ECOLOGICAL SUSTAINABLE FEATURES

1.0 Introduction

In the context of ever rising energy costs, climate change and increasingly stringent legislation aimed at reducing our carbon dioxide emissions, every household is in need of a heating technology that is future-proof, cost effective and independent of fossil fuels.

The use of renewable energy which is derived from inexhaustible sources such as wind, the sun, sea, or replaceable sources such as waste products and crops, is a way of reducing our impact on the planet. Using renewable sources brings a number of benefits including:

- a secure, local and inexhaustible resource
- reduced dependence on non-renewable fossil fuels
- cleaner air
- less carbon dioxide and other greenhouse gases
- a good option for people living in remote areas who may find it difficult or costly to get connected to the grid
- lower fuel bills and heating system running costs

The I Capannini concept is to provide luxury living in a spectacular location, but at low cost to the owner and the environment.

I Capannini will have fully integrated leading edge eco technology installed to heat and cool the building, heat the swimming pool, heat the domestic water and provide the electricity required for everyday living and even recycle rainwater for irrigation.

The buildings will be traditionally reconstructed in stone, but achieve very high (Grade A) insulation standards. Heating will be provided underfloor by geothermal heat pumps with photovoltaic and solar panels providing energy, not only for I Capannini but also fed back into the grid itself, ensuring a carbon neutral impact on the environment. The design of the buildings maximises the use of natural daylight within the building, minimising the need for lighting in the houses and utilises solar lighting in the gardens, paths and driveways.

2.0 Eco features - Main House and swimming pool

The main house will secure its energy needs from a geothermal ground source heat pump. This will provide under floor heating/cooling and hot water supplemented by photovoltaic panels. The swimming pool and hot tub will also be heated through these sources and enhanced with a heat recovery system, minimising loss of energy. Solar panels will provide a electricity supply to all pumps and feed back into the grid when excess energy is produced, generating further income that can offset costs.

Heat Pumps

Heat pumps are among the most efficient heating and hot water systems available today, supplying more energy than they consume by tapping into the freely available, inexhaustible solar energy stored in the earth, the ambient air or water and converting this for use in a heating system.

Approximately 75% of the energy needed by the heating system is extracted from the environment, so the only energy required is electricity needed to drive the heat pump compressor. This can be provided by the PV panels.

Every 1kWh of electricity used to run the heat pump, up to 4kWh of useful heat is provided, giving the heat pump an efficiency of up to 400%.

Low carbon heating solution

Whenever fossil fuels such as gas or oil are burnt, carbon dioxide is released. CO_2 is the principle contributor to the greenhouse effect which is leading to long term climate change.

However as heat pumps extract as much as 75% of their heating energy from the environment, building carbon emissions for heating can be reduced by as much as 50% compared with gas fuelled heating systems.

This helps result in:

Lower heating system carbon dioxide emissions

Lower heating system running costs

Low running costs, low ownership costs

The considerable contribution from renewable energy sources also helps to provide running cost savings over fossil fuelled heating system as well as future proofing the system against future energy price increases.

But fuel costs are only part of the story. Unlike gas and oil based systems, heat pumps require no costly regular maintenance or annual safety inspections. And because a heat pump has a reasonable life expectancy of 20 – 25 years – typically twice that of a boiler – the investment costs can be recovered over a longer period, meaning the total ownership costs over the working life of the system are significantly lower.

The technology

A heat pump heating system consists of 3 components: the heat source, the heat pump itself and a heat distribution and storage system. Heat pumps are able to produce more energy than they consume by using the conventional refrigeration cycle to absorb heat from the environment and raise it to a suitable level for heating.

A large quantity of low grade energy absorbed from the environment is transferred to the refrigerant inside the heat pump (evaporator). This causes the temperature of the refrigerant to rise (even at sub zero temperatures) causing it to change from a liquid to a gaseous state.

The refrigerant is then compressed, using an electrically driven compressor, reducing its volume but causing its temperature to rise significantly. A heat exchanger (condenser) then extracts the heat from the refrigerant to heat water for underfloor heating and domestic hot water. After giving up its heat energy the refrigerant turns back into a liquid and after passing through an expansion valve can once again absorb energy from the environment, allowing the cycle to begin again

Ground source heat pumps extract heat from the earth all year round via ground heat collectors buried beneath the ground. Due to highly stable temperatures below the earth's surface, ground source heat pumps provide high levels of efficiency for space and water heating all year round. Significant savings can be achieved from a 48kW system, which would cost approximately £40,000 to install:

Fuel Displaced	£ Saving per year	CO2 saving per year
Electricity	£3500	28 tonnes
Oil	£1960	7.2 tonnes
Solid	£1600	26 tonnes

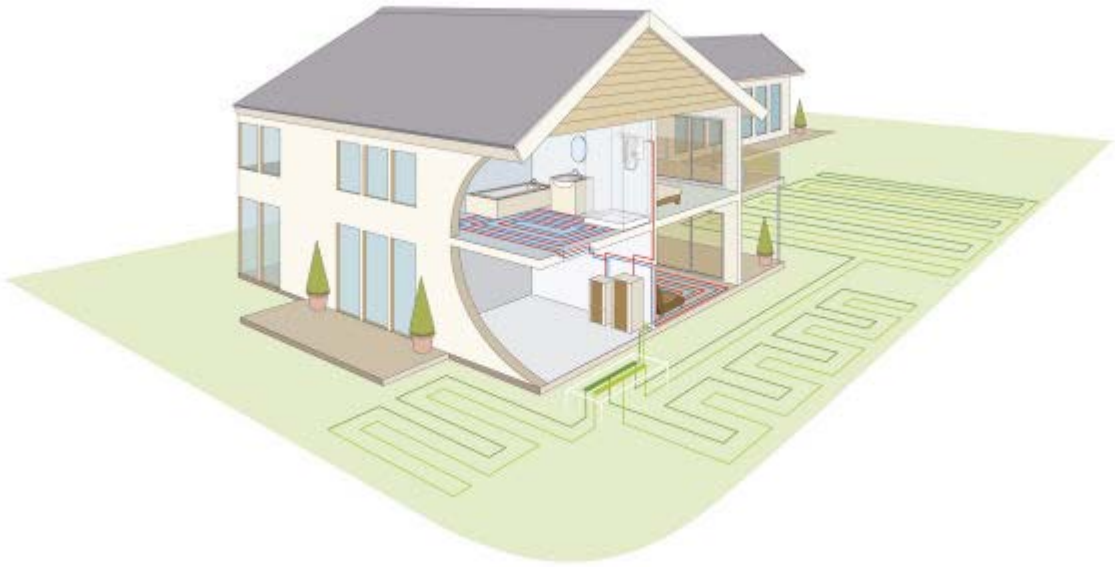
Savings above are approximate and assume ground source heat pump installed providing up to 50% of domestic hot water as well as 100% of space heating.

The earth stores an enormous amount of solar energy from both solar radiation and rainfall. To extract this energy, ground collectors consisting of flexible poly ethylene pipes are buried in the earth, either horizontally or vertically. A mixture of water and anti-freeze is then circulated through the pipe loops, attracting the heat energy and transferring it to the heat pump.

Horizontal ground collectors

If a large enough land area is available, horizontal ground collectors provide an effective method of extracting heat from the ground. The pipework is buried at a depth of approximately 1.2m and spaced 0.75m apart. The land area required is dependent on both the capacity of the heat pump and heat conductance of the soil

type in which the pipes are buried. As a space saving alternative to horizontal collectors, slinkies - consisting of coiled pipes buried in a trench – can be used.



Vertical boreholes

If land space is limited the ground collectors can be installed vertically in a borehole, drilled up to 100m deep in the ground. Multiple boreholes are commonly used in large installations where very high levels of heat extraction are required.

Solar photovoltaic panels

Solar PV (photovoltaic) uses energy from the sun to create electricity to run appliances and lighting. PV requires only daylight, not direct sunlight to generate electricity and so can still generate some power on a cloudy day.

Photovoltaic systems use cells to convert sunlight into electricity. The PV cell consists of one or two layers of a semi conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers causing electricity to flow. The greater the intensity of the light, the greater the flow of electricity.

PV cells are referred to in terms of the amount of energy they generate in full sunlight, know as kilowatt peak or kWp. The main house at I Capannini will utilise approximately 6kWp of energy from this source, with the smaller property requiring about 1.5 kWp. Installation costs are approximately £5,000 for each kWp installed.

Installation costs are mitigated in the short term, through the generation of surplus energy, which will be sold back to the energy company Enel and in the longer term by significantly reduced energy bills and maintenance costs.

PV systems produce no greenhouse gases. A domestic system can save over 5 tonnes of carbon dioxide per year, adding up to almost 120 tonnes over a system's lifetime.

Grid connected systems **require very little maintenance**, generally limited to ensuring that the panels are kept relatively clean and that shade from trees has not become a problem. The wiring and components of the system should however be checked regularly by a qualified technician.

Solar Water systems

Solar water heating systems use heat from the sun to work alongside the conventional water heater. The technology is well developed with a large choice of equipment to suit many applications. For domestic hot water there are three main components

Solar panels or collectors - are fitted to your roof. They collect heat from the sun's radiation. There are 2 main types of collector:

Flat plate systems - which are comprised of an absorber plate with a transparent cover to collect the sun's heat, or

Evacuated tube systems - which are comprised of a row of glass tubes that each contain an absorber plate feeding into a manifold which transports the heated fluid.

A heat transfer system - uses the collected heat to heat water;

Hot water cylinder - stores the hot water that is heated during the day and supplies it for use later.

Solar water heating can be used in the home and the swimming pool. A large installation, typically costing approximately £20,000 to provide can generate significant savings:

Fuel Displaced	£ Saving per year	CO_2 saving per year
Electricity	£320	2400 kg
Oil	£260	1460 kg
Solid	£220	2600 kg

All savings are approximate.

3.0 Eco features - Second House and plunge pool.

The second house in the grounds of I Capannini also uses renewable energy and minimises energy use through high insulation standards.

Again photovoltaics and solar panels will provide additional hot water and electricity needs. Investigations are also being conducted to examine the benefits of wind generated energy provided by a micro wind turbine, to take advantage of the cooling winds that I Capannini benefits from year round.

The high insulation standards of the building will mean that energy use is minimised. A mast mounted micro wind turbine, costing approximately £15,000 could generate as much as 6KW supply which would satisfy the bulk of the property energy needs.

4.0 Other eco energy sources

Biomass is a carbon neutral energy source as it only releases the amount of CO2 that it absorbed whilst growing. It is most cost effective and sustainable when a local fuel source is used, utilising local employment and minimising transport costs.

Woody biomass can comprise of forest products which can be simply harvested from the surrounding national forest surrounded I Capannini. Wood burners will be installed in the main house and the second house to provide top up energy, typically generating 5-7 kW in output, to provide a perfect ambience on cold winter days.

5.0 Summary and Conclusions

I Capannini will provide an ultramodern energy efficient environment in a traditional tuscan setting. Whether the properties are used as the main home or for recreational purposes, the owner can be assured that not only are the running costs of the homes minimised, but also the cost to the environment is significantly reduced.

Eco technology has an established track record across the world for reliability and functionality. The location of I Capannini with its natural rich resources of sunshine and water allow the maximum benefit to be derived, without harming the environment in which it is situated.