazed collectors can also be used independently for heating water in outdoor swimming pools. Designed for swimming pool heating, they are generally made of cheap materials, heavy-duty rubber or plastic. The pool water circulates directly from the collector to the swimming pool. Therefore, neither a storage tank nor a heat exchanger are needed. The solar system is part of the circuit used to filter the pool water.

These systems are cheap, easy to install and very effective in warm and sunny conditions. They will allow you to achieve a longer bathing day or season without energy consumption. However, when either the outside temperature or the solar irradiation decreases, their efficiency drops rapidly.

Flat plate or Vacuum tubes can be used with solar domestic hot water systems, combi or combi+ systems so as to heat the swimming pools, using the heat stored into the hot water storage tank (Large DHW or Combi systems) or the rejection heat from the cooling process (Combi Plus systems).

Various efficient combinations can be offered according to the specific potential and needs.

#### What are the basic components of a swimming pool geothermal heated system?

Geothermal Heat Pumps are a modern technology for heating of swimming pools.

They make full use of geothermal energy (the heat stored beneath the earth surface) almost anywhere throughout Europe. Swimming pools with geothermal heat pumps are systems with 3 main components: a ground site to get heat out or into the ground, a heat pump to convert heat to a suitable temperature level, and the equipment of the swimming pool transferring the heat into the pool.

The heat pump is a device which allows transformation of heat from a lower temperature level to a higher one, by using external energy (e.g. to drive a compressor).

Shallow geothermal systems can be adapted to almost every subsurface condition. Ground systems can be classified generally as open (with ground water) or closed (with ground collectors) systems.

#### Recommendations

Solar thermal and geothermal energy technologies can be applied in different conditions to meet various requirements: these technologies can be used both for domestic hot water heating, space heating and cooling, heating of the swimming pools, at a very low cost at no-cost energy throughout the year.

These technologies can be used in any climate and are almost maintenance free. If your site has unshaded East or south-facing areas, it is a good candidate for a solar thermal system. A professional installer can evaluate your roof as a location for the collectors. If your roof doesn't have enough space, you can also install the system on the ground. Geothermal solutions request a surface of ground available for the exchangers, should they be horizontal or vertical.

#### Link with other solutions

Swimming pool solar water/geothermal heating systems are compatible with any other energy source as back-up or main energy source.

## BENEFITS FOR THE HOTEL



### COST REDUCTION

- The sun and the earth don't send monthly bills!!!

Swimming pool solar water/geothermal heating systems will insulate your hotel from rising fossil fuel costs and protect you from fuel-price inflation over time since your hotel will not receive any more monthly energy bills for heating swimming pool water.



### STAFF INVOLVEMENT

Train your staff as guides to show guests the swimming pool solar water/geothermal heating system you have applied and explain them how it works, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!



### GUEST INVOLVEMENT

Install a demonstration diagram near the swimming pool to show your guests how the sun/earth are heating the swimming pool. Surprise your guests by showing them other ways to use solar/geothermal energy. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

## BENEFITS FOR THE ENVIRONMENT



### CARBON EMISSIONS REDUCTION

The energy produced is clean and emission free. Swimming pool solar water/geothermal heating systems do not require fuel and produce any waste.



# Renewable Energy Solutions

## Small wind energy systems

### 1. General Information

*Wind energy has been used for thousands of years to mill grain and pump water. Now, modern wind energy systems use the energy of the wind to turn turbines, which convert this energy to electricity. Wind has the potential to produce substantial amounts of green electricity, and small wind energy systems have a genuine role in achieving this.*

#### How well developed are small wind energy systems?

Small wind turbines are a proven technology with a track record of over 30 years. Growing demand for small wind systems could cut costs by more than half over the next decade. Small wind turbine generation capacity usually ranges from 1 to 75 kW.

#### How does a small wind energy system work?



A wind turbine works in the opposite way of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. Wind turbines convert the kinetic energy in wind into mechanical power that runs a generator to produce clean electricity. Small wind turbines are turbines which have lower energy output than large commercial wind turbines, such as those found in wind farms.

Wind turbines typically consist of three or more blades which can be mounted on a horizontal axis or a vertical axis. Horizontal axis wind turbines are by far the most common. Smaller models can be roof mounted whilst larger turbines tend to be mounted on masts up to 15 meters high. They are particularly useful where mains electricity is not available or is expensive to connect.

#### Is there enough wind in my region to install small wind energy system?

Knowledge of the local wind is critical to designing a wind energy system and predicting output. Strong and consistent winds will maximize energy generation. In general, a more exposed property has better wind potential.

#### Where do I mount small scale wind turbines in my hotel?

Wind speed increases with height so it is best to have the turbine high on a mast or small tower. The ideal siting is a smooth-top hill with a flat, clear exposure, free from excessive turbulence and obstructions such as large trees, houses or other buildings.



However, small-scale building-integrated wind turbines suitable for urban locations have now been developed and sit near to the apex of the roof - similar to an aerial or satellite dish.

### Do I need any planning permissions in order to install a small wind energy system?

Yes. Always consult your local planning department for details. Wind towers typically rise some meters to catch the best wind. Check local zoning ordinances for height and set-back restrictions before investing in a small wind energy system. Planning issues such as visual impact, noise and conservation issues also have to be considered.

### Are small wind turbines noisy?

Noise levels will clearly vary according to design, wind-speed and so on. A 2.5 kW turbine for example generates a noise that is negligible - hardly greater than the noise of the wind in the trees, and never a cause of complaint for local hotel guests.

### How much does it cost to install a small wind energy system, and how much can my hotel save?

Costs vary depending of the turbine, mast, inverters, battery storage (if required) and installation; however it is important to remember that costs always vary depending on location and the size and type of system.

### What is the lifetime of a small wind energy system?

Turbines have an expected life span of 20 to 25 years but require service checks every few years to ensure they work efficiently. For battery storage systems, typical battery life is around 6-10 years, depending on the type, so batteries may have to be replaced at some point in the system's life.

### How much maintenance does a small wind energy system needs?

All wind turbines should be serviced annually. This usually involves visual and noise checks for blade corrosion and component failure.

Some parts may need lubrication, but most systems have sealed bearings requiring no maintenance. For systems that use batteries you will need to keep the electrolyte regularly topped up and grease the terminals, unless they are maintenance free batteries. You should check in advance the cost of maintenance with your installer.

### What is the payback time of a small wind energy system?

Larger electricity users will have a shorter payback period, 10-15 years versus 15-25 years for smaller users, because generation costs decline as you increase turbine size and therefore production and use. The price your hotel pay for electricity, the cost per kilowatt hour and your hotel total monthly bill, dictate how long it will take to recover your investment in a wind turbine.

### How can I finance a small wind energy system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your small wind energy system. Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support. There also banks promoting the use of small wind energy systems by granting long-term, low interest loans.

Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).

## Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are increasingly taking over of the application paperwork to receive an incentive. Local energy agencies may also help you.

## Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a small wind energy system is in your best interest, because it will help make the existing electricity consumption as efficient as possible and will lower your consumption and monthly energy bills. By reducing your electricity consumption you will need to pay much less for small wind energy system that's capable of meeting one part of your lowered-new electricity demand.

## Who can install a small wind energy system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

## What is an ESCO?

An Energy Service Company (ESCO) reduces the hotel energy costs, by taking care of the investments involved in installing a small wind energy system and sharing the resulting future cost savings with you by letting it install the a small wind energy system in your hotel.

### Follow the next steps to make your small wind energy system a reality:

- Learn as much as you can about small wind energy systems before you make a decision.
- Schedule an on-site energy audit.
- Call an installer and obtain estimates.
- Check zoning, permit and utility requirements, insurance, and other legalities.
- Look for financing options.
- Install and learn how to safely maintain your system.
- Enjoy producing your own electricity.





# Renewable Energy Solutions

## Small wind energy systems

### 2. Technical information

*Wind energy has been used for thousands of years to mill grain and pump water. Now, modern wind energy systems use the energy of the wind to turn turbines, which convert this energy to electricity. Wind has the potential to produce substantial amounts of green electricity, and small wind energy systems have a genuine role in achieving this.*

#### What are the basic components of a small wind energy system?

Small wind energy systems are based on a rotor, a generator or alternator mounted on a frame, a tail (usually), a tower, wiring, and the electrical components: controllers, inverters, and/or batteries.

#### There are also two different ways of installing small-sized wind turbines:

- **Mast mounted:** these are free standing and are erected in a suitably exposed position, often around 2.5kW to 10kW in size.
- **Roof mounted:** these are smaller than mast mounted systems and can be installed on the roof of a hotel where there is a suitable wind resource. Often these are around 1kW to 5kW in size.

#### There are two different types of small wind turbines in the market:

**Horizontal-axis wind turbines (HAWT)** have the main rotor shaft and electrical generator at the top of a tower, and are pointed into the wind by a simple wind tail. Small HAWT can also be installed in roofs.

**Vertical-axis wind turbines (VAWT)** have the main rotor shaft arranged vertically. Key advantages of this arrangement are that the turbine does not need to be pointed into the wind. By using VAWT the generator and gearbox can be placed near the ground. VAWT are able to take wind from multiple directions, so that they are more applicable for use at low heights, on rooftops, and in urbanized areas. Their ability to function well at low heights is particularly important when considering the cost of a high tower necessary for traditional HAWT.



Vertical-axis wind turbines (VAWT)



Horizontal-axis wind turbines (HAWT)

## Is a small wind energy system suitable for my hotel?

A small wind electric system will work for you if:

- The hotel property has a good wind resource
- No large obstacles like buildings, trees or hills are near your hotel
- There is enough space
- The local zoning codes or covenants allow wind turbines
- Your hotel is comfortable with long-term investments

## Design your small wind energy system

For hotel applications, you should establish an energy budget to help define the turbine size you will need. Depending upon the average wind speed in the area, a wind turbine rated in the range of 5 to 20 kW would be fine to make a first significant contribution to an hotel energy demand.

Wind turbine manufacturers will help you size your system based on your electricity needs and the local wind patterns. Manufacturers can provide you with an expected annual energy output of the turbine as a function of annual average wind speeds and will also tell you the maximum wind speed at which the turbine is designed to operate safely. This information will help you decide which turbine size will best meet your electricity needs.

## Will I need any permits or inspections to install a small wind energy system?

Turbines used for hotels are much quieter than their wind farm counterparts, but you'll need to check with your local authorities as “bigger” turbines could not be permitted in some areas. Small vertical turbines emit lower noise, have a lower profile and are considered to be generally more aesthetically pleasing than their small horizontal axis counterparts.

A wind turbine can be a relatively large device, needs to be high above nearby buildings and mature tree lines, and often must abide by zoning laws.



### TIPS:

- Small wind turbines can be mounted on a free-standing pole or mast or on a building above the highest point of the roof.
- Bigger turbines should be mounted on a suitable tower to raise them above any nearby obstacles. A good rule of thumb is that turbines should be at least 9 m higher than anything within 150 m. In general, an effort should be made to make sure that a small wind turbine is as far away as possible from large upwind obstacles.
- The economics of a wind system are very sensitive to the average wind speed in your hotel and the electricity prices. As a rule of thumb, you should have at least a 15 km/h average wind speed and be paying at least 10 € cents/kWh for electricity. Some new vertical axis models are now being produced to generate electricity with wind speeds as little as 8 km/h.



### Link to other solutions

- Small wind energy systems complement PV solar energy systems very well.
- A solar-wind hybrid energy system can provide a more reliable source of electricity because the sun tends to shine stronger when the wind is slack and vice versa.
- Battery storage provides more consistent output from a wind turbine.
- Costs vary, as hybrid systems can be tailored to meet site conditions and customer needs.



## BENEFITS FOR THE HOTEL



### COST REDUCTION

- The wind doesn't send monthly bills!!!

Over the long term, a wind turbine is a good investment because a well-sited wind system increases property value, similar to any other hotel improvement.



### STAFF INVOLVEMENT

Train your staff as guides to show guests the small wind energy system you have installed and explain them how it works, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!

## BENEFITS FOR THE ENVIRONMENT



### GUEST INVOLVEMENT

By installing a small-scale wind turbine on a suitable site, you can generate electricity to help power your home, reduce your energy bills and cut down harmful carbon dioxide (CO<sub>2</sub>) emissions at the same time.



### CARBON EMISSIONS REDUCTION

Install a demonstration diagram near your small wind turbine to show your guests how the wind is producing clean energy for your hotel. Surprise your “small” guests with a colourful windmill to show them the power of the wind. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

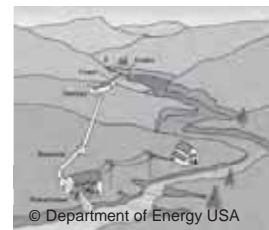


# Renewable Energy Solutions

## Micro Hydropower System

### 1. General information

*Micro hydropower is one of the most reliable and consistent sources of renewable energy available. A good water resource with a year-round flow and elevation drop can provide years of continuous power. Hydro resources are the most site specific, since your hotel must have a usable water source. If you are one of the lucky few hotels with a stream running down your hillside, it's the resource to assess first.*



#### How does a micro hydropower system work?

A micro hydropower system converts the energy from flowing water into electricity. Flowing water turns a turbine, which in turn converts this energy to electricity.

#### What can my hotel use a micro hydropower system for?

This electricity can then be used, offsetting the cost of buying in electrical power, and any excess power can be sold back into the grid, often generating significant incomes to your hotel.

#### How much electricity can my hotel produce by installing a micro hydropower system?

The first step before installing a micro hydropower system is to evaluate your water resource by measuring the vertical drop and flow of your stream. These two measurements are necessary to calculate the energy potential of your stream/river/creek. The next step is to design a system that will effectively harness that potential since the electrical power output depends of the efficiencies of the turbine and generator.

#### How many types of micro hydropower systems exist?

Although there are several micro hydropower systems, run-of-the-river systems, which do not require large storage reservoirs, are the most often used for micro hydropower systems.

#### What is a run-of-the-river micro hydropower system?

Although there are several ways to harness the moving water to produce energy, run-of-the-river systems, which do not require large storage reservoirs, are often used for micro hydro systems. A 'run-of-river' system means that the water passing through the generator is directed back into the stream with relatively little impact on the surrounding ecology. In run-of-river systems the turbine generates electricity as and when the water is available and provided by the river meaning that they have no or relatively small water storage capability.

#### Is a micro hydropower energy system suitable for my hotel?

To build a small hydropower system, your hotel needs access to flowing water and sufficient



quantity of falling water must be available, which usually, but not always, means that hilly or mountainous sites are best.

### What happens in summer?

If the river dries up and the flow falls below some predetermined amount or the minimum technical flow for the turbine, the electricity generation stops.

### Do I need to build a dam?

The dams built for micro hydropower systems are very small and impound little water—and many projects do not require a dam at all.

### What are the environmental impacts of a micro hydropower system?

Micro hydropower systems are exempt from many of the environmental problems associated with large-scale hydropower systems (impacts on wildlife habitat, fish migration, and water flow and quality) because they use the natural flow of the river, and thus produce relatively little change in the stream channel and flow.

### How can I avoid any visual impact by installing a micro hydropower system?

The turbine and the majority of the machinery for micro hydropower systems can be hidden in a small building by the side of the river. This may be designed in a traditional style to blend in with the surroundings. Similarly the pipes can be buried, reducing any visual impact that they might have to the hotel.

### What are the advantages of micro hydropower systems?

If your hotel has a suitable site, harnessing the energy from a stream or creek can be the most cost-effective way to produce renewable electricity. Compared to the sun and wind's variability, a stream's flow is relatively consistent, making micro hydropower systems output one of the most predictable of all the renewable energy systems.

### Do I need any planning permissions in order to install a micro hydropower system?

Planning permission will almost certainly be required for any micro hydropower system. Contact your local planning authority for more information. Installing dams, weirs or other water diversions in rivers and streams requires a permit or approval

### How much does it cost to install a micro hydropower system, and how much can my hotel save?

It is difficult to generalize the cost of micro hydropower systems, as every site is unique. The initial costs could be quite high, but with micro hydro sites having the potential to run indefinitely, they represent a good investment that can be very cost effective. The price for a turbine and generating equipment may be similar at two sites but pipelines length and required civil works can vary greatly, impacting the costs.



### How much maintenance does a micro hydropower system need?

Micro hydropower systems generally require less time for operation and maintenance than other renewable energy systems. However, hotels must be willing and able to perform maintenance to keep their systems running optimally and safely. Micro hydropower systems will require periodic component replacements, e.g. a new generator every 10-15 years and new turbine approximately every 25 years, but with this maintenance they can produce clean, green electricity indefinitely.

### What is the impact of a micro hydropower system for fish?

Well-designed micro hydropower systems are environmentally benign. However, poor design can disrupt an ecosystem, especially for spawning fish.

### What is the payback time of a micro hydropower system?

This will vary depending on the local cost of electricity, state and local rebates or incentives, and the installed cost of the micro hydropower system. The range can be from 5-10 years up to 20 years depending on these factors.

### How can I finance a micro hydropower system?

You may fund your renewable energy system in several ways. Many financial incentives which can benefit your hotel are available for example. However, these have not been used to their maximum potential. Incentives can save you in some cases more than 50% of the cost of your micro hydropower system. Check for national incentives and don't forget that your local utility company or other local organization may also provide additional support.

There also banks promoting the use of micro hydropower systems by granting long-term, low interest loans.

Visit [www.iea.org/country/index.asp](http://www.iea.org/country/index.asp) under 'related country and regional information' for more information about available incentives in your country (available for IEA member countries only).

### Who can help me with the paperwork for applying to receive financial incentives?

Installation companies are more and more taking over of the application paperwork to receive an incentive. Local energy agencies may also help.

### Should my hotel receive an energy audit?

Definitively yes. Doing an energy audit before investing in a micro hydropower system is in your best interest, because it will help make the existing energy consumption as efficient as possible and will lower your energy consumption and monthly energy bills. By reducing your energy consumption you will need to pay much less for a micro hydropower system that's capable of meeting your lowered-new energy demand.

### Who can install a micro hydropower system for my hotel?

A qualified installer or an Energy Service Company (ESCO). Installers will estimate the overall cost, and will also inform your hotel about rebates and incentives for which you may qualify.

### What is an ESCO?

An Energy Service Company (ESCO) reduce the hotel energy costs, by taking care of the investments involved of installing a micro hydropower system and sharing the resulting future cost savings with you by letting the ESCO install micro hydropower system in your hotel.

#### Follow the next steps to make your micro hydropower system a reality:

1. Learn as much as you can about micro hydropower systems before you make a decision.
2. Schedule an on-site energy audit.
3. Call an installer and obtain estimates.
4. Check zoning, permit and utility requirements, insurance, and other legalities.
5. Look for financing options.
6. Install and learn how to safely maintain your system.



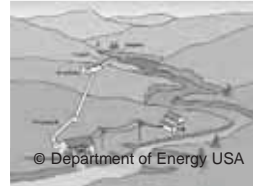


# Renewable Energy Solutions

## Micro Hydropower System

### 2. Technical information

*Micro hydropower is one of the most reliable and consistent sources of renewable energy available. A good water resource with a year-round flow and elevation drop can provide years of continuous power. Hydro resources are the most site specific, since your hotel must have a usable water source. If you are one of the lucky few hotels with a stream running down your hillside, it's the resource to assess first.*



#### How does a micro hydropower energy system work?

Micro hydropower is a term used for hydroelectric power installations that typically produce up to 100 kW of electricity. A micro hydropower system can produce enough electricity for a small hotel. Micro hydropower is based on very simple concepts. Moving water turns a turbine, the turbine spins a generator, and clean electricity is produced. Hydropower systems use the energy in flowing water to produce electricity.

#### What are the basic components of a micro hydropower energy system?

The construction details of a micro hydropower plant are site-specific, but the common elements of all hydroelectric plants are always present. Micro hydropower energy systems consist of:

- Water conveyance—channel, pipeline, or pressurized pipeline (penstock) that delivers the water.
- Turbine or waterwheel—transforms the energy of flowing water into rotational energy
- Alternator or generator—transforms the rotational energy into electricity
- Regulator—controls the generator
- Wiring—delivers the electricity.

#### Designing your micro hydropower energy system

In order to take full advantage of the electrical potential of small streams, a suitable site is needed. Before you can begin designing your micro hydropower system or estimating how much electricity it will produce, you will need to make four essential measurements:

- Head (the vertical distance between the intake and turbine)
- Flow (how much water comes down the stream)
- Pipeline (penstock) length
- Electrical transmission line length You'll need to determine the amount of power that you can obtain from the flowing water on your site. The power available at any instant is the product of what is called flow volume and what is called head. Water power is the combination of head and flow. Both must be present to produce electricity.

Consider a typical micro-hydro system. Water is diverted from a stream into a pipeline, where it is directed downhill and through the turbine (flow). The vertical drop (head) creates pressure at the bottom end of the pipeline.

The pressurized water emerging from the end of the pipe creates the force that drives the turbine. More flow or more head produces more electricity.

## Which are the main requirements to install a micro hydropower system?

The obvious site requirement is to have a water source which is suitable for a micro hydropower system. The most important suitability criteria for the watercourse are:

- Head (difference in height between the water inlet and the turbines)
  - Flowrate (volume of water passing per second)
- The typical components of a system are:
- An intake to divert the flow of water from the water course
  - A penstock pipe to convey water from the source to the turbines
  - A generating set to convert the head and flowrate into electricity
  - An outflow through which water is returned to the watercourse
  - Cables, either overhead or underground, to bring the electricity to the hotel

## Do micro hydropower systems impact the environment?

All micro hydropower systems have an environmental impact. Water is abstracted from the main stream and diverted through a turbine before being returned to the main flow.

During this stretch the flow in the main stream is depleted which could adversely affect biodiversity – because of this the amount of flow that can be taken from the flow will be regulated in order to leave an acceptable base ‘residual’ flow level. However a well-designed hydro scheme will mitigate any environment damage caused during construction and over time will generate ‘clean’ energy for many years.

## Are micro hydropower systems fish friendly?

Where migratory fish exist in a river, a fish ladder must be installed to enable fish to complete their journey upstream. Turbines are not ‘fish friendly’ so adequate screening both up and down stream has to be provided to stop fish entering the turbine.

## Link with other technologies?

Micro hydro systems complement PV solar energy systems because in many areas, water flow, is highest in the winter when solar energy is at a minimum.



©European-travel scenery

## BENEFITS FOR THE HOTELS



### COST REDUCTION

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- Water doesn't send monthly bills!!!

Whatever the upfront costs, a micro-hydro system will typically last a long time and is relatively maintenance free. There are many factors to consider when buying a system, but with the right site and equipment, careful planning, and attention to regulatory and permit requirements, small hydropower systems can provide you a clean, reliable source of power for years to come.



### STAFF INVOLVEMENT

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Train your staff as guides to show guests the micro hydropower energy system you have installed and explain them how it works, you can both attract more tourists and further involve your staff in order to get them feeling more responsible for their working place!



### GUEST INVOLVEMENT

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Install a demonstration diagram near your micro hydropower turbine to show your guests how the water flow is producing clean energy for your hotel. By motivating your guests, they will also feel more responsible and involved in taking care of your hotel! Guests will value the fact that your hotel is environmentally conscious.

## BENEFITS FOR THE ENVIRONMENT



### CARBON EMISSIONS REDUCTION

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By investing in a small hydropower system, you can reduce your exposure to future fuel shortages and price increases, and help reduce air pollution.

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# Renewable Energy Solutions

## Deep Water Cooling

### General Information

*The demand for air conditioning in hotels has grown over the years but a method to provide air conditioning to hotels by taking advantage of an available cold water source (usually deep cold water from a lake or ocean) already exists.*

#### For what can my hotel use a deep lake/ocean water cooling system for?



With deep lake/ocean water cooling system you can provide air conditioning to your hotel by taking advantage of an available cold water source from deep cold water from a lake or ocean.

#### How does a deep lake/ocean water cooling system work?

Deep cold water from a lake or ocean is pumped through a heat exchange which facilitates the energy transfer between the deep lake/ocean water and the internal hotel building closed loop, providing chilled water for your hotel cooling system.

#### How well developed is deep lake/ocean water cooling technology?

Deep lake/ocean water cooling system is a proven technology and is technically and economically feasible today.

#### Where can I install a deep lake/ocean water cooling system?

In hotels that have access to a large quantity of cold water.

#### How do I know if a deep lake/ocean water cooling system is a good choice for my hotel?

Along many ocean coastlines and lake shorelines, there is reasonable access to naturally cold water that is as cold or colder than the water used in conventional air conditioning systems. If this water can be tapped, then the significant power for operating mechanical chillers can be eliminated. The process is very similar to using chillers in conventional air conditioning systems. The only difference is that the cold temperature is not achieved by evaporation of a liquid into a gas. Rather, it is retrieved from a natural cold water source - from a deep ocean or lake.

#### How is the corrosion of salt water avoided in a deep lake/ocean water cooling system?

Heat exchangers are normally made of titanium to avoid the corrosion from salt water.



## What are the advantages of a deep lake/ocean water cooling system?

- Up to 90% reduction in energy consumption
- CFC-free chilling technology
- Fixed pricing promotes operating cost predictability



## How much would a deep lake/ocean water cooling system cost?

The economic viability of a deep lake/ocean water cooling system for your hotel is site specific. Each location has unique opportunities as well as problems. The main factors influencing the economic viability of a specific location include:

- The distance to reach the cold water from your hotel: longer pipelines are more expensive than short pipelines
- The size of your hotel air conditioning load: small systems are less economically viable
- The global use of the air conditioning system: The higher the use of air conditioning throughout the year, the higher the direct benefits
- The local cost of electricity: high electricity costs makes a deep lake/ocean water cooling system more attractive







Contact  
**World Tourism Organization**  
ICR-HES@unwto.org

42, Capitan Haya  
28020 Madrid SPAIN  
Tel: +34 91 5679 305  
**www.unwto.org**

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