Householders As Energy Providers

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By

Remi Wilkinson
Senior Analyst

CarbonFree undertakes consultancy, research and analysis for vendors, investors and energy providers.

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For further information contact:-

CarbonFree
20 Leaden Hill, Orwell
Royston, Herts.
SG8 5QH
UK
Tel. ++ 44 (0) 1223 208926
Email info@carbonfree.co.uk
Web www.carbonfree.co.uk

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Small-scale energy generation, or microgeneration, is not a new concept and householders were using solar water heating systems long before the 1970s energy crisis. However, it was the oil price shock that brought the concept of small-scale energy production to the public's attention, creating what promised to be a thriving market for household microgeneration systems. While falling oil prices have depressed this market, some homeowners have persisted with DIY generation of energy from renewable sources.

During the 1970s, when oil seemed set to break the $50 ($100 at today's prices) per barrel barrier, energy derived from renewable sources was on the verge of becoming competitive with energy generated by burning fossil fuel. The reason the alternative energy market did not disappear completely when oil prices fell is that, for some householders, the decision to invest in their own generating equipment was motivated by emotion rather than economics. These householders wished to reduce their carbon footprint by replacing some of the energy generated by burning fossil fuels – which they use to heat and light their homes – with energy derived from renewable sources.

Recently the cost of fossil fuels has begun to climb again. This time price rises are steady and uniform and, so far, the industrial economies of the developed world have been spared an oil price shock. Even so, householders have started to spend money on small-scale energy generation equipment. Energy consumers keen to reduce their carbon footprint have been joined by householders who believe that oil prices will continue to rise as will the cost of heating their homes. The idea of having an energy generation system under their own control is attractive for householders who are currently dependent on expensive and insecure energy supplies. As well, the prospect of selling surplus energy back to an incumbent energy provider is an added incentive for potential purchasers of microgeneration systems.

In the US, 61% of the housing stock is detached. If the owners of just 10% of these 70 million houses installed a single kilowatt of energy generation capacity, up to 7 Gigawatts of energy demand would be removed from the grid and annual demand for fossil fuel could be reduced by the equivalent of 14 million barrels of oil. However, there are a number of key issues that have to be addressed as the market for small-scale energy generation installations residential use develops. Choosing the most suitable technology – solar, wind, geothermal or hybrid – for a particular location will be key to the success of the installation. As the householder is basing investment on projected fossil fuel prices, there is the potential for the formation of a market bubble that distorts investment decisions throughout the industry.

This report examines key factors that will influence the growth of small-scale generation technology that householders can use to convert natural energy into power for domestic use. It also analyses a range of technologies supplied by vendors who are already active in the alternative energy market, and considers how wider deployment of these technologies will impact on the energy market.

At A Glance

Householders concerned over the size of their carbon footprint are experimenting with DIY energy generation, creating a niche market for microgeneration technology vendors.

In the face of a steady and persistent rise in fossil fuel prices, householders are concerned they will not be able to afford to power their homes.

These householders provide microgeneration technology vendors with a rapidly growing customer base. Solar PV, solar hot water, wind and geothermal technology vendors are all seeing a growing demand for their products and services.

Continued market growth will see the dynamics of the domestic energy market change and technologies, such as hybrid geothermal, provide opportunities for incumbent energy providers.

Some householders are being led to believe they will have surplus energy to sell back to grid operators. In the future, validation of vendor's claims regarding performance of microgeneration systems may be necessary.

This report examines the key factors that will influence the growth of small-scale generation technology that householders can use to convert natural energy into power for domestic use.

Included in this report are profiles of Solartwin, Solar Century, EarthEnergy and Windsave and analysis of the role these companies will play in the microgeneration market.

1 Introduction

The threat of climate change, insufficient fossil fuel reserves for the long-term future, and insecurity of imported fuel supplies is driving the search for alternatives to fossil fuels. The price of fuel has been rising and will continue to do so in the face of the increasing rate of development in the economies of China and India. There will come a time when the cost of the energy required to provide light and heat for homes, and to power an increasing number of household appliances, will become prohibitively expensive. Although nuclear energy will be added to the fuel mix, it will take a decade or more to build nuclear fission plants, and issues such as the disposal of radioactive waste and public confidence in the safety of the technology still need to be resolved. Similarly, generating power from nuclear fusion plants is still in the experimental stage. Much is being done by governments to encourage greater use of renewable energy. Recently there has been increasing attention paid to the potential role of the householder in the reduction of carbon emissions and the use of renewable energy based microgeneration technology as a means of reducing dependence on fossil fuels.

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In the developed world, domestic energy consumption per household runs in excess of 2,000 kg of oil equivalent . Some of this consumption can be offset, with a consequent reduction in energy bills, by the use of renewable energy. Geothermal and solar energy can be used for space heating and heating water, while solar photovoltaic (PV) systems and micro-wind turbines can be used to generate electricity. Some environmentally aware householders are switching to providers who supply energy derived from renewable sources such as hydro, tidal, wave, and large-scale wind turbine installations, while others are resorting to microgeneration.

Geothermal and solar energy can be used for space heating and hot water. Solar PV systems and micro-wind turbines can generate electricity.

In 2004, only 0.5% of energy used in homes was from renewable sources, which includes energy from waste [1]. Clearly, there is significant scope for increasing the use of this largely untapped resource. The high cost of installing renewable energy systems and the long payback times remain a barrier to widespread adoption of microgeneration technology. However, as more householders install systems, the renewable energy sector will achieve scale and the cost of equipment will eventually fall to the point where microgenerated energy is competitive with that produced by burning fossil fuel.

There are a number of practical issues regarding the installation of wind, solar and geothermal technologies in housing. The distributed energy generation model will impact on the business model of the energy provider and grid operator, while the use of renewable energy within the consumer market will impact the fossil fuel market.

The idea that householders could become energy providers is relatively new and has been picked up on by vendors of equipment and systems that extract energy from renewable sources. Care must be taken that householders are not misled as to what is achievable using current technology and do not expect to earn a significant return on their investment by selling surplus energy back to grid operators.

Care must be taken that householders do not have their expectations of what is achievable using current technology raised too high.

2 Wind Energy

Harnessing the power of the wind requires the installation of wind turbines that can be either off-grid or on-grid. Turbines can be mounted on poles, rooftops, masts or towers. Depending on its location and size, a typical home would require a 2.5–6 kW peak output system to meet its total power requirements. Systems providing up to 1 kW cost approximately $5,000 while those providing 1.5–6 kW cost between $7,000 and $30,000. These costs are inclusive of the turbine, mast, inverters, battery storage and installation.

Installing wind turbines is only cost effective for the householder if the house is sited in an off-grid location with average wind speeds in excess of 5 metres per second and where there are no obstructions, such as tall buildings and trees, to cause turbulence. Turbines need to be mounted reasonably high up to take advantage of the fact that wind speeds increase significantly with distance from the ground. Planning permission, or planning consent in the case of micro-wind turbines, must be obtained before installation in view of a turbine's height, visibility, and possible impact on wildlife. Consideration must also be given to neighbours who may object to the potential noise from, and visual impact of, the turbine. Small-scale building integrated micro-wind turbines that are silent and non-resonating with the building structure are now available from manufacturers such as Windsave and Renewable Devices. Turbines can have a useful life of up to 20 years, but require service checks every few years to ensure they are working efficiently. Depending on local wind conditions, the typical payback period for the outlay on equipment and installation for a microturbine is between eight and ten years. Either the price of electricity must rise or the cost of turbines must fall, by at least 50%, if the technology is to gain widespread appeal.

Installing wind turbines is only cost effective for the householder if the house is sited in an off-grid location with average wind speeds of 5 metres per second and where there are no obstructions.

The average payback time for the outlay on equipment and installation of a microturbine is between five and eight years.

Small-scale building integrated micro-wind turbines that are silent and non-resonating with the building structure are now available from manufacturers such as Windsave and Renewable Devices.

www.windsave.com
www.renewabledevices.com

3 Solar Energy

3.1 Solar Hot Water Systems

Solar panels, or collectors, can be used to provide or augment space and water heating in a home. Solar panels mounted on the roof transfer the sun's heat to a hot water tank by circulating water by convection (in a passive system) or by a pump (in an active system). Pumps need to be powered by electricity that is, in most cases, taken from the grid. However, systems provided by Solartwin and Solar Century incorporate a solar photovoltaic (PV) powered pump.

While the amount of radiation available in northern Europe is not as high as in other parts of the world, solar water heating is currently the most cost effective, affordable renewable technology for most householders. A typical domestic system will provide 72% of a household's hot water over the course of a year – around 15% in winter and 100% in summer. Temperatures of 70°C to 85°C can be expected on sunny summer days, and 50°C to 60°C on sunny winter days (10–15 days per winter month). The typical cost for a domestic system, including installation, is between $10,000 and $13,000 with the equipment expected to last 10 years. Typical payback periods range from 10 to 12 years.

While the amount of radiation available in northern Europe is not as high as in other parts of the world, solar water heating is currently the most cost effective, affordable renewable technology for housing.

Solartwin and Solar Century supply systems that include a photovoltaic powered solar pump.

www.solartwin.com
www.solarcentury.co.uk

3.2 Solar Photovoltaic (PV) Systems

There are now a range of solar photovoltaic (PV) technologies that can be used to convert the sun's energy into electricity. The electricity consumption of an average household is 4,700 kilowatt-hours (kWh) per year, and a PV system can provide between 30% and 50% of this. Planning permission is not normally required unless the panels project significantly beyond the roof slope, or the building is of historic significance or located in or close to a conservation area.

The electricity consumption of an average household is 4700 kWh per year, and a PV system can provide between 30% and 50% of this.

The average domestic system costs between $7,000 and $16,000 per kilowatt-peak (kWp), with most domestic systems usually between 1.5 and 2 kWp, putting total expenditure in the range of $14,000 for a 2 kW system and $50,000 for a 5 kW system. Solar tiles that closely resemble conventional tiles are now available from vendors such as Solar Century, although they charge a premium for such products. The same applies to panels that can be integrated into, rather than sitting proud of, a roof. Typically, a PV system will last for more than 30 years, but the payback period for this technology far exceeds this, and with electricity priced at 10 cents per kW/h the householder will not be able to recoup their outlay on a solar PV system for over 40 years. There are new solar PV technologies that are in the advanced stage of development and these should reduce the payback period for solar PV systems. It is unlikely, however, outside the solar belt, that even these new technologies will reduce payback periods to those of wind or solar hot water systems.

The photovoltaic solar cell industry and emerging photovoltaic technologies were examined in greater detail in the CarbonFree report 'Farming Renewable Energy'.

Other than keeping the panels clean and ensuring that they do not fall under the shade of trees, PV systems require very little maintenance. It is, however, advisable that a qualified technician checks electrical components and batteries regularly.

The current rise in fossil fuel prices and advances in thin film technology are driving investment and innovation in the PV sector. Anyone installing a PV system can expect to see collector technology that is both cheaper and more efficient come onto the market before they have recouped the investment they made in their own system. It is important therefore that the householder pays particular heed to the timing of their investment. They should also regard their relationship with the system vendor as ongoing with planned upgrades to collectors. In the case where PV technology is being built into a new house, the architect and developer should ensure that collectors are easily accessible and can be upgraded with the minimum of modifications to the rest of the building.

Anyone installing a PV system can expect to see collector technology that is both cheaper and more efficient come onto the market before they have recouped the investment they made in their own system.

4 Geothermal Energy

The average ground temperature just below the surface is between 8°C and 13°C, and remains relatively constant throughout the year. Geothermal heat at these temperatures can be used for space and water heating; however, geothermal heat at higher temperatures from hot rocks underground or volcanic rocks close to the surface can be used to generate electricity.

Geothermal energy can be harnessed in three ways: directly, via heat pumps or from water heated by rock.

Geothermal energy can be harnessed in three ways:

Directly: Geothermal water underground is pumped to the surface and used for heating a single building, such as a greenhouse, or a group of houses.

Through the use of heat pumps: Ground source heat pumps use the top 15 m of the earth's surface as either a heat source or heat sink to heat or cool a building. The pump uses a series of pipes in a closed loop to circulate a mixture of water and refrigerant through the ground. In winter when the ground is warmer than the building above, the liquid absorbs heat from the ground which is then concentrated and transferred to the building. In the summer, when the ground is cooler than the building, the pump transfers heat from the building back into the ground. In a similar fashion, water-source heat pumps can be used to tap the heat from water bodies or disused flooded mines, and air-source heat pumps can extract heat from the atmosphere.

Ground source heat pumps use the temperature of the top 15 m of the earth's surface to heat or cool buildings.

There is some divergence of views on the maintenance required to ground source geothermal systems. Some manufacturers state that an annual inspection to check flow rates and refrigerant levels is essential to maintain efficiency, whereas others claim that, since most of the components are underground where they are sheltered from the weather, no attention is needed unless there is a fault.

Heat pumps have a number of disadvantages:

- Their high capital cost compared with conventional boilers has impeded market growth.
- Their cost is almost directly proportional to their heat output, meaning that doubling the output of an installation doubles the cost of the system.
- They have a relatively low temperature output and, while they are well suited to underfloor heating applications where low temperatures suffice, radiators need to be significantly larger than those fed by a conventional boiler.
- In the UK the geothermal industry is still in its infancy and there are few companies that provide a complete supply, installation and back-up service. A limited number of heating contractors offer servicing, maintenance and repair of heat pumps.
- The cost of a typical household system is between $7,000 and $10,000 and an 8 kW system costs between $11,000 and $17,000. On average, the payback time is 8 years, and a system can be expected to last for over 40 years. A typical system will provide between 95% and 100% of a household's heating requirements. Running costs for a geothermal heat pump are lower than oil fired heating for space heating, but more expensive than gas fired heating.

On average, the payback time is 8 years, and a system can be expected to last for over 40 years. A typical system will provide between 95% and 100% of a household's heating.

From water heated by hot rocks: Holes are drilled down into an underlying rock bed, then water is pumped into the holes to emerge as steam that, after purification, is used to drive turbines in a geothermal power station. Geothermal power plants take up very little land compared with traditional fossil-fuel plants.

In some cases, electricity from a geothermal power plant is cost competitive with that generated by a conventional power station.

In some cases, electricity from a geothermal power plant is cost competitive with that generated by a conventional power station.

All three applications can be used for community heating. However, only the first two are usually used to heat single buildings. Geothermal heating is well established in the US and the Nordic countries of Europe. The main market is newly built housing, with most equipment suppliers operating in the social housing sector and the commercial developer market. A small number of individual self-build householders have installed rock bed geothermal systems.

5 Starting From Scratch

Fitting renewable energy systems is best carried out when a house or residential complex is being constructed. At this stage, PV roof tiles can be used instead of conventional roof tiles, and their colour and appearance can be matched to those of the roof of the building and of surrounding buildings to minimise the visual impact of the system. Solar hot water panels can be integrated into the roof itself rather than being placed on top of existing roof tiles, minimising the load on roof supports. To minimise land use, geothermal heat pumps can be placed under a living area. If a group of houses is being developed, a single wind turbine can be mounted on a pole or a mast near the development as an alternative to installing multiple microturbines.

Fitting renewable energy systems is best carried out when a house or residential complex is being constructed.

For homes with one or two bathrooms, a combination condensing boiler may be the most energy-efficient solution for the occupier. Given that combination condensing boilers do not require hot water tanks or cold water cisterns, and most are designed to take in cold water, solar hot water systems or ground source heat pumps would not be appropriate. There are a few combination boilers that will accept pre-heated water, but the extra plumbing needed for this type of system reduces its cost effectiveness.

All renewable energy systems can be integrated into a building and its surroundings after it has been completed. Some housing associations and co-operatives have retrofitted properties with ground source heat pumps. One has replaced the existing coal heating system with ground source heat pumps in 14 bungalows in Ludgvan, Cornwall, UK. Funding was received from the UK Department of Trade and Industry's (DTI's) Clear Skies programme (now replaced by the Low Carbon Buildings programme) with additional support from the Powergen HeatPlant scheme – see EarthEnergy in the Vendor Profiles section.

Renewable energy systems can be integrated into a building and its surroundings after it has been completed.

In the UK installers accredited by The Energy Saving Trust undertake the supply and fitting of microgeneration systems. There are also a number of equipment suppliers that produce DIY kits for those who have relevant plumbing experience.

www.energysavingtrust.org.uk

6 Hybrid Systems

Hybrid power systems combine two or more energy conversion devices, or two or more fuels for the same device, which when integrated overcome limitations inherent in either. In large-scale residential projects hybrid systems combine renewable energy, such as solar, geothermal or wind, with conventional energy sources or sustainable energy options such as gas extracted from landfill sites.

Hybrid power systems combine two or more energy conversion devices, or two or more fuels for the same device.

Some projects also combine fossil fuels with sustainable energy options such as gas extracted from waste, biomass, landfill. Most building developers attempt to use the most cost effective and available resources within their vicinity.

The most common renewable/renewable combination is solar hot water with solar PV.

The most common renewable/renewable combination is solar hot water with solar PV. For an independent electricity system, wind and solar complement each other well, as most of the wind comes in winter and most of the sun in summer.

An example of a housing project using a renewable/renewable combination is the Glasgow UK development by Shettleston Housing Association – a new build, 16 unit, timber frame terrace of houses. It uses a combined geothermal/solar system for heating water. Heating for hot water is provided by pre-warmed water (12°C) piped up from an old coalmine 100 m below the site. The water temperature is boosted by a heat pump and the water is stored in a large insulated storage tank (10,000 litres), and boosted further by 36 m^2 of solar panels. The water is used to supply low-temperature radiators (45°C) and warm water via storage cylinders. Tenants can raise the temperature of the hot water using electric immersion heaters [2].

It is the renewable/renewable combination that most interests the householder. They may not want to invest a substantial amount of money in a geothermal system and then still be reliant on the incumbent power provider for the electricity to drive it.

It is the renewable/renewable combination that is of most interest to the householder who may not want to invest a substantial amount of money in a geothermal system and then still be reliant on the incumbent power provider for the electricity to drive it. At the same time, wind and solar energy equipment vendors are conscious of the fact that their smaller systems are incapable of providing all the energy the householder needs to power a house. There is scope here for vendors of any of the three renewable energy technologies – wind, solar and geothermal – to enhance their offering by providing hybrid systems that incorporate either one or both of the other technologies.

Solar PV and wind energy could be used to provide basic power that is then leveraged through a geothermal system, while a solar hot water system could be used to raise the temperature of the heat sink from which the geothermal system draws its raw energy. The potential of a combined solar hot water and geothermal system that acts as a medium- to long-term energy store is an area that CarbonFree is currently researching.

7 Community Systems

There are two types of community energy schemes: those that provide heat and/or power from one central source to multiple buildings and those that generate electricity for resale to a grid operator.

There are two types of community energy schemes: those that provide heat and/or power from one central source to multiple buildings – homes, schools, universities, hospitals, leisure centres, prisons or offices – and those that generate electricity for resale to a grid operator, providing a return for the organisation or individuals who funded the scheme.

7.1 Social Housing Initiatives

A system supplying electricity and/or heat to multiple buildings in the same vicinity has two advantages over one set up for a single house.

Firstly, it has a better load factor – the ratio of the average load over a designated period of time to the peak load occurring during that period. A high load factor indicates high usage of the system's equipment and is a measure of efficiency. Secondly, redundancy in the installed plant is reduced due to increased usage over any given period. These benefits can be passed on to the consumer in the form of a reduced unit cost of heat.

A better load factor and reduced redundancy are two key benefits of a community renewable energy initiative.

An example of a community scheme is the Community Renewables Initiative (CRI) launched in 2002. The CRI established ten Local Support Teams throughout the UK to provide advice and support for the development of community based renewable energy projects.

Funding can be obtained for wind, solar PV and hot water, ground source heat pumps and biomass schemes for a group of houses, housing developments, schools, hospitals, offices, shops, farms and community halls. It was hoped that this scheme would engage people in communities to make more use of, or switch to, renewable sources for their heat and power, creating a sense of ownership, unity and teamwork.

Only a small number of communities have taken advantage of the CRI scheme, but Fawside Foundation's Deneholme Community Centre installed a ground source heat pump and a large solar heating array; the latter saved 3,320 kWh per annum.

7.2 Investing In Community Systems

There is financial gain to be made by individuals, developers and communities investing in community systems.

7.2.1 Investment By Individuals

Electricity from wind farms costs 5 to 7 cents per kWh to produce – competitive with electricity generated using nuclear reactors or coal fired power stations. It is possible for an individual with sufficient land to develop a wind farm with a view to selling the electricity to the grid operator. In theory, this wind farm should provide a reasonable return on investment (ROI). An individual could also invest in a community renewable energy scheme such as the Baywind Energy Cooperative, which would provide a better ROI.

It is possible for an individual with sufficient land to develop a wind farm with a view to selling the electricity to the grid operator. In theory, this wind farm should provide a reasonable return on investment (ROI).

Baywind Energy Cooperative (www.baywind.co.uk) owns six turbines in Cumbria. It raises capital through share offers, buying wind turbines with preference given to local investors so that the community can share in the financial returns. Baywind's site near Ulverston, the UK's first community owned wind farm, has been generating electricity since 1997.

Baywind aims to extend the cooperative ownership model to other parts of the UK. To this end, it has established a company called Energy4All, which will support new cooperatives such as the Westmill Wind Farm Co-op – the largest community owned wind farm in the UK – and will be jointly owned by Baywind and the new cooperatives.

7.2.2 Investment By Developers

The drive by the Scottish Executive to increase renewable electricity generation from the current 12% to 40% by 2020, coupled with renewable energy trading through the Renewables Obligation, has resulted in unprecedented interest in wind and hydro-powered electricity generation in the Scottish Highlands. Twenty-one hydro projects are complete and twenty-five wind farm projects are planned or in the pipeline [3]. Local communities gain by either taking a stake in the enterprise and/or receiving funding – community benefit – donated by the developer where the project will have a long-term impact on the environment. Before this policy was introduced, community benefit contributions from wind farm development in Scotland amounted to approximately $1,800–$2,000 per MW per annum; they are now expected to rise to at least $7,000–$9,000 per MW per annum [3].

There is range of renewable energy developments that are commercially attractive to developers. The average annual profits vary considerably between technology types.

There is a range of renewable energy developments that are commercially attractive to developers. The average annual profits vary considerably between technology types. While wave and tidal technologies are unproven, they are expected to become marginally profitable in the near future for developers and communities that are geographically well placed to take advantage of them.

8 Earning Money From Microgeneration

8.1 Grid Connection

There are two types of micro-wind turbines and solar PV installation – off-grid and on-grid – and two ways the electricity can be measured – by dual metering or net metering.

There are two types of micro-wind turbines and solar PV installation: off-grid and on-grid. If a house is not connected to the grid, the surplus electricity generated can be stored in batteries for use at peak times or when the wind speed or solar radiation is low. Where a house is grid-connected, the surplus can be sold back to the electricity supplier. A microgeneration system requires the installation of an inverter to convert the direct current (DC) from the generator and battery into alternating current (AC) at mains voltage – 210/250 V at 50 Hz in Europe/UK or 110 V at 60 Hz in the US.

There are two ways in which the electricity used or generated can be measured and priced. In dual metering, the amount of electricity taken from the grid is measured separately from the surplus that is generated in-house. In this scheme, an import–export meter is used to take the measurements, and the price paid for surplus power generated can be fixed at a different rate to that paid for using the mains. In net metering, the meter runs forwards when electricity is being used from the grid, and backwards when surplus energy is being put into the grid, in effect, measuring the net energy taken from the grid.

Many grid operators will buy electricity from a customer, but at a much lower price than they sell to the same customer.

Not all electricity suppliers provide their customers with the ability to sell the surplus electricity they generate. Where they do, most will buy it at a much lower rate than they sell it for, acting as a strong disincentive for small-scale renewable energy producers.

However, there are some providers that will buy and sell at the same rate. Electricity companies have been reluctant to embrace net metering arrangements, and it is unlikely they will do so unless legislation is enacted.

A tariff agreement, or sell and buy back agreement, can be drawn up stating the prices at which electricity will be bought and sold.

Grid-connected systems require the householder to inform the electricity supplier in advance of installation, so that a tariff agreement, or sell and buy back agreement, can be drawn up stating the prices at which electricity will be bought and sold. Sometimes, permission is required from the local Distribution Network Operator (DNO), the company that operates the distribution network in the area who may or may not be the electricity supplier.

In some ways the householder or community building its own renewable energy based microgeneration system is in the same position as small Internet Service Providers (ISPs) were in the early days of the Internet. Although they are increasing the value of the network – or, in the case of the microgenerator, the grid – they find it difficult to unlock that value and turn it into revenue. To a large extent, the incumbent energy provider, whose grid becomes marginally more resilient due to the householder's presence as a microgenerator, reaps the benefits of the householder's efforts as they can purchase whatever power flows back onto the grid at below market prices. The owner of a microgeneration system will only be able to unlock its value if they are allowed to sell energy directly to other householders.

However, even if the electricity supply market were liberalised to allow microgenerators to sell electricity to their neighbours, it is unlikely that power grids would become populated with thousands of energy providers. Instead, just as happened with the Internet, large independent operators would start providing householders with turnkey microgeneration systems that included energy buyback contracts. In effect, these new operators would overlay their own business model over the incumbent power provider's grid.

Even if the electricity supply market was liberalised to allow microgenerators to sell electricity to their neighbours, it is unlikely that power grids would become populated with thousands of energy providers.

8.2 Renewables Obligation Order

The Renewables Obligation (RO) scheme is a UK government mechanism for increasing the amount of electricity produced from renewable sources. It obliges electricity suppliers to obtain a specific percentage of their electricity supply – 5.5% for 2005/06 and increasing each year to 15.4% in 2015/20 – from renewable sources, or pay a fixed sum – buyout price – set by the power industry regulator and adjusted annually for each MWh shortfall.

In some cases householders can participate in a Renewables Obligation Certificate scheme or ROCs which is designed to encourage incumbent energy providers to use renewable energy sources.

For each MWh of electricity generated from an accredited renewable source, a tradable Renewables Obligation Certificate (ROC) is issued to the generator by the industry regulator Ofgem with a market value set by Ofgem of the order of 7 cents/kWh. These ROCs can then be sold to suppliers who have failed to meet their stated annual renewable energy quota by suppliers who have exceeded their quotas. The value of ROCs fluctuates depending on demand and they have regularly traded for over $70. Recent changes to the legislation mean that producers of electricity from renewable sources can participate in the Renewables Obligation scheme irrespective of the amount of electricity they generate, so householders are now included.

When a householder participates in the ROC scheme the energy supplier assists with the application and administration of ROCs and acts as an agent for the householder's ROC account. One supplier offering this service is Northern Ireland Electricity (NIE) through its Smart programme (http://www.niesmart.co.uk/microtariff.htm).

The energy supplier assists with the application and administration of ROCs and acts as an agent for the householder's ROC account.

NIE sends the householder's meter reading to Ofgem which rounds it down to the nearest 500 kWh when calculating the number of ROCs the householder is entitled to. Ofgem then credits the NIROC (Northern Ireland ROC) account with the appropriate number of NIROCs. Once these are transferred to NIE's NIROC account, NIE will send the householder a cheque or bank transfer for the appropriate amount.

For a householder not participating in the RO scheme, NIE offers a credit for electricity they generate but do not use on their premises (export or spill electricity). The amount offered is published each year in advance and varies between technologies. The current export prices are 8 cents/kWh for wind, hydro, and micro-CHP (Combined Heat and Power), and 10 cents/kWh for solar PV. Good Energy (www.good-energy.co.uk) is another supplier that allows householders to participate in ROCs in its Home Generation programme.

Good Energy supports homes that install microgeneration by paying them for their total generation including the units that they use on the premises. The Ashley Vale Action Group which builds sustainable homes received 7 cents per kWh for the power they generated. However, in general, customers will be given a price quote on application.

9 Grants and Support

The Microgeneration Strategy for consumer based sustainable energy production launched in March 2006 is designed to encourage more use of renewable energy in the domestic sector. Within this scheme the UK government has made available $90 million in extra funds for microgeneration.

Governments are active in encouraging more use of renewable energy in the domestic sector. The UK government has made available $90 million in extra funds for microgeneration.

The UK Department of Trade and Industry's (DTI) Low Carbon Buildings Programme, an instrument of this strategy, provides grants to householders, community organisations, schools, the public sector, and businesses, and runs from 1 April 2006 for three years. It replaces the DTI's Clear Skies and Major Photovoltaic Demonstration programmes which closed for applications on 31 March 2006. The programme is UK-wide, apart from the Channel Islands and the Isle of Man.

The programme covers solar PVs, wind turbines, small hydro, solar hot water, ground/water/air-source heat pumps, bio-energy, renewable CHP (Combined Heat and Power), micro-CHP, and fuel cells. In order to qualify for the funding, an applicant is obliged to have: a minimum of 270 mm of loft insulation, installed cavity wall insulation, low energy light bulbs in all appropriate light fittings, and basic controls in the heating system including a room thermostat and a programmer or timer.

There are different grant levels for a range of renewable energy technologies, reflecting their varying stages of market development. A householder can apply for funding for more than one technology for use within the same building:

Different grant levels for a range of renewable energy technologies reflect their varying stages of market development.

- Solar PVs: a maximum of $5,400 per kWp installed, up to a maximum of $27,000 subject to an overall 50% limit of the installed cost.
- Wind turbines: a maximum of $1,800 per kW installed, up to a maximum of $9,000 subject to an overall 30% limit of the installed cost.
- Solar thermal hot water: a maximum of $720 regardless of size subject to an overall 30% limit.
- Small hydro: a maximum of $1,800 per kW installed, up to a maximum of $9,000 subject to an overall 30% limit of the installed cost.
- Ground-, water-, and air-source heat pumps: a maximum of $2,160 regardless of size subject to an overall 30% limit.
- Grant levels are still to be defined for renewable CHP, micro-CHP and fuel cells.

The Scottish Community and Householder Renewables Initiative (SCHRI) is a Scottish Executive programme for small-scale renewables, and is delivered by the Energy Saving Trust (EST) and the Highlands and Islands Enterprise. The SCHRI offers grants of up to 30% of the cost of the installation of renewable technologies to community groups and households.

There are also a number of local based initiatives to encourage the use of renewable energy within the home.

The EST determines the amount of grant available on a case-by-case basis. The maximum grant available is $7,000 per technology (maximum of two technologies per property). Grants are available for renewable energy generating equipment, essential enabling equipment, and essential non-equipment expenditure.

Renewable energy generating equipment includes wind turbines and micro-hydro turbines with a minimum rated output of 0.5 kW unless otherwise agreed by the EST; solar water and space heating; ground source heat pumps which should be powered by a green electricity tariff; automated wood fuel heating systems; and connection to the Lerwick District Heating Scheme.

To obtain grants from either of the two schemes above, the system must be installed by a company approved by the EST.

The Northern Ireland Project Fund funds potential schemes from the domestic, transport and renewable sectors. Small-scale projects (up to $18,000) may receive 100% funding. Medium-scale projects (between $18,000 and $36,000) may receive up to 75% or $18,000, whichever is the greater. Larger projects (over $36,000) may receive 75% or $27,000, whichever is higher, up to a maximum of $36,000.

Currently, a 5% reduction in VAT (Value Added Tax/sales tax) applies to installations of a specific list of energy saving materials including solar collectors and PV panels, wind turbines, micro-CHP and renewable (ground and air) source heat pumps. Renewable energy systems purchased as DIY kits and installed by householders are not eligible for any of the grants listed above or VAT reduction.

It remains to be seen whether the Microgeneration Strategy will be effective in increasing the use of renewables in the domestic sector when it is translated into policies and legislation, and whether the sums set aside will meet householder demand. Stamp duty rebates for domestic customers that install microgeneration within a defined period after moving home are certain to boost the uptake of microgeneration if introduced.

It is too early to tell whether microgeneration funding schemes are effective in increasing the use of renewables in the domestic sector.

10 Impact

10.1 Impact On Householders

The installation of renewable energy systems is attractive to householders wishing to reduce their carbon footprint. However, to do this the householder needs to install equipment costing between $5,000 and $18,000 – depending on the type and size of the system and the household's energy consumption. This is beyond what most households can afford or will want to spend, even with grant funding, while energy supplied by incumbent providers is relatively cheap. Payback periods are long – in the case of some technologies, such as PV based solar collectors, they far exceed the practical working life of the system or the length of time a householder is likely to remain in a particular dwelling. Grants go some way to reducing payback periods. In the long term, however, as microgeneration becomes more popular, these grants will be scaled back.

The installation of renewable energy systems is attractive to those householders who wish to reduce their ecological footprint. However, even with grants and subsidies, the cost of microgeneration is high.

While the price of energy from the grid remains relatively low, the most cost effective way for the average household to participate in increasing the use of renewable energy is to select renewable energy suppliers such as Powergen (www.powergen.co.uk), Good Energy (www.good-energy.co.uk), Ecotricity (www.ecotricity.co.uk), and Green Energy UK (www.greenenergy.uk.com).

Even so, some householders regard microgeneration as an investment for the future and feel the technology could pay for itself if fuel prices continue to rise at their present rate. Here some care must be taken, as some vendors are factoring in benefits, such as a potential increase in the value of a property following the retrofitting of microgeneration technology, to reduce payback periods. The focus should remain on whether a particular system is cost effective during its lifetime.

Microgeneration installations could be an investment for the future and could pay for themselves if fuel prices rise above inflation.

10.2 Impact On The Power Supply Industry

In the US, 61% of the housing stock is detached – approximately 70 million homes. Fitting just a fraction of these homes with solar panels would impact significantly on the power supply industry. Since the early part of the last century, there has been a tendency for people to move out of cities, where they lived in tenements, terraced or semidetached housing, and settle in detached houses in suburbs. The availability of cheap personal transport accelerated this trend.

If the owners of just 10% of the 70 million detached houses in the US had 5 kilowatts of energy generation capacity, up to 35 gigawatts of energy demand would be removed from the grid.

Detached houses are less energy efficient than more compact alternatives. As well as requiring fuel to travel between their home and work, the suburban dweller also needs more energy to heat their home. However, the owner of a detached house has more scope for using renewable energy to power their home. They have their own roof and space to construct a wind turbine. They may also have a large enough garden to exploit ground based geothermal energy. If the owners of just 10% of these 70 million houses installed 5 kilowatts of energy generation capacity, up to 35 gigawatts of energy demand would be removed from the grid and annual demand for fossil fuel could be reduced by the equivalent of 50 million barrels of oil.

In some cases the net flow of power would be from the home back onto the grid. The 35 gigawatts, if it were generated near or at the point of consumption, would not be prone to losses in the transmission infrastructure, and its net impact on the incumbent generators' perceived level of demand would be greater than the sum of the power generated by the householders.

Energy generated near or at the point of consumption would not be prone to losses in the transmission infrastructure.

While suburbanites are prime candidates for microgeneration, the city dweller is not totally excluded from the energy generation market and in some cases can also use renewable energy sources to supplement the power requirements of their home.

Typically the ambient temperature of a city is one or two degrees higher than that of its suburbs or the surrounding countryside. This is due to energy losses from intense activity within the city and the ability of manmade structures to capture and retain the sun's energy. In the future is may be possible to harvest this retained energy using geothermal technology.

In most cases, however, the urban dweller's most logical route into the microgeneration market is via a community wind or solar scheme.

10.2.1 Impact Of Government Policy

The Energy Efficiency Commitment (EEC) is the UK government's key policy aimed at reducing domestic carbon dioxide emissions by 1% per annum and reducing fuel poverty. It requires all gas and electricity suppliers in the UK with at least 15,000 domestic customers to achieve energy savings targets set by Ofgem in relation to the number of domestic customers they have. At least 50% of the target has to be met in relation to a priority group of consumers defined as those receiving certain income-related benefits and tax credits.

Government policy is key to driving change within the power supply industry and will impact on investment decisions and on the relationship between the provider and the consumer.

The UK government sets the overall target to be met by the energy suppliers, while Ofgem administers the scheme and determines the targets for each supplier on whom obligations are imposed for each year of the EEC. Eight suppliers are currently obligated under EEC2 (2005–08): British Gas, EDF Energy, npower, Opus Energy, Powergen, Scottish and Southern Energy, Scottish Power and Telecom Plus. The target assumes that projects will be funded partly by the suppliers and partly by third parties such as social housing providers. Suppliers have the option of trading their obligation or energy savings with other suppliers.

The effect of the EEC has been to create partnerships between energy suppliers and renewable energy equipment vendors, and between energy suppliers and housing associations, local authorities, and housing developers to promote their own energy supply offerings and the idea of energy efficiency through the installation of energy saving equipment. In return, the energy saving produced by the installation of their partners' equipment goes into meeting their EEC targets.

Incumbent energy providers are entering partnerships with suppliers of microgeneration technology and in some cases marketing this technology to their customers.

British Gas is in partnership with Windsave, the micro-wind turbine manufacturer; Scottish and Southern Electricity with Renewable Devices, another wind turbine manufacturer; and Powergen with EarthEnergy Ltd., the ground source heat pump manufacturer.

The EEC has only managed to marginally increase the installed base of renewable energy equipment. The most commonly installed energy saving technology has been insulation, contributing 56% of the total savings achieved [4]. Energy suppliers saw a less expensive avenue to increasing the adoption of renewable energy in the domestic sector through the Low Carbon Buildings programme.

10.2.2 Impact Of Distributed Generation

Householders generating their own electricity with renewable energy sources create, in effect, a distributed power supply system. Growth in distributed generation will affect the energy supply market in a number of ways. The advantages may include:

The householder's ability to generate their own electricity using renewable energy sources creates, in effect, a distributed power supply system. Growth in distributed generation will eventually impact on the energy supply market.

- an improvement in energy security, with less dependence on imported fuels.
- a reduction in the demand for fossil fuels, resulting in lower energy prices, and conservation of the fossil fuel reserves for use further into the future than currently anticipated.
- a lowering of transmission and distribution losses, as a proportion of the energy is being generated close to where it is consumed.
- a lowering in production costs, with power suppliers requiring less expensive generating facilities to cover peak demand.
- a reduction in the need for significant investment in transmission and distribution lines.
- a reduction in the size and frequency of short-term price spikes and thus in the risks to suppliers' financial stability.
- a reduction in the vulnerability of power supply to terrorist attacks.

A disadvantage may lie in the potential degradation in the performance of the electricity network if poorly maintained equipment feeds electricity into the grid at an incorrect frequency or voltage, resulting in power fluctuations.

Given that inadequate power output would be difficult to find and isolate within a multitude of sources, new regulation may be required to ensure inverters cut out if they are not producing electricity at the correct voltage and frequency, or to impose penalties on householders who supply substandard energy.

If the amount of energy generated from renewable sources rises above 20% of the total energy consumed, then thought has to be given to what happens during long periods of cold, windless, cloudy weather. If up to 20% of grid capacity disappears for up to two weeks, energy providers will require access to some form of backup. If, by then, storage products – for example fuel cells and thermal stores for household use – are installed in homes, then some estimate of total storage capacity on the grid will have to be recorded and updated on a regular basis.

If the amount of energy generated from renewable sources rises above 20% of the total energy consumed, then serious thought has to be given to what happens during long periods of cold, windless, cloudy weather.

Energy providers will need to diversify their business portfolio to replace revenue lost when demand for centrally generated electricity falls. To some extent, energy providers are already working in this direction by including a range of microgeneration technology, such as heat pumps and wind turbines, within their product portfolio. In the longer term, energy providers may start looking at energy as a service as much as a commodity. While the day when this happens is still over a decade away, the impact of the Internet on the incumbent telecom providers plays on the minds of most incumbent energy providers and grid operators.

The fact that some DIY stores are considering adding microturbines to their product range will cause concern to the electricity supply industry which would like to maintain complete control over domestic energy supply.

Inevitably, the growth of distributed generation will lead to the restructuring of the retail electricity market and the generation, transmission and distribution infrastructure. The probability of the events listed here occurring are very low at the moment and will rise only when the market in renewables grows with the lowering of costs due to uptake and improvements in technology.

Inevitably, the growth of distributed generation will lead to the restructuring of the retail electricity market and the generation, transmission and distribution infrastructure.

10.3 The Wider View

Government schemes described in this report provide support for microgeneration and are having an impact on both householders and power suppliers in the UK. However, there are similar schemes and initiatives in most industrial countries:-

Throughout the industrialised world, governments have been putting in place schemes to encourage householders to install microgeneration technology and use renewable energy sources to power their homes.

The California Solar Initiative is the largest solar programme in the US, which will provide the money in consumer rebates between 2007 and 2016. The initiative's goal is to install 3,000 megawatts of solar capacity – equivalent to six large power plants – in 1 million homes, businesses and public buildings by 2017.

New York State bill (S.4962-a) exempts the sale and installation of solar energy systems equipment from state sales and compensating use taxes, and gives municipalities the option of granting the local exemption.

New York State bill (S.5252) broadens the existing solar electricity generating equipment personal income tax credit to also include equipment utilising solar radiation to provide heating, cooling and/or hot water

New York Energy $martSM Photovoltaic (PV) or Solar Electric Program currently offers cash incentives that can offset the total installation costs of a PV system by 40–70%.

Aspen, Colorado's Renewable Energy Mitigation Program (REMP). Launched in 2000, homeowners who wish to construct a house over 5,000 square feet, or those using energy for snowmelt or outdoor pools, have the option of installing a renewable energy system or paying a renewable energy mitigation fee.

In 29 US states, homeowners on the grid can get state rebates or tax breaks that subsidise up to 50% or more of the cost of clean energy systems. They then sell the electricity they generate, but do not use themselves, to utilities, offsetting the cost of the power they draw from the grid as they spin their meters backward and drive their electric bills toward zero.

In 29 US states, homeowners on the grid can get state rebates or tax breaks that subsidise up to 50% or more of the cost of clean energy systems.

Seventeen US states and some power companies now offer utility customers rebates on the purchase and installation of solar or wind systems, up from three in 2000. Florida and Pennsylvania are among those considering rebates. Meanwhile, the number of states with 'net metering' laws – which permit customers to sell the power they produce to the electric company at retail rates – has doubled to 40 in the past six years.

Seventeen US states and some power companies now offer utility customers rebates on the purchase and installation of solar or wind systems, up from three in 2000.

Australian Photovoltaic Rebate program: This programme commenced on 1 January 2000 and has been extended to 2007. Under it, cash rebates are available to householders, owners of community use buildings, display homebuilders and housing estate developers who install grid-connected or stand-alone PV systems.

German 100,000 Solar Roofs Programme was launched in late 1998 and ended in 2003 when all targets were met. It provided ten-year low-interest loans with reduced interest rates to buyers of PV systems.

The German 100,000 Solar Roofs Programme was launched in late 1998 and ended in 2003 when all targets were met.

German Renewable Energy Sources Act (Feed-In Tariff). Customers receive 45.7 euro cents per kWh (US56¢ per kWh) for solar-generated electricity sold back to the grid. By the end of 2003, German installed capacity was 400 MW, well beyond the initial goal of 300 MW.

Japanese New Sunshine Program. Launched in 1992, introduced renewable energy throughout the country. Targets were set and a net metering law enacted.

Japanese 70,000 Roofs Program was established in 1994, initially covered 50% of PV installation costs, and provided a budget of $18.3 million. By 2002, the number of residential systems installed in Japan had reached 144,000. In 2003, the subsidy was reduced to 15% as the cost of solar cells had fallen with increased production, and the budget allocation was increased to $186 million.

The Japanese 70,000 Roofs Program established in 1994 initially covered 50% of PV installation costs, and provided a budget of $18.3 million.

11 Investment And Overshoot

Ultimately it is the domestic consumer that drives investment in renewable energy. A manufacturer of PV equipment is able to attract funds for the construction of a new plant because they can show that there is an existing or growing demand for rooftop solar panels. Historically, low fossil fuel prices have made investment in microgeneration systems particularly unattractive for householders. In most cases the householders who installed systems were motivated to do so by a desire to adopt a 'greener' lifestyle.

Historically, low fossil fuel prices have made investment in microgeneration systems particularly unattractive for householders. In most cases the householder was motivated to install equipment by a desire to adopt a 'greener' lifestyle.

Even with oil at over $70 per barrel, the household production of alternative energy is uneconomic. However, energy prices have been rising at their fastest rate for over a decade. What is more, prices have risen steadily over a relatively long period.

Media reports claim that energy price rises are due to demand exceeding supply and that, unlike in the 1970s, this situation will become the norm rather than a temporary phenomenon. Consumers now factor an increasing fossil fuel price into their decision whether or not to invest in alternative energy technology.

Consumers who are approaching retirement or are newly retired may project the current fossil fuel prices forward by over ten years to the point where there would be a significant cost advantage in generating energy from wind, solar or geothermal sources rather than being reliant on energy providers who are themselves reliant on fossil fuels suppliers.

Consumers who are approaching retirement or are newly retired may project the current fossil fuel prices forward by over ten years to the point where there would be a significant cost advantage in microgenerating energy.

The consumer may also wish to install generating equipment while they are young and fit enough to do the work themselves. They may feel that they will reap the rewards later and that selling excess energy generated by solar arrays or wind turbines will supplement dwindling pension incomes. While these perceived benefits might prove illusory, they may be used as a selling point by microgeneration system vendors.

There is potential here for 'overshoot' – with investment decisions based on the projected, rather than the current, market price of oil. This process could inflate a speculative bubble within the equity market. There is also potential for 'overshoot' to spread up through the equipment supply chain to microgeneration equipment manufacturers.

There is potential for 'overshoot' – where the investment decision is based on the projected, rather than the current, market price of oil.

At each level another multiple of growth rate is added to the projected market size, and vendors overlook, or are unaware of, competing companies and technologies entering the market. The market for microgeneration technology could therefore collapse, not because the price of fossil fuel falls but because it just stops rising.

There is also scope for the relatively immature and fast-moving renewable energy technology industry to oversell its technology to the householder. At some point it may become necessary for the industry to either regulate itself or have regulation forced upon it. Then vendors would have to prove that their technology met agreed performance targets and claimed benefits could be realised by the householder. Here the incumbent domestic energy provider has a clear advantage in that it is regarded by the householder as a trusted party.

11.1 The 1970s Revisited?

Following the oil price shocks of the 1970s and early 1980s a number of energy producing nations either expanded production or discovered new resources. An emerging alternative energy market was squeezed by a combination of increased conservation and falling oil prices. Conventional wisdom has it that this will happen again and at some point larger oil and gas provider nations will increase supply and destroy the emerging renewable energy market. This would leave domestic consumers with equipment that would never pay for itself, let alone generate a return on the householder's investment. If the supplier were no longer in business the system would be unsupported and the householder would find it difficult to upgrade it and take advantage of advances in technology.

In the 1970s an emerging alternative energy market was squeezed by a combination of increased conservation and falling fossil fuel prices.

There is some justification in believing that the current round of energy prices is a permanent feature of the world economy. New consumer nations, such as India and China, have entered the fossil fuel market at a time when the rate of consumption already exceeds the rate at which new sources of energy are being discovered.

Nevertheless, householders installing renewable energy systems today should be aware that they are pioneers and are investing at the top of the market. Advances in technology and competition amongst vendors will ultimately lower the cost of alternative energy technology.

Some form of renewable energy generation will become the norm in new houses, and this, together with energy conservation measures, will lower overall domestic energy consumption and hold down energy price rises. This, combined with a prolonged period of flat or falling fossil fuel prices, could see electricity prices fall or stagnate and legacy microgeneration systems stop generating a return – or even start operating at a loss. The impact of falling energy prices on the householder could be twofold. First, they would see payback periods extended – perhaps beyond the point at which they were intending to sell their property. Second, the value of the microgeneration system could fall and the householder would only be able to recoup a small fraction of their investment when they do sell their property. For investors in larger community based initiatives, falling fossil fuel prices could pose a greater threat by undermining the long-term viability of projects and starving schemes of future investment.

Householders and other microgenerators should therefore ensure that the system they install can be easily and cheaply upgraded and that they base calculations of return on investment on realistic projections of fossil fuel prices.

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12 Market Growth

12.1 Determining Factors

A key factor governing the growth of the microgeneration market is the price and availability of fossil fuels. While in the short term the price of oil is likely to stabilise – and with it the price of other fossil fuels – the long-term price trend will continue its upwards path.

A key factor governing the growth of the microgeneration market is the price and availability of fossil fuels.

In the short term, however, a recession triggered by the current rise in fuel prices would both dampen the householder's enthusiasm for microgeneration and reduce their ability to pay for the technology required to generate power. A recession would see a shift in emphasis away from microgeneration to conservation – improved insulation and more efficient lighting for example. As mentioned in other CarbonFree reports, if it is to be guaranteed success in the medium term any renewable energy based technology must be cost effective in a market where oil could be supplied at $30 per barrel. If the growth in interest in microgeneration continues long enough for vendors to achieve scale, then this target should be achievable for some technologies.

In the short term, however, a recession triggered by the current rise in fuel prices would both dampen the householder's enthusiasm for microgeneration and reduce their ability to pay for the technology required to generate power.

A second important market determinant is the structure of a country's housing stock. It is unlikely that a person who does not own their home would be willing, or allowed, to install microgeneration technology. As well, a person who does not live in a detached property may experience difficulty gaining the consent of neighbours or permission from a local authority to install a wind turbine or to fit solar panels to their roof.

In the US, there are 115 million dwellings of which 68 million (59%) are privately owned and 70 million (60%) are detached. In the UK, out of a total of 25 million dwellings 17.5 million (70%) are privately owned and just over 5 million (20%) are detached. This diversity in the structure of the housing market is repeated throughout the developed world, with countries such as Germany and France having proportionally fewer dwellings owned by their occupiers.

The rate at which the housing stock is replaced is an important factor in the case where the vendor is selling microgeneration technology for incorporation into new properties. Over 10 million of the 25 million dwellings in the UK have been built since 1964 – approximately 238,000 building starts per year. While this number of new properties appears to represent a significant market for microgeneration vendors, it is worth noting that new developments tend to go in short sharp bursts, and, while a building boom is underway at present, during the 1970s the annual figure for housing starts fell as low as 130,000. Over the next two decades an increasing number of people will be retiring and moving out of large detached properties, and the demand for new houses may, as a consequence, fall sharply. Currently the number of building starts in the US is approximately 2 million per annum, and in the UK it is approximately 150,000.

The rate at which the housing stock is replaced is an important factor where the vendor is selling microgeneration technology to a builder or developers for incorporation into new properties.

12.2 Identifying The Winners

Who will earn revenue from microgeneration depends to a great extent on which renewable energy option is under consideration. In the case of small-scale wind turbines, the consumer electrical industry should be the principal beneficiary. As the major component in a solar PV system is a PV collector, the semiconductor industry will earn a large part of the revenues from system sales. However, in the case of solar hot water and geothermal based microgeneration, a significant proportion of the system is low technology installation and building services, such as plumbing. Here the building industry itself will receive a significant share of the revenue generated from system sales.

Who will earn revenue from microgeneration depends to a great extent on which renewable energy option is under consideration.

Other beneficiaries could include the electronics companies who provide energy management and billing technology for microgeneration systems.

12.3 Sector Specifics

12.3.1 Wind

Of the four technologies, small-scale wind generation has the best prospects of surviving a collapse in oil prices. At present, with demand outstripping supply due to media interest in the technology, it is difficult to gauge a true measure of the wind energy market. However, as long as energy prices either continue to rise, or remain stable, for a further two years the wind turbine manufacturers should achieve sufficient scale to be able to drive down unit costs to the point where their technology has a reasonable payback period even if the oil price slips back to $30 per barrel. Assuming the price of a system falls from its current price of $5,000 to under $2,000 and just 1% of detached houses in the US fit a microturbine over the next five years, the market will be worth $280 million per annum. Wind turbines also have an added advantage in that they are a highly visible indication that the householder is environmentally aware – a factor that will help equipment vendors if oil prices fall but concerns over global warning continue to be the focus of media attention. Small-scale wind turbines also benefit from being the simplest of all microgeneration technologies to retrofit into an existing building.

The US market for small-scale wind turbines could be worth up to $280 million per annum, with the UK market being worth up to $60 million – assuming microturbines become mass produced consumer products.

A beneficiary of the growing demand for small-scale wind could be the manufacturers of household energy management and metering systems that will become necessary to support microgeneration systems and measure the energy sold to grid operators. While, initially, this will be a smaller market than for other consumer electronics products – for instance digital TV set-top boxes – it could leave companies well placed if the structure of energy generation changes and we see an emergence of the Internet of electricity.

A beneficiary of the growing demand for small-scale wind could be the manufacturers of household energy management and metering systems.

The UK market for small-scale wind turbine should remain buoyant, in part because the country is in a particularly windy region of the world and a number of domestic suppliers, having entered into distribution deals with incumbent energy providers, are well entrenched within the market. As the UK is a comparatively small market, it is unlikely that the cost of a small-scale wind turbine system will fall below $3,000. However, it is possible that 2% of the owners of detached properties in the UK will purchase systems at this price, providing the industry with $60 million of revenue. If progress is made with development of a low-cost, silent, small-scale turbine, there may also be a greater penetration of the UK semidetached property market (8 million households).

12.3.2 Solar PV

The challenge for the solar PV market is to bring down the cost of PV technology. Many householders are aware that a new generation of PV devices are in an advanced stage of development, and are unlikely to commit to a solar PV system based on expensive polycrystalline technology.

Householders are unlikely to commit to photovoltaic technology if they believe the price of collectors is about to fall.

Many household solar PV systems are integrated within the design of the building itself. This is either because local authorities are insisting that new houses are capable of producing some of their own power or because the architect feels polycrystalline solar cells have some aesthetic value. This may make the solar PV market less sensitive to falling oil prices as local authority energy strategies and regulations governing building design are likely to remain in place after fossil fuel prices have eased. Solar PV is also another technology that advertises the environmentally friendly credentials of a building's occupant – a factor that has encouraged its inclusion in modern office blocks.

Many household solar PV systems are integrated within the design of the building. This is either because local authorities are insisting that new houses are capable of producing their own power or because the architect feels polycrystalline solar cells have some aesthetic value.

One of the key factors determining the growth of the market for solar PV is the number of housing starts. Assuming the cost of the average solar PV system is $30,000 and these are installed in 1% of 150,000 housing starts in the UK, the market for systems would be $45 million per annum. However, this figure is ambitious as the UK's climate is not sunny enough to warrant an investment of $30,000 in solar heating. As well, the number of housing starts will probably fall below 150,000 per annum during the next two decades.

The US market for solar PV could be worth $600 million per annum. While sales in the UK could in theory reach $45 million per annum, the poor climate will hold sales below this level.

In many parts of the US the climate is more suitable for solar PV. As well, many people relocate to sunnier areas when they retire, encouraging development in sunnier states. There are approximately 2 million housing starts per annum in the US, and assuming that 1% of these starts were to incorporate $30,000 worth of solar PV microgeneration technology then the market would be worth $600 million per annum.

12.3.3 Solar Hot Water

Over the next five years the UK market for solar hot water could be worth $57.5 million per annum and the US market could be worth $800 million.

This is a mature industry and, while there are a large number of turnkey systems, many householders take the DIY approach. Much of the installation work is plumbing, and therefore installation engineering companies will earn a significant proportion of the revenue in this market. This does mean that there is little scope for reducing the cost of a solar hot water system and it may not scale as well as other microgeneration technology. The solar hot water vendor will derive revenue from the sale of the overall system, the water storage tank, the controller and the collector. However, over time more sophisticated energy management controllers, developed for the small-scale wind energy market, may incorporate much of the functionality of the solar hot water controller. This would leave the way open for installation companies to pick and choose the components they need to build a system, thus increasing competition and driving down prices. Solar hot water is likely to take a small proportion of both the retrofit and new building market.

Assuming a typical solar hot water system costs $10,000 and they are retrofitted to 0.5% of detached houses over the next five years, the UK market would be worth $57.5 million per annum and the US market would be worth $800 million. The market will be particularly sensitive to a drop in oil prices, especially as many householders who may be tempted to retrofit a solar hot water system will already have a conventional water heating system in place.

There is some scope for the use of solar hot water as a preheating system for geothermal microgeneration systems. However, this is a relatively new and untried concept and the market for such a system is difficult to determine at this stage.

There is some scope for the use of solar hot water as a preheating system for geothermal microgeneration systems.

12.3.4 Geothermal

The number of households with access to the land area necessary to feed heat energy into a geothermal microgeneration system is very small. Typically there will be proportionally more properties with large gardens or yards in the US than in the UK and the rest of Europe. A typical system will cost in the region of $14,000. Although a number of systems have been installed as retrofits in the UK, many of these are demonstration sites and it is unclear whether the householder has paid the full market price for their system. Once again the bulk of the work involved in installing a system is plumbing-related, with the actual system vendor acting as little more than a supplier of heat pumps and energy management technology. There is some scope for reducing the cost of a system by producing custom-made modular units – collectors and underfloor heating equipment etc. However, it is unlikely that the market will achieve sufficient scale for this to happen during the next five years.

The UK market could be worth $2.1 million per annum and the US market could be worth $28 million per annum.

Ignoring the retrofit market and assuming that 0.5% of building starts were to include a geothermal microgeneration system of some description, then the UK market would be worth $2.1 million per annum and the US market would be worth $28 million per annum. Revenue from geothermal systems may prove less sensitive to falling oil prices than is the case with other microgeneration technology. Electricity companies are actively promoting geothermal technology, as they regard it as a means of attracting householders who previously used oil fired central heating. If this trend continues, the market for geothermal systems may continue to grow even if oil prices ease, and there could also be a significant market for retrofitted geothermal systems.

Revenue from geothermal systems may prove less sensitive to falling oil prices than is the case with other microgeneration technology if electricity companies come to regard it as a means of attracting householders who previously used oil fired central heating.

13 Conclusions

While the cost of installing microgeneration technology is relatively high, in general, payback times fall within the lifetime of the equipment. Most equipment requires little maintenance, can be fitted to new builds and retrofitted to older ones. In large housing complexes, this technology can be used in conjunction with other non-fossil fuel alternatives such as biomass and more efficient fossil fuel technologies such as micro-CHP.

The cost of installing microgeneration equipment is high, but rising fossil fuel prices reduce payback periods during the life of the equipment.

Individuals, communities, and commercial developers can benefit from investing in renewable energy through shared ownership in cooperatives and the development of wind farms and hydro projects.

Individuals and communities can benefit from a range of investment opportunities.

For householders, installation of renewable energy equipment can be seen as a long-term investment, effectively providing free energy after the payback period is over, especially if energy prices rise above inflation. In the short term, microgeneration installations can bring some financial reward if the surplus energy generated can be sold back to grid operators. The householder may also see a benefit in reducing their carbon footprint.

For the householder, long-term benefits include the opportunity to resell surplus energy, and a reduction of their carbon footprint.

To date, the high cost of renewable energy technologies and their long payback times, in the face of cheap fossil fuel derived energy available from the grid, have been a deterrent to their take up by householders.

To date, cheap fossil fuel has limited microgeneration to the renewable energy enthusiast.

Government incentives go some way in encouraging greater use of renewable energy, but not far enough to kick-start the industry into the high growth, high volume production and faster technological development that would reduce the price of generating equipment. To achieve this, incentives should be offered to housing developers – for example providing tax breaks based on the amount of energy saved by installing renewable energy systems.

Government incentives play a key role in encouraging adoption of domestic energy microgeneration.

House builders already have to deal with regulations covering the environmental impact of new buildings. At some point it may need to become mandatory for all new builds by property developers and local governments to employ renewable technology.

Developers may need to be encouraged to incorporate microgeneration into new building schemes.

Household based microgeneration will create a distributed generation scenario that, in the long term, could force incumbent power providers to restructure their generation, transmission and distribution infrastructure.

Microgeneration will eventually impact on incumbent energy providers.

Incumbent power providers may have to diversify their businesses to make up for the revenue loss due to lower demand. The energy markets may also change both internationally and nationally to align with the new reality of a greater supply of clean energy and lower demand for fossil fuels.

Incumbent power providers may have to diversify their businesses to make up for the revenue loss due to lower demand.

Incumbent power providers and grid operators have an advantage within the microgeneration market, as they have access to distribution networks and are seen as trusted partners within the energy market.

As trusted parties, incumbent energy providers are well placed in the microgeneration technology market.

Householders need to be made aware that microgeneration systems will require maintenance and possibly, in the case of solar PV, upgrading. Before investing they should assess how resilient their system provider is and whether the vendor could ride out a period of falling fossil fuel prices.

As household microgeneration equipment will require upgrading and maintenance, consumers should choose suppliers with care.

If household microgeneration becomes popular and is widely adopted, the power supply industry and regulators will need sophisticated tools to determine how much generating capacity is available at any given time. If most of the microgeneration capacity is based on renewable energy sources, weather conditions will heavily influence the amount of power flowing back onto the grid from individual households.

New tools will be needed to determine the amount of generating capacity available on a grid populated with many thousands of households generating their own power.

Householders will be tempted to become microgenerators to reduce their dependence on highly priced fossil fuels or in the hope of earning extra income by selling energy that is surplus to requirements. Faced with a wide array of microgeneration technology and basing investment decisions on an inflated projection of fossil fuel prices, there is scope for the householder to be misled when purchasing technology. Government and industry regulators should address this problem if rising energy prices continue to drive take up of microgeneration.

Some regulation of the household microgeneration industry may be required, as there is scope for mis-selling of technology to consumers concerned over rising fossil fuel prices.

The hybrid geothermal microgeneration market provides an opportunity for electricity providers to enter to push oil and gas companies out of the domestic heating market by providing the energy needed to drive heat pumps.

The hybrid geothermal market could become a battleground for the domestic gas and heating oil suppliers.

The US market for small-scale wind turbines could be worth up to $280 million per annum, with the UK market being worth up to $60 million – assuming microturbines become mass produced consumer products. The US market for solar PV could be worth $600 million per annum. While sales in the UK could in theory reach $45 million per annum, the poor climate will hold sales below this level. Over the next five years the UK market for solar hot water could be worth $57.5 million per annum and the US market could be worth $800 million. The UK market for geothermal energy could be worth $2.1 million per annum and the US market could be worth $28 million per annum.

The market for microgeneration technology is heavily influenced by the structure of a country's housing market, in particular the number of housing starts per annum and the proportion of detached properties. Other factors include regional climate variations and prevailing oil prices.

Vendor Profiles

Windsave

Glasgow based Windsave Ltd was formed in 2002, with an aim to allow consumers to participate in the green revolution today. It manufactures a microturbine, the WS1000, that can be used on commercial and domestic premises. It generates 1 kW of electricity with wind speeds of 12 m/s at a height of 10–20 m. However, it can operate in wind speeds as low as 3 m/s. The Windsave System is roof mounted and a cable leads directly from the turbine into an inverter so it can be fed into the household mains through a 13 amp plug. The system claims to have virtually no vibration or noise and was designed to blend into urban landscapes. Affordable, and not much larger than a satellite dish, this system should need planning consent rather than planning permission. The WS1000 costs around $2,700 plus 5% VAT fully installed and subject to the site survey. Windsave claims that using its system can result in a potential saving of up to 30% on the average UK domestic electricity bill, i.e. 3.2 MWh per annum, and will pay for itself in five to six years. It has a minimum life of 15 years.

Customers of Windsave systems are able to participate in the ROC scheme through their Windsave Green DividendTM cheque scheme. An inbuilt meter will allow remote monitoring of the power generated, from which the value of the ROCs will be calculated.

Windsave markets its product through distributors like WellieBoot for southern UK, and Renewables Ireland for Ireland. In May 2005, the company signed a three-year joint venture with Centrica (parent company of British Gas), the UK's largest energy supplier, to sell, install and maintain Windsave wind turbines. It is also hoping to sign a distribution deal with a wind farm operator in the USA, and potential partners in Australia and China with the aim of breaking into the Chinese market. Windsave plans to float on the AIM market in the second quarter of 2006 with a market value of around $90m.

Windsave At A Glance

Manufactures a microturbine, the WS1000, that can be used on either commercial or domestic premises.

www.windsave.com

Competitors include Ampair, Proven Energy and Renewable Devices. Renewable Devices claims to have the world's first silent, building-mountable wind turbines in their product called Swift, a 1.5 kW system.

www.ampair.com
www.renewabledevices.com
www.provenenergy.com

Analysis

Rising household energy bills have focused media attention on DIY microgeneration, and the media's liking for quick and simple solutions means that microturbines have received a great deal of exposure. Manufacturers who, until recently, have been addressing small niche markets such as electricity generation for remote wireless communication and marine applications, are now faced with the challenge of supplying technology for the mass market.

Microturbine suppliers are trying to upgrade their distribution networks and ramp up production to meet demand. A major DIY store has been trying to source a supply of turbines priced at a level that will suit their customers. Windsave distribute their turbine through Centrica, a major household energy provider. This makes sense for Centrica, a gas supplier that has moved into the electricity supply sector. For householders hoping to sell electricity back to the grid operator, wind is an ideal solution especially in northern Europe where solar radiation is low compared with regions in the solar belt. Wind energy can also be used to feed geothermal based microgeneration systems.

Perhaps the greatest threat to the microturbine manufacturer is the rapid growth of the market. The turbines themselves are relatively simple and, if manufactured in volume, could be retailed for a good deal less than their current market price – perhaps even sub $1,000. If major stores cannot source a sufficient volume of low cost product locally, they will start to look to Asia. This will be good for the householder and radically reduce payback periods, but bad for the pioneers of household wind energy systems.

Solartwin

Solartwin Ltd was formed in 1998 and installs solar water heating systems throughout the UK and Ireland, and exports DIY kits worldwide. The company aims to broaden the market for solar technology by making its equipment simple, quick to install (usually within one day), and affordable.

Solartwin's technology was developed with the support of a DTI SMART award, and their products manufactured in the UK. The company claims its solar hot water technology has a number of advantages over competing technologies. According to the company, the pump is solar PV rather than mains powered and the system is freeze-tolerant and does not need a heat exchanger – the thermally conductive pipes freeze in winter but do not crack. This means that the system does not need antifreeze. (Competing systems either use antifreeze in the circulating water or drain water back from the collector during extreme temperature conditions.)

Solartwin employs 16 people and markets its products through a network of component suppliers, installation subcontractors, and resellers.

A typical DIY system costs approximately $3,000 while a professionally installed, 2.8 sq m system serving a home of one to four people would cost in the region of $5,000.

Solartwin

Solartwin At A Glance

Founded in 1998 and funded with a DTI SMART award. The company employs 16 people and builds basic entry level solar water heating systems suitable for the DIY and professional microgeneration market.

www.solartwin.com

Analysis

Solar hot water systems were one of the original microgeneration systems, and their simplicity makes them popular with DIY alternative energy enthusiasts. Conceivably these systems could be used in community energy generation projects, and the hot water sold to scheme members. However, in the main there is little scope for reselling energy produced using solar hot water technology, and as no electricity is produced by the system, incumbent energy providers and grid operators show little interest in entering this sector of the microgeneration market.

At first sight there seems to be no obvious role for solar hot water within hybrid microgeneration systems, and here again this may explain the reluctance on the part of traditional energy providers to become heavily involved in its promotion. However, solar hot water systems could be used to heat water that is being used to raise the temperature of a heat store in a geothermal system.

It would cost relatively little for a DIY enthusiast to build a solar hot water system using readily available materials, and the payback period for the resulting system would be relatively short. However, turnkey systems provided by commercial companies need a degree of integration by a plumbing or heating engineer. This raises the cost of the system substantially and extends the payback period.

Solar Century

Solar Century provides solar PV solutions for housing, commercial and public buildings, street furniture and schools. Its products include PV roof tiles and slates, cladding, glazing, louvers, and sound barriers.

Solar Century claims it is one of the UK's leading solar PV companies. Its off-grid 'streetsmart' systems provide lighting to over 1,000 bus shelters, and power for bus stops, real-time information displays, ticketing machines and signage lighting, in the UK, Denmark, France, Spain Holland and Germany. However, it is also active in the residential PV market. Typical of its installations is a 157 kWp grid-connected Sharp monocrystalline module retrofit system across three sites on the Priors Estate. This urban installation is located on an estate in London that is home to 200 residents.

Solar Century also installs PV based systems within new housing developments, becoming involved in the projects at an early stage. Typical of this type of development is a 20 kWp grid-connected integrated module installation on 15 houses, on a new-build development by Maidenhead and District Housing Association. This development also featured superinsulation, passive solar architecture, solar thermal heating, stack ventilation, sedum roofs, sustainable timber construction and greywater recycling.

The company plans to launch its Complete Solar Roof system in spring 2006. This product will generate both electricity and hot water at the same time, using solar electric and solar hot water roof tiles mounted in dark grey frames that blend with conventionally tiled roofs. Its system includes the use of antifreeze in the water circulation, and a heat exchanger.

Since 1999 Solar Century has completed 385 solar PV installations.

Solar Century At A Glance

The company employs 40 people and received a £75,000 grant from the DTI to develop a range of solar powered street furniture. The company has also designed its own PV roofing tile.

In 2005 Solar Century had sales of £4.2 million, up from £2.8 million in 2004.

www.solarcentury.co.uk

Analysis

The current round of energy price rises has seen a great deal of activity in the photovoltaic (PV) solar device market. There has been a steady migration of skills and investment from the information technology to the renewable energy sector. Thin film technology and improved manufacturing techniques should have reduced the cost of solar panels. However, to date, these cost savings have not been reflected in the price of solar panels, and a householder thinking of retrofitting their property may be wise to wait until prices fall before installing PV technology. There is also the possibility that the PV device industry, unlike its information technology counterpart, will not see prices fall and production increase (see the CarbonFree report on Farming Renewable Energy). That being said, solar PV requires less integration than solar hot water systems and there is the possibility of selling any excess electricity back to the grid operator.

One key advantage of solar PV is that devices can be easily integrated into conventional building materials such as roofing tiles, and Solar Century has undertaken a number of projects where solar PV is installed in new developments. In theory, this should reduce the cost of microgeneration projects, as a building would incorporate a roofing system whether it was based around solar PV or not. However, care should be taken that the developer has not committed the householder to a PV technology that is not easily upgraded should more efficient materials come on to market at a later date.

EarthEnergy

UK based GeoScience Ltd is a specialist geothermal energy consultancy and a designer and installer of ground source heat pump systems including retrofits. Through its wholly owned subsidiary EarthEnergy Ltd, it has designed and installed more than 200 heat pump units ranging from 3 kW to 250 kW in the UK, and distributes ground source heat pumps manufactured by Viessman, Calorex Heat Pump Ltd, Kensa Engineering Ltd, Genie, and Florida HeatPump (AIJ Ibérica) among others.

Earth Energy Engineering Ltd – a separate company from GeoScience's EarthEnergy Ltd – designed a ground source heat pump system which is built by Calorex Heat Pump Ltd, promoted and sold by the utility company Powergen, and installed by EarthEnergy as a product called HeatPlant. HeatPlant was designed for small well-insulated homes typical of new builds being constructed by housing associations. HeatPlant provides full space and water heating at lower costs than a condensing gas boiler, and produces hot water at 60°C without the need for supplementary heaters.

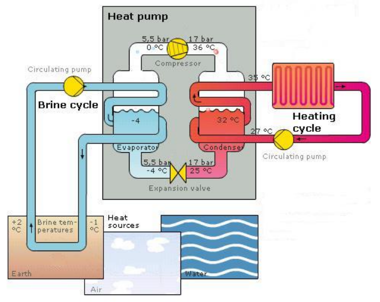
HeatPlant is being marketed at a discounted rate by Powergen in association with the Metropolitan Housing Trust to provide central heating for low energy, social housing developments at locations across Nottinghamshire. Powergen HeatPlant packages have also been installed in several properties belonging to Penwith Housing Association. Powergen intends to support the installation of 1,000 units in the social housing sector as part of its Energy Efficiency Commitment.

EARTHENERGY

EarthEnergy At A Glance

In 1995 GeoScience developed the ground source heat pump system that is now marketed by its subsidiary EarthEnergy. The company claims to be the leading geothermal system supplier in the UK.

www.earthenergy.co.uk



Analysis

Geothermal based microgeneration as an energy source for household use is a small but growing market. This may be because a large number of the pioneering adopters of microgeneration are relatively affluent and typically have access to the large area of land needed to provide the basic energy for a geothermal heating system.

The geothermal energy market could become a battleground on which incumbent energy providers fight each other for a larger share of the household energy market. In most cases the householder will be using a geothermal energy source to replace a gas or oil fired domestic heating system. The system will require electricity to drive a heat pump, and approximately 25% of the energy the householder uses to heat their property will now be provided by an electricity, rather than an oil or gas, supplier. This is perhaps why the electricity provider Powergen has started to market HeatPlant.

The providers of wind and solar microgeneration technology, knowing their systems cannot easily provide all the energy required to heat the average home, will also be hoping to exploit the growing interest in geothermal energy and use hybrid solutions to leverage the energy output from solar panels and wind turbines.

Resources

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4. Ofgem. A review of the Energy Efficiency Commitment 2002 – 2005, August 2005 (online) http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/12015_18105.pdf?wtfrom=/ofgem/work/index.jsp&section=/areasofwork/energyefficiency

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