YOUR GUIDE TO

RENEWABLE ENERGY IN THE HOME

SUSTAINABLE ENERGY IRELAND

Who is Sustainable Energy Ireland?

Sustainable Energy Ireland (SEI) was set up by the government in 2002 as Ireland's national energy agency with a mission to promote and assist the development of sustainable energy. SEI's activities can be divided into two main areas:

- ***Energy Use*** - Energy is vital to how we live our daily lives but most of us don't use energy as efficiently as we could. By assisting those who use energy (mainly industry, businesses and householders), to be more energy efficient, SEI can help to reduce the amount of energy we use overall.

- ***Renewable Energy*** - Energy that is generated from renewable sources such as wind and solar power is clean and doesn't produce harmful greenhouse gases. By promoting the development and wider use of renewable energy in Ireland SEI can help to further benefit the environment, in particular reducing the threat of climate change.

SEI is also involved in other activities such as stimulating research and development, advising on energy policy and publishing energy statistics.

Sustainable Energy Ireland is funded by the National Development Plan 2000-2006 with programmes part financed by the European Union.

sei SUSTAINABLE ENERGY IRELAND

Did you know…

- **Energy use is responsible for two-thirds of Ireland's greenhouse gas emissions.**
- **Irish homes use around a quarter of all energy used in the country– that's even more than industry.**
- **The average home consumes almost 40% more electricity than it did in 1990.**
- **Renewable energy currently accounts for approximately 2% of Ireland's energy supply.**

Introduction

Energy is essential to the comfort of our homes, providing space and water heating and electricity. However, there are many ways in the design, construction and operation of our homes of reducing energy needs and meeting those needs with renewable sources, without compromising warmth and comfort.

Currently, we rely heavily on fossil fuels such as coal, oil, and gas to provide our energy needs. Fossil fuels are non-renewable, that is, they draw on finite resources that will eventually run out. In contrast, renewable energy resources, provided from the sun, wind and water are constantly replenished and will never run out.

Fossil fuels are also damaging to the environment. They contribute significantly to many of the environmental problems we face today such as greenhouse gases, air pollution, and water and soil contamination - while renewable energy technologies enjoy lower running costs and are clean sources of energy that have a much lower environmental impact.

Energy is available from a variety of renewable sources appropriate to our homes, including solar, geothermal, biomass, hydro and wind.

Solar Energy

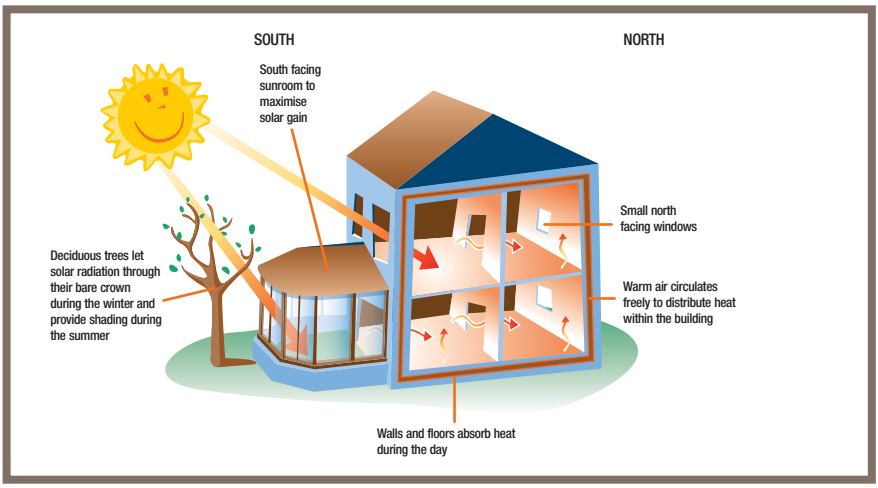
A horizontal surface of 1m^2 receives an average of between 1,000 and 1,100 kWh of solar energy per year, similar to that of central Europe. This energy is provided by both direct sunlight (40%) and indirect sunlight (60%) and can be harnessed in many ways to heat your home, provide hot water and generate electricity.

Passive Solar Design

Passive solar design is a design approach that maximises the collection of solar heat, minimises heat loss from the building and provides natural ventilation and daylight. Unlike active solar heating systems, it doesn't involve the use of mechanical and electrical devices, such as pumps, fans or electrical controls to collect or store the solar heat. Instead energy costs are reduced and the comfort of your house increased by:

- selecting a sheltered location to build on
- constructing a compact building form with high levels of insulation
- positioning the house at an orientation that maximises passive solar heating and daylight

Direct gain is the simplest passive solar design technique. It necessitates glazing to be concentrated to the south façade and minimised to the north façade. Sunlight enters the house through south-facing windows and is absorbed and stored in the masonry walls and floors. At night, as the room cools, the heat stored in the thermal mass convects and radiates into the room. This maintains a comfortable, even temperature in the home.



A well designed sunspace or conservatory on the south façade can also reduce the heating needs of a house by acting as a solar collector in late spring, summer and early autumn, and by acting as a buffer against heat loss at other times. It is important to choose a high performance glazing, at least double-glazing with a low-emmisivity coating, to limit heat loss through glazed areas. However, there are many examples of sunspaces which are poorly designed from an energy point of view and increase heating requirements. Fully glazed conservatories should not be heated and should be separated from the heated space by closeable doors. They should not be regarded as being habitable all year round, as the energy losses from heated conservatories can negate the energy saved by passive solar collection.

Passive solar homes can look like any other home, and need not cost any more to build, but they are more comfortable to live in and cost less to run.

Active Solar for Space and Water Heating

Introduction

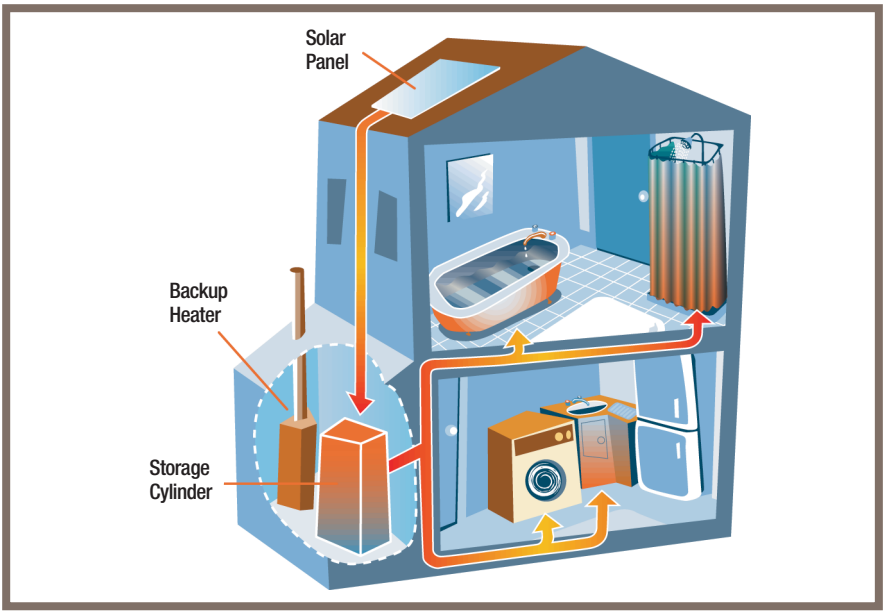
Active solar energy systems generally incorporate a roof mounted solar collector, which receives direct and indirect sunlight and changes it into heat. This heat may be used to provide for hot water, or in a combined system, for space and hot water needs. At the end of 2003, approx. 12 million m^2 of solar thermal collectors were installed in the EU. There is great potential to increase this further.

How it works

Solar collectors can provide 50% of the annual hot water demand of a typical home, depending on the orientation, size, mounted angle and efficiency of the collector. The most common application is for water heating, and $4m^2$ of solar collector can provide about 80% of hot water needs in summer and 20% in winter (when there is less solar heat available) for a typical family. The solar water system needs to be backed up with a conventional heat source to provide the remainder of the hot water needs such as an electric immersion in the storage cylinder.

Installation in the Home

Solar water heating systems for homes have two main parts: a solar collector and a hot water storage cylinder. Typically, a flat-plate collector (a thin, flat, rectangular box with a transparent cover) is mounted on the roof, facing the sun. The sun heats an absorber plate (usually a black metal plate) in the collector, which, in turn, heats the fluid running through pipes within the collector. To move the heated fluid between the collector and the storage cylinder, a system either uses a pump or gravity, as



water has a tendency to naturally circulate as it is heated. Systems that use fluids other than water in the collector's pipes usually heat the water by passing it through a coil of tubing in the storage cylinder. Evacuated tube collectors can also be used instead of the flat plate. These consist of an array of evacuated glass tubes each containing an absorber tube, which collects solar energy and transfers it to a heat transfer fluid. During the manufacturing process, air is evacuated from the space between the two tubes, forming a vacuum. This vacuum greatly reduces heat loss from the system because there is no air to conduct the heat away.

The heat absorbed by the collectors is then transferred to the hot water storage cylinder through a number of heat exchangers. Evacuated tube systems tend to be more efficient than flat plate systems. However, a similar output could be achieved with a flat plate system simply by increasing the area of the collector.

Ideally, panels need to face directly south. However, a good output can still be achieved between south east and south west. A typical installation will take 2-3 days.

Today, solar thermal systems are readily available, easy to install and are reliable in operation. Flat plate systems are imported from Northern Europe and evacuated tube systems are manufactured in Northern Ireland. Generally systems come with a 10 year warranty. A professional installer will advise on an optimised solution for your specific needs.

Payback and Maintenance

The payback period of a solar water heating system will vary depending on the cost of the fuel you are replacing and the amount of hot water you consume. A typical correctly installed system has a payback period of between 7 and 15 years and little maintenance is necessary. Most systems are run by an electricity-powered pump, which will cost a small amount to run per year. Generally systems come with a 10 year warranty and their lifetime is about 25 years. For a list of suppliers, contact us (see back of booklet for details).

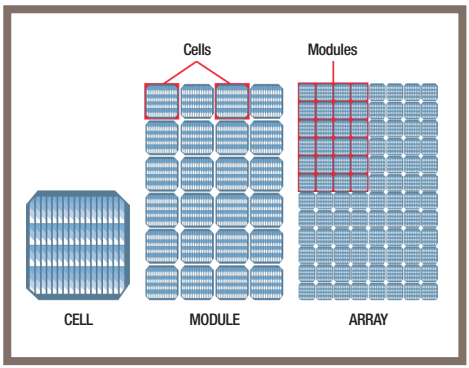
Active Solar for Electricity

Introduction

Photovoltaics (PV), which also collect sunlight, are a very different technology to solar water heating, as they use the light to generate electricity. Today, the industry's production of photovoltaic (PV) modules is growing at approximately 25% annually, and major programs in the U.S.A., Japan and Europe are rapidly accelerating the implementation of PV systems on buildings and connection to electricity grid networks.

How it works

Photovoltaic solar cells, which directly convert sunlight into electricity, are made of semi-conducting materials, such as crystalline silicon. The power output of a PV cell depends on its efficiency and surface area, and is proportional to the intensity of sunlight striking the surface of the cell.



Groups of PV cells are electrically configured into modules and arrays, which can be used to charge batteries, operate motors, and to power electrical loads. With the appropriate power conversion equipment, PV systems can produce alternating current (AC) compatible with any conventional appliances, and operate in parallel with and interconnected to the electricity grid network.

PV has the great advantages of being silent in operation with a low visual impact making them particularly suitable for urban areas.

There are two general types of PV systems, stand-alone and grid-connected systems:

Stand-Alone Systems

Stand-alone systems produce power independently of the electricity grid network. In some off-the-grid locations, stand-alone photovoltaic systems can be more cost-

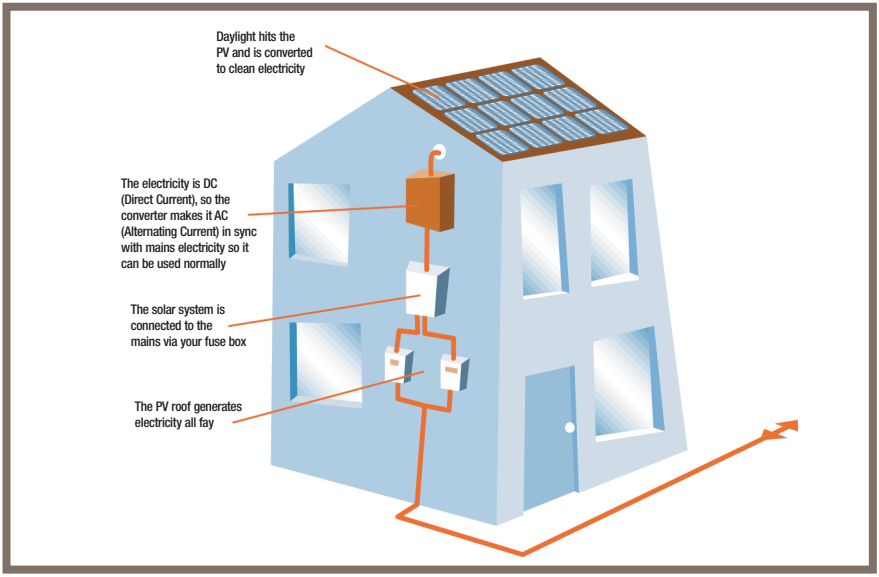
effective than extending existing power lines. Direct-coupled systems need no electrical storage because they operate only during daylight hours, but most systems rely on battery storage so that energy produced during the day can be used at night. Some systems, called hybrid systems, combine solar power with additional power sources such as wind or diesel generators. As well as domestic applications, stand-alone systems can be used to power traffic warnings, parking meters, emergency telephones and buildings in remote locations.

Grid-Connected Systems

Grid-connected photovoltaic systems, supply surplus power back onto the grid and electricity is drawn from the grid at periods when demand in the home exceeds the PV output. Grid-connected systems are generally integrated into the structure of buildings, but can also be ground mounted. These systems remove the need for battery storage. In some cases, utility companies allow additional metering*, which allows the owner to sell excess power back to the utility company.

Installation in the Home

A PV array produces power when exposed to sunlight. They can be installed on an existing roof, be an integral part of the roof covering as panels or tiles installed within roof glazing systems or installed on a nearby structure. It is important that nothing casts a shadow over the area where the PV panels will be mounted. PV panels generate more electricity on bright days but do not require direct sunlight, so normal daylight is sufficient to produce electricity. The ideal orientation for PV panels is south facing, although they still produce around 80% of the optimum output when facing east or west.



* At time of print no utility company offered this option for domestic scale generation in ROI

A number of other components are required to properly conduct, control, convert, distribute, and store the energy produced by the array. Depending on the functional and operational requirements of the system, the specific components required, may include major components such as a DC-AC power inverter, battery bank, system and battery controller, auxiliary energy sources and sometimes the specified electrical load.

Payback and Maintenance

PV is expensive, but with new materials and ongoing product development, it is expected that the price of PV cells will become more competitive in the future. In fact, the price has reduced by one third in the last ten years. Stand-alone systems often provide the most effective solution when grid electricity is not available. For installations in larger buildings, cost savings are possible when PV panels are integrated in the building design, where they can substitute for other construction materials providing the external skin of a building.

Today's photovoltaic modules are extremely safe and reliable products, with minimal failure rates. Most major manufacturers guarantee the high efficiency operation of their PV modules for 20 or more years, with projected service lifetimes in excess of this. PV panels have no moving parts and require minimum maintenance.

Ground Source Heat Pumps

Introduction

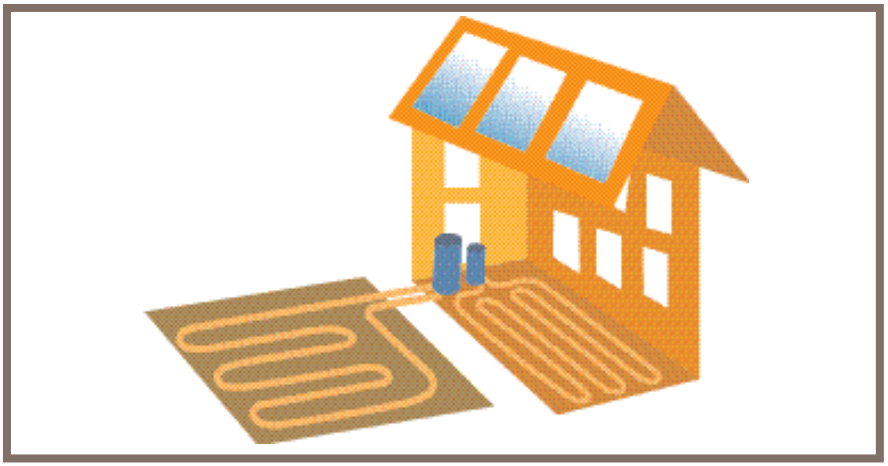
Ground source heat pumps, also known as geothermal heat pumps, are used for space heating and cooling, as well as water heating. They operate on the fact that the earth beneath the surface remains at a constant temperature throughout the year, and that the ground acts as a heat source in winter and a heat sink in summer. They can be used in both residential and commercial or institutional buildings.

How it works

The earth's surface acts as a huge solar collector, absorbing radiation from the sun. In this country the ground maintains a constant temperature between 11ºC and 13ºC, several metres below the surface. Ground source heat pumps take advantage of this by transferring the heat stored in the earth or in ground water to buildings in winter and the opposite in summer for cooling. Through compression, heat pumps can 'pump up' heat at low temperature and release it at a higher temperature so that it may be used again. A heat pump looks similar and can perform the same functions as a conventional gas or oil boiler, i.e. space heating and sanitary hot water production. For every unit of electricity used to operate the heat pump, up to four units of heat are generated. Therefore for every unit of electricity used to pump the heat, 3-4 units of heat are produced.

Installation in the Home

The system has three main components: a series of pipes in the ground, a heat pump and a heat distribution system. Lengths of plastic pipes are buried in the ground, either in a borehole or a horizontal trench near the building to be heated or cooled. Fluid, normally water with anti-freeze, absorbs or emits heat to the soil, depending



on whether the ambient air is colder or warmer than the soil. In winter, the heat pump removes the heat from the fluid, upgrades it to a higher temperature for use in the building, typically in under-floor heating.

A distribution system is needed to transfer the heat extracted from the ground by the heat pump. The heat is often in the form of hot water and is distributed around the dwelling by radiators or a low temperature underfloor heating system.

Payback and Maintenance

The initial capital costs of installing a ground source heat pump system is usually higher than other conventional central heating systems. A large proportion of the outlay will be for the purchase and installation of the ground collector. However, the system is among the most energy efficient and cost effective heating and cooling systems available. Typically, four units of heat are generated for every unit of electricity used by the heat pump to deliver it, and the payback is typically about 8-10 years. The life expectancy of the system is around 20 years. Once installed a heat pump requires very little maintenance and anyone installing a heat pump should speak with their installer regarding a maintenance agreement. For a list of suppliers, contact us (see back of booklet for details).

Biomass / Wood

Introduction

The words biomass or bioenergy are used to describe energy resources derived from organic matter, such as residues from forestry, agriculture and industry, or from purpose grown crops. These resources can be used to provide heat, electricity and transport fuels. It provides about 1% of Ireland's energy needs in the form of domestic and industrial wood heating. Using wood fuel instead of fossil fuels (oil, coal, gas or peat) makes a positive contribution to the environment. Wood, is a 'carbon neutral' fuel. It absorbs as much CO_2 when it grows as is released when it burns – a natural cycle. Wood fuel takes just 5-20 years to grow, whereas fossil fuels such as peat and coal were formed over hundreds of thousands of years.

The main types of wood fuel are chips and pellets. Wood chips are a bulk fuel and, as such, are generally unsuitable for domestic properties. However, they are usually a cheaper fuel than pellets and are appropriate for larger buildings such as offices, public buildings or to heat clusters of domestic properties through a district heating system. Wood pellets are compressed wood, usually sawdust or wood shavings. They are typically 6-12 mm in diameter and 6-20 mm in length. Pellets have the advantage of uniformity in shape and composition, are easy to ignite, are dry, create little ash and will flow freely through feeding mechanisms such as hoppers and augers. These properties make pellets ideal for automatic appliances.

Wood fuel can be used to create both electricity and heat and is a well established renewable energy source in many countries, including the USA, Sweden, Austria and Denmark. It has a great potential for use in the country, particularly for heating.

How it works

Pellets are highly suitable for houses and can be burned in either a boiler or a stove. Pellet boilers provide full central heating and hot water, with a convenience normally associated with oil or gas. Stoves provide heating for a single room. Stoves are available in a range of styles, from traditional-looking wood-burning stoves to modern, minimalist designs. Good quality appliances use modern controls to ensure an efficient, clean burning fire. Because they use thermostatic controls and fans to distribute warm air around the room they are safer than traditional stoves, which rely on radiated heat to warm the room, making the room's temperature uneven and the body of the stove dangerously hot.

Installation in the Home

The installation is similar to that of any central heating boiler or stove, and requires a flue and a fresh air supply to be installed for safe and efficient combustion. Many products are programmable to allow you to set the temperature that you require and some can even be controlled by mobile phone remote control.

Stoves contain an integrated fuel hopper that must be filled manually. Once full, the hopper automatically supplies fuel to the stove, allowing it to operate independently for around 20-40 hours. For boilers or larger systems which require a greater fuel input, you may decide to site your storage facility adjacent to the boiler, and install a completely automatic fuel feed system, such as an auger, so that you do not have to re-fill the hopper manually.

Fuel storage is an important consideration as pellets are a bulky fuel, requiring about three times the storage space of oil. However this requirement could be met with more frequent deliveries. The store must also be kept completely dry as pellets disintegrate on contact with water.

Payback and Maintenance

Maintenance is similar to that of conventional stoves and boilers. The ash pans of both stoves and boilers will require emptying, typically once per month for stoves and once every three months for boilers.

Unlike many renewable energy technologies, with biomass you still need to buy fuel. Wood chip boilers are usually cheaper to run than oil or mains gas. Pellet prices vary, but are generally comparable with oil and mains gas. Pellets are usually available in bags or are delivered loose in bulk.

Planning permission may be required if you need a flue or chimney to be installed or if you live in a conservation area.

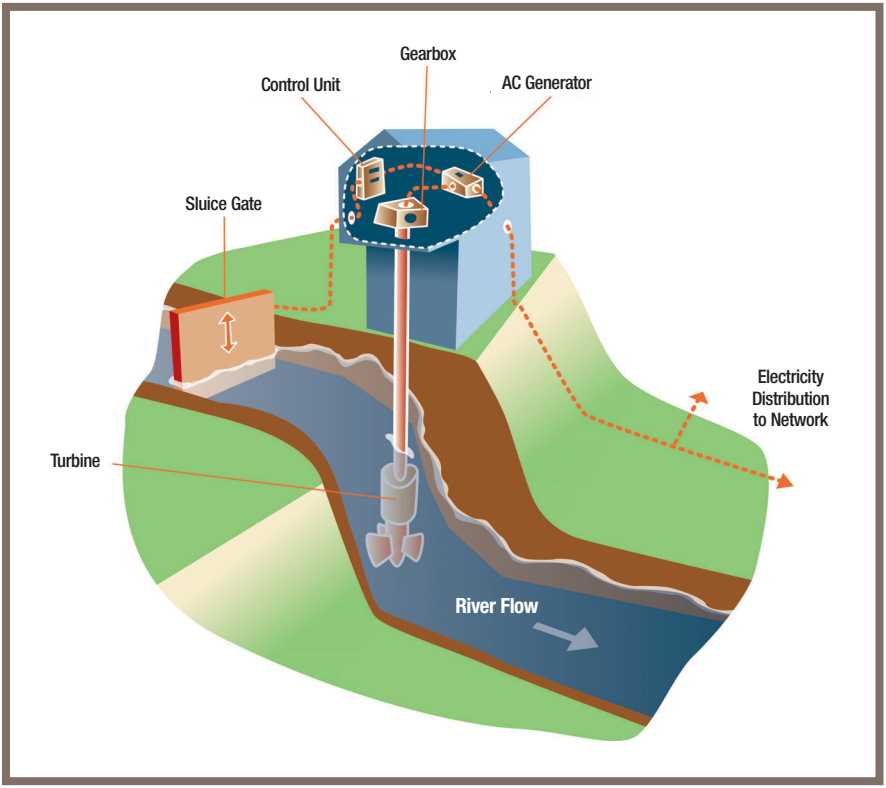
For a list of suppliers, please visit our website.

Hydro

Introduction

Hydropower has produced mechanical energy for hundreds of years but was first used to produce electricity in the 1870's. Most Irish installations are run of river installations. As such, hydro installations in this country are generally dependent upon precipitation and have little impact on their surrounding environment.

Hydro electricity has the greatest energy yield factor of the renewable technologies meaning the energy it produces in its lifetime greatly exceeds the amount of energy used in its manufacture, operation and eventual disposal. This is due to the reliability and long lifespan of a hydro system. For example, a modest 20kW scheme would save 70 tonnes of CO_2 being released into the atmosphere each year from fossil fuelled power stations.



How it works

The power generation from a hydro scheme is dependent upon two variables, the height the water falls, (head) and the volume of water available, (flow). Water is diverted from a given point on a river, ideally near a weir and piped through to a turbine house downstream, where the water falls through a turbine and drives a generator. The water passes through the turbine and returns to the river unpolluted. Various measures are taken to ensure fish are not directed into the channel, which feeds the turbine. These can include mesh screening and electric currents in the water to deter fish from entering. If a hydro scheme is proposed on a fish migratory route, a 'fish pass' is built which is designed to guide fish away from the turbine house and up a series of basin-like steps.

Installation

The feasibility of a hydro scheme will depend very much upon the proposed site, as much capital is often spent on civil engineering work such as the weir, water channel and fish pass. A site such as a disused millrace may have an existing weir or water channel and this will reduce the capital per kilowatt outlay.

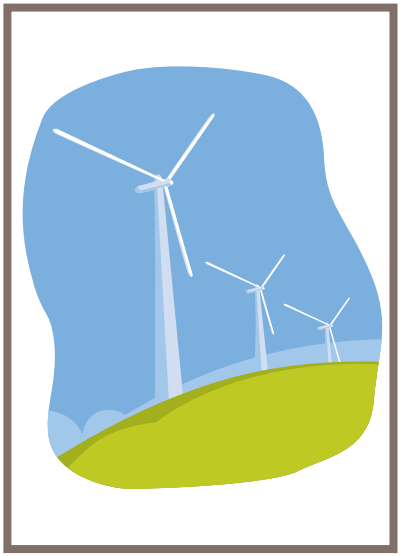
Communication with downstream water users is essential to unite support. Fisheries and anglers who use the river can be strong opponents and will seek assurances that their livelihoods or leisure activities will not be harmed.

Your local planning authority should be consulted at an early stage and planning permission must be sought for any hydro installation.

Wind

Introduction

Wind is an abundant source of energy, especially in Ireland. Large-scale wind turbines are now installed around the country and off shore to provide for Ireland's electricity needs and supplying 'green' electricity to consumers from the utility grid.



How it works

For residential sites that have connection to the electricity grid, the cost effectiveness of installing a wind turbine should be carefully examined. In this situation, the annual electricity demand, wind resource and daily demand profile must be considered. If you wish to purchase electricity from a wind turbine, you may be able to sign up to a 'green electricity' supply tariff.

Small-scale wind turbines range in size from less than 1kW to 50kW. They can be cost effective in off-grid applications and wind power can be more economic than other renewable options. Energy storage in batteries is necessary in off-grid applications. Large-scale turbines up to 3MW in size, usually installed on windfarms, are generally connected to the grid.

Installation

Wind speed and direction will determine the most suitable position for a wind turbine. Wind speed increases with height, so turbines will give a greater output if placed at a higher level.

Further information on local wind speeds can be obtained from *www.sei.ie/renewableenergy* for ROI or *www.actionrenewables.org* which has a postcode-based wind atlas for NI.

Payback and maintenance

Wind turbines have a number of moving parts so annual maintenance is required and your installer can provide this. The payback period of a wind turbine is dependent on utilisation of the electricity generated, which should be off set against that taken from the grid. Payback is therefore highly variable, but could be as short as 15 years.

Notes

Notes

Relevant Standards

Building Regulations, 2002
Part L: Conservation of Fuel and Energy
Part F: Ventilation/Part J: Heat Producing Appliances

ISEN 832 - Thermal performance of buildings - calculation of energy use for building -residential buildings CEN 1998.

Useful Contacts for Further Information

For information on renewable energy in the home
SEI Renewable Energy Information Office, Shinagh House, Bandon, Co Cork
www.sei.ie

For information on energy efficiency measures
SEI, Glasnevin, Dublin 9

For information on sustainable living
ENFO Information on the Environment, 17 St. Andrew Street, Dublin 2
www.enfo.ie

For information on solar technologies
Energy Research Group, UCD School of Architecture, Richview, Clonskeagh, Dublin 14.

For information on insulation
Insulating Contractors Association, Construction Industry Federation,
Federation House, Canal Road, Dublin 6.

For information on building products standards
National Standards Authority of Ireland, Glasnevin, Dublin 9.

Irish Agrément Board, Glasnevin, Dublin 9.

Source Text

Energy Research Group UCD

This booklet is printed on environmentally friendly paper.

Read our other publications:

A Detailed Guide to Insulating Your Home

A Detailed Guide to Home Heating Systems

Your Guide to Renovating an Older Home

Your Guide to Building an Energy Efficient Home

A Consumer Guide to Sustainable Energy

How to Make Your Home More Energy Efficient

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