

WOKING: LOCAL SUSTAINABLE COMMUNITY ENERGY

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WOKING: LOCAL SUSTAINABLE ENERGY COMMUNITIES

This paper summarises a practical strategy for a sustainable energy society deriving its initial energy needs from energy efficient low carbon energy resources whilst at the same time establishing a sustainable community energy infrastructure to enable future energy needs to be derived from wholly renewable energy resources via a hydrogen economy within the Royal Commission on Environmental Pollution¹ timescales to reduce CO₂ emissions by 60% by 2050 and by 80% by 2100. These concepts can be applied to any community in the UK or indeed in the world.

Woking Borough Council with its unique experience and expertise in local sustainable community energy systems has been able to tease out the real issues and barriers to a sustainable energy future through the actual implementation of such systems, including sustainable and renewable energy systems, fuel cell technology and low carbon transport systems.

1.0 WOKING: ENERGY SERVICES FOR THE NEW MILLENNIUM

1.1 Background

Woking Borough Council has implemented a series of sustainable energy projects in the past 14 years, including the UK's first small-scale combined heat and power (CHP)/heat fired absorption chiller system, first local authority private wire residential CHP systems, largest domestic photovoltaic/CHP installations, first local sustainable community energy systems, first fuel cell CHP system and first public/private joint venture Energy Services Company or ESCO.

The Council is recognised as the most energy efficient local authority in the UK having already achieved an average National Home Energy Rating of NHER 8.13 towards its target to improve the energy efficiency of the Council's own public sector housing stock to NHER 9 as well as maintaining accreditation under the Institute of Energy's Energy Efficiency Accreditation Scheme since 1995.

In recognition of this pioneering work the Council gained the **Queen's Award for Enterprise: Sustainable Development 2001** in respect of its Energy Services activities in the development of Local Sustainable Community Energy Systems, the only local authority ever to receive a Queen's Award for Enterprise.

1.2 Summary of Energy, Environmental and Financial Savings

Since the Council implemented its energy efficiency and environmental policies in 1990/91 (the base year), it achieved its target to reduce energy consumption by 40% in

1. Royal Commission on Environmental Pollution's Report: Energy – The Changing Climate – June 2000.

10 years. Achievement from 1991/92 and 2002/2003 was, as follows:-

Energy Consumption Savings	200,231,075 kWh	46.0% Saving
Carbon Dioxide CO ₂ Emissions Savings	116,546 Tonnes	75.0% Saving
Nitrogen Oxides NO _x Emissions Savings	369.6 Tonnes	71.8% Saving
Sulphur Dioxide SO ₂ Savings	1,171.4 Tonnes	78.5% Saving
Water Consumption Savings	376,428,000 Litres	43.8% Saving
Savings in Energy and Water Budgets	£5,098,842	32.6% Saving

The above savings are for corporate property and housing stock, where the Council pays the energy and water bills, and exclude Council tenant and private sector savings brought about by the Council's Housing energy conservation and CHP/renewable energy programmes.

The Council's innovative energy efficiency recycling fund, where financial savings achieved by energy and water efficiency projects are ploughed back into the capital fund creating an ongoing recycled capital fund (ESCO finance model) has led to a total investment of **£2.8M** over the previous 12 years from the original capital fund of **£0.25M** established in 1990/91 which has enabled savings of over **£5.0M** over the same period to be made resulting in current annual savings of over **£974,000 a year**.

1.3 Climate Change Strategy

In December 2002, the Council's energy efficiency policy was replaced by the Climate Change Strategy for Woking, not just for Council buildings and transport but for the Borough as a whole, shifting the focus from savings in kWh's of energy to savings in tonnes of CO₂ as well as adapting to a changing climate. The key three principles of the Strategy are:-

- Adopting an overall target to reduce Woking's CO₂ equivalent emissions by 80% of its 1990 level by 2090 in steps of 10% up to 2050 and 5% from 2050 to 2090;
- Adopting the concept of an Environmental Footprint for the Borough which has as its base 1,060,000 tonnes of CO₂ equivalent emissions of greenhouse gases; and
- Declaring itself Climate Neutral and setting up a Climate Change Fund.

As part of a number of action plans the Strategy adopts targets for purchasing 20% of the Council's electrical energy requirements from renewable sources and 100% of the Council's electrical and thermal energy requirements from sustainable energy (including CHP) sources by 2010/11.

By 2002/03 the Council had already reduced CO₂ equivalent emissions by 14.51% of the whole of the Borough's CO₂ emissions in 1990 through its own actions alone. In addition, the Council purchased 84.2% of its own electrical and thermal energy requirements from local sustainable sources and 3.9% of its own electrical energy requirements from local renewable sources.

1.4 Home Energy Conservation Act

The Council's achievement against its Home Energy Conservation Act target from 1 April 1996 to 31 March 2003, was as follows:-

Energy Efficiency Savings Achieved	721,946 GJ pa Saving (200,540,870 kWh pa Saving)
Reduction in CO ₂ Emissions Achieved	77,638 Tonnes pa Saving
Improvement in Energy Efficiency Achieved	21.27%

1.5 Innovative Projects

Innovative projects implemented by the Council include:

(i) The first small-scale CHP/heat fired absorption chiller system in the UK which provides heating, hot water services, air conditioning and electricity to the Civic Offices without the use of CFC's, HCFC's or HFC's as water is used as the refrigerant. As the absorption chiller is in effect a heat load this has the effect of increasing the base heat load available to the CHP unit all year round leading to increased energy savings.

(ii) The Thameswey Condensing Boiler Scheme offers a condensing boiler for the same or lower price than a conventional boiler with an exclusive further discount of at least £50, as part of an energy conservation package to householders. A joint public/private partnership

was established with British Gas to run the scheme which has since been extended to 14 other local authorities. Entry to the scheme costs the participating Council £150 plus an annual fee of £150 with scheme publicity and marketing material being provided at cost + 15%, and will incorporate the participating Council's name and logo. Councils also receive HECA data for use in their annual HECA reports.

(iii) The Council installed the first (and still the only) local authority private wire residential combined heat and power and renewable energy systems in the UK to provide heating, hot water services and electricity directly to its sheltered housing residents. The savings for residents have been substantial reducing residents total energy bills to only 6% to 7% of state pension income, well within the Government's affordable warmth criteria of 10% of income for heating only.

(iv) Woking, with the support of the Energy Saving Trust, incorporated in 1999 the UK's first Energy and Environmental Services Company or EESCO called Thamesway Ltd., and Thamesway Energy Ltd., a public/private joint venture Energy Services Company or ESCO. Again, like the condensing boiler scheme Thamesway will be able to provide energy services to other local authorities, public bodies and the private sector both within and outside Woking to enable green energy projects to be implemented in their area to serve their buildings directly with green energy.

(v) Thamesway Energy Ltd., completed the first phase of the first sustainable community energy system in the UK in Woking Town Centre, comprising combined heat and power, thermal storage and absorption cooling with heat, chilled water and HV/LV private wire networks serving the Civic Offices, two hotels (including a new 161 bedroom Holiday Inn Hotel), conference and events centre, leisure complex and bowling alley, nightclub and multi-storey car park. The application of the mixed green technologies achieves a 135% sustainability in electricity which enables island generation to be provided making the buildings connected to the system self sufficient in electricity and able to be provided with energy services in the event of an external power cut for prolonged periods. The surplus electricity is exported to other Council sites, including sheltered housing passing on affordable energy benefits to more residents in addition to those residents already served by local private wire residential CHP/renewable energy island generation sites.

(vi) The first integrated CHP and photovoltaics system in the UK comprising photovoltaic roof and CHP system at Brockhill. The reverse winter/summer electricity profile has the potential to achieve 100% sustainability in electricity.

(vii) The first fuel cell CHP system in the UK at Woking Park providing heating, cooling and electricity to a swimming pool and leisure complex. Hydrogen is chemically reformed from natural gas and oxygen is extracted directly from outside air to fuel the fuel cell. Due to the electrochemical process virtually no harmful pollutants are produced and 100% pure water is produced as a by product.

2.0 TACKLING FUEL POVERTY

2.1 Benefits for Social Tenants

The Council has the most energy efficient public sector housing stock in the UK with an average energy efficiency rating of NHER 8.13 being part way through to achieving its target of NHER 9. Most of the traditional energy conservation measures have already been installed with most of the effort now concentrated on external wall insulation (as part of overcladding planned preventative maintenance works) and private wire residential CHP and renewable energy systems to provide affordable heating to all Council tenants, where the Council provides heating, by 2010/11.

2.2 Benefits for Fuel Poor Households

Although the greatly increased energy conservation grants and the inclusion of heating for low income over-60's, chronically sick and the disabled in the New HEES (Warm Front) are to be welcomed there are some fuel poor households that now fall outside the eligibility criteria for New HEES/New HEES Plus.

In developing its fuel poverty strategy the Council recognised that some fuel poor households in the private sector needed top measures over and above the old HEES maximum grants to provide them with full energy conservation measures (eg., draughtproofing, cavity wall and loft insulation) which it funded through SRB for Sheerwater and Maybury and the CRI for the remainder of the Borough up to 1999/2000. The Council has included further funding in its HIP for 2000/01 to 2007/08 to address top up measures to Warm Front and for fuel poor households that fall outside of Warm Front, taking advantage of other grants where it can to tackle fuel poverty in the Borough.

Out of 32,500 private sector households in Woking, nearly 11,000 households have so far taken advantage of the Council's energy conservation schemes from 1996 to 2003, of which over 3,100 households have been provided with energy conservation grants to provide full insulation measures.

3.0 THAMESWEY ESCO - SUSTAINABLE ENERGY SYSTEMS

3.1 Introduction

As part of the DETR funded Energy Saving Trust ESCO Programme, the Council obtained leading counsel's opinion on local authority vires with respect to forming or participating in ESCO's. The outcome of this work was the formation of the UK's first EESCO and ESCO, called Thameswey, to take forward the innovative and unique green energy services concept that Woking Borough Council had so successfully employed over the previous 10 years at a small-scale level using local authority finance to a large-scale level using primarily private finance. The Council owns the intellectual property in Thameswey and the Thameswey registered trademarks.

Thameswey Ltd., is an Energy and Environmental Services Company or EESCO wholly owned by Woking Borough Council which enters into public/private joint ventures to deliver its energy and environmental strategies and targets (primarily green energy, tackling fuel poverty, water, waste and green transport). The local authority vires and the Memorandum of Articles and Articles of Association of the EESCO enables Thameswey Ltd., to participate in energy services projects both inside and outside the Borough of Woking.

Thameswey Energy Ltd., is a public/private joint venture Energy Services Company or ESCO between Thameswey Ltd., and ESCo Danmark Aps owned by Pen-Sam Danish Pension Fund. Projects are financed with shareholding capital and private finance with project and finance development carried out jointly between Thameswey Ltd., and DDH Contractors UK Ltd., (owned by Det Dansk Hedeselskabet, one of the Hedeselskab foundation companies), who act as the turnkey design, build and operation contractor on Thameswey large scale district energy schemes. Hedeselskab is a foundation (founded in 1866) committed to environmental projects whose patron is Her Majesty Queen Margarethe II of Denmark.

The formation of Thameswey has so far enabled the Council to increase its embedded generation capacity by 800% since 2000.

Thameswey is not an energy supplier but an energy services provider. The production and use of energy and their cost implications involves several things, including the cost of new or replacement primary energy plant (boilers and chillers), their eventual replacement in say 15 to 20 years time, the related inflation, consultancy and financing costs, their maintenance and the consumption of energy.

3.2 Energy Services Concept

The energy services concept is not the provision of electricity and gas but the services that energy provides, ie., heating, cooling, lighting, power, etc., and intrinsically includes the primary energy plant. Thameswey's approach to energy services is to use the customer's own brown energy costs (including their primary energy plant costs) to calculate and provide them with a green energy services proposal in place of their brown energy supplies. Green energy is more expensive than brown energy because of the higher cost of the plant but Thameswey is able to provide green energy services for similar costs as brown energy services for most customers through the payback on the green energy plant by the sale of heating, cooling and electricity directly to the customer.

Thameswey provides a potential customer with a breakdown on how this is worked out. The normal approach is for Thameswey to match a customer's current electricity unit price and to assimilate the energy services costs into the heat and chilled water unit prices. The customer's electricity consumption will be reduced since electricity will no longer be needed to generate cooling and where residential customers or small to medium enterprises are provided with energy services by Thameswey savings can be achieved against their brown energy suppliers. The energy services prices agreed at the commencement of the long term contract are indexed linked annually so the customer maintains the benefits of the contract throughout the length of the contract.

There are further benefits to the customer in that there is a transfer of risk from the customer to Thameswey of the primary energy plant. Thameswey will be responsible for the design and implementation of the plant, inflation, financing, maintenance, etc., as well as the green energy and stand by and top up supplies which offers customers further security of supply. There is also the additional benefit of 'green kudos' by being a customer of Thameswey, particularly if a customer's site becomes a catalyst for a local sustainable community energy system serving the local community. This may or may not be of importance to an organisation but many companies, organisations and residents are beginning to recognise not only the importance of environmental performance but also symbiosis with the local community who are after all customers or potential customers (in some shape or form) of the companies or organisations concerned and these customers are becoming increasingly environmentally aware.

3.3 Thameswey

Thameswey as a concept and the green energy services that it offers is unique being based on the Council's own innovative green energy projects, including CHP, thermal storage, absorption cooling, renewables and private wire. The advantage to customers is that they actually receive a green energy supply as well as exemption from the Climate Change Levy through their requirement for heat and/or cooling, not some 'notional' green electricity that can never reach them plus the transfer of risk from the customer to Thameswey of the primary energy plant.

Instead of the customer being responsible for their own primary energy plant Thameswey provides its own primary green energy plant which takes into account the customer's capital cost of replacement or new plant as well as the maintenance costs, consultancy fees, inflation and financing costs. This is the difference between an energy services contract and an energy contract since energy services contracts take all of these other factors into account.

3.4 Thameswey Sustainable Energy Systems

Energy services contracts are long term contracts since the costs of providing, maintaining and eventually replacing plant has to be financed from the payback of providing the energy services which will be at Thameswey's risk. Thameswey would become a customer's energy services supplier providing electricity, heating and cooling (where applicable) plus being responsible for primary energy plant instead of just gas and electricity from the utilities. All plant will be green energy plant:-

CHP - Combined heat and power recovers the heat as well as generates electricity providing efficiencies of up to 90% instead of the central power stations/national grid system which can be as little as 21% efficient at the point of use as most of the energy in the form of thermal energy is wasted through power station cooling towers, electricity losses through the grid transmission and distribution systems and the inefficiencies of separate boiler heating systems. Conventional brown energy systems in the UK wastes more energy than the entire North Sea annual gas output, enough energy to heat every home in the country.

The worldwide waste of energy arising from central power stations/national grids is about the same as the total amount of energy consumed by the global transport sector².

In the UK, the Regulator – the Office of Gas and Electricity Markets (Ofgem) estimates that nearly \$1billion worth of electricity is lost each year in the UK distribution networks alone³.

CHP is connected to the local distribution network to provide standby and top as well as spill export of electricity. All CHP is designed to comply with the CHPQA scheme to achieve Climate Change Levy exemption.

Absorption Cooling - Chilled water is generated by hot water through a process of absorption at very low pressure which causes the water to boil at 2°C. Heat is provided by the CHP and green electricity is therefore generated from the requirement for cooling as well as heat. No CFC's, HCFC's or HFC's are used as water is used as a refrigerant in a sealed system. Absorption cooling is unaffected by the Montreal Protocol or the EC CFC Phase Out Programme so the occupants of a customer's buildings can feel particularly 'green' as well as more comfortable.

Private Wire - Private wire enables green electricity to be sold directly to customers rather than exporting the electricity to the grid and incurring unnecessary use of systems and losses charges since under the laws of physics electricity will always flow the nearest load, i.e., the local community. Woking is unique in that it is the only local authority in the UK to supply electricity as well as heat to local residents on its CHP/renewable energy private wire sustainable energy networks. Thameswey is also the only ESCO in the UK to supply electricity as well as heat to local residents on its CHP/renewable energy private wire sustainable energy networks.

New and Renewable Energy - Woking's Thameswey concept enables these technologies to be much more commercially viable than they would otherwise be. Thameswey's approach is much better since a customer can actually enable a green project to happen and to directly serve their own buildings. If a customer is interested in new and renewable energy technologies such as photovoltaics or the fuel cell CHP in Woking Park, this can also be supplied with a capital or revenue top up.

2. World Alliance of Decentralized Energy (WADE) – 1 November 2002.

3. International Power Generation – February 2003.

3.5 Green Air Conditioning/Refrigeration

The energy services proposal would cover absorption cooling deriving its heat input from the CHP or district heating network but not the provision of absorption chillers or the provision or conversion of a customer's air handling or refrigeration plant. However, customers can be provided with a price for any new or conversion of air conditioning/refrigeration systems which can be paid for as a capital sum or added to a customer's energy services prices, whichever a customer prefers.

3.6 Local Sustainable Energy Systems

If other associated sites can also be brought onto the green energy supply network a local sustainable community energy system could be developed which would further enhance a customer's environmental performance. This would be of particular benefit to new housing and commercial developments where the impact on the local community and the environment of such new developments can be offset or even eliminated by the new development acting as a catalyst to a local community energy system displacing conventional, inefficient and polluting brown energy systems.

4.0 WOKING TOWN CENTRE CHP - PHASE 1

4.1 Introduction

The buildings connected to Phase 1 of the sustainable community energy system comprise the Civic Offices, Victoria Way Car Park, new 4 star 161 bed Holiday Inn Hotel (with no boiler or chiller plant, since the hotel derives its energy services from the CHP station), the Metro Hotel, the Big Apple (Bowling and Diner), Chameleon Bar, Quakes Nightclub and HG Wells Conference and Events Centre. Surplus power is exported to other local buildings and sheltered housing over public wires via an enabling agreement for exempt supplier operation which also receives the benefit of exemption from the Climate Change Levy. The project was supported with an Energy Saving Trust grant.

The CHP system in Woking Town Centre will be developed organically taking a distributed embedded generation approach. The new County Hall and Galleries developments in Woking Town Centre are planned to be connected to the Woking Town Centre district energy system and other town centre building owners/occupiers are also in discussion with Thamesway to connect to the system, particularly following the recent power cuts in the national grid serving the town centre.

4.2 Project Description

The installation utilises distributed CHP, large scale thermal storage, heat fired absorption cooling, standby and top up boilers and 11kV/400V private wire, heat and chilled water distributed energy system networks. All buildings are interconnected with heat mains and high voltage/low voltage private wire networks with a single connection point to the local distribution network at the CHP station.

As an exempt generator/distributor/supplier Thamesway is able to achieve the true value of green energy by selling the electricity (as well as heat and chilled water) directly to customers on the network rather than to a licenced supplier. This approach enables the ESCO to increase its income to fund the investment whilst at the same time providing competitive electricity to customers by cutting out high transmission/distribution losses and use of system charges.

The combination of the green technologies connected to the sustainable community energy system (with reverse winter/summer thermal profiles) enables the CHP to be much bigger than conventional CHP achieving 135% minimum sustainability in electricity (ie., makes the site self sustainable in electricity with a minimum of 35% available as export off site over public wires to other local customers). This sustainability also enables island generation to be provided so that the buildings connected to the system can be supplied at full load in the event of a failure in the grid which is very attractive to customers, particularly in the event of a prolonged external power cut, when buildings on the network can continue in operation for as long as a gas supply is available.

Surplus power is exported over public wires to other Council buildings to reduce the Authority's exposure to the Climate Change Levy and to some local residents but as the system grows other local businesses and residential customers will be supplied in this way.

This project is the first sustainable community energy system, operating in a competitive energy market, of its type in the world and has important implications for future sustainability and how to supply local green energy rather than outdated inefficient national energy systems which have no future in a declining fossil fuel world.

5.0 WOKING PARK - FUEL CELL CHP

5.1 Introduction

The sponsors of the project are the Department of Trade and Industry (DTI), Advantica Technologies Ltd (formerly BG plc), the Energy Saving Trust and the US Department of Defense (via the US Department of Energy) under the USA Climate Change Program with the balance of funding being provided by the host organisation Woking Borough Council via the Council's innovative Thamesway Energy and Environmental Services initiative.

5.2 How the Hydrogen Fuel Cell Works

The principle of hydrogen fuel cells (www.utcfuelcells.com/fuelcell/how_fl.shtml) was first demonstrated by a British scientist and judge **Sir William Grove** in 1839. He discovered a relatively straightforward electro-chemical process where hydrogen and oxygen interact within a cell to generate electricity and heat.

The fuel cell contains an anode and a cathode with an electrolyte sandwiched between them, separating the two. Hydrogen is supplied into the anode and oxygen into the cathode. The two gases want to join but are prevented from doing so by the electrolyte which causes the hydrogen to split into a proton and an electron. The proton passes freely through the electrolyte whilst the electron is forced to take a different route around it, creating an electric

current before re-combining with the proton to make hydrogen again and combining with oxygen through a catalyst, creating a molecule of water.

There are several different types of fuel cell, each using a different material for the electrolyte (alkaline, phosphoric acid, molten carbonate, solid oxide and proton exchange membrane or solid polymer). Each operates at a different temperature and is suitable for a different application for stationary or portable power or transport.

Since Grove's experiments, the technology has been developed intermittently facing opposition from the prevailing Hydrocarbon Economy, and it was not until the 1960's space programme that fuel cells were used in a real practical environment. UTC International Fuel Cells (who make the alkaline fuel cells for the NASA Space Programme) produced the first commercial stationary phosphoric acid fuel cells in the early 1990's and more recently other manufacturers have produced commercial fuel cells for the emerging stationary and residential CHP and transport markets.

5.3 Project Description

The cost of the fuel cell CHP was diluted by integrating the project into a larger green energy project as part of the Thameswey concept to demonstrate how such technologies can be implemented in the deregulated energy market in the UK.

The project comprises a 200kW_e fuel cell CHP, together with new and existing reciprocating engine CHP, solar shading photovoltaic systems, heat fired absorption cooling and large scale thermal storage located in Woking Park interconnected together by heat and chilled water mains and private wire.

The quadgeneration fuel cell CHP system was commissioned on 21 December 2001 and supplies low grade heat to the hot water services system and high grade heat to the district heating systems and chilled water to cooling and air conditioning systems via the heat fired absorption chillers, electricity and 100% pure water via a water recovery system. The high grade heat is recovered twice, once through the high grade heat circuit and again through the low grade heat circuit supplementing the low grade heat.

As water from a fuel cell has never been recovered and utilised as a water supply in this way before (other than in spacecraft) the recovered clean exhaust water will be subject to testing prior to utilisation. Some of the generated water is utilised to cool the fuel cell but approximately 1,000,000 litres of surplus 100% pure water is generated each year demonstrating that the sustainable water resources attributes of fuel cells may be as, if not more, important than the sustainable energy attributes of fuel cells.

The combined system not only meets the energy demands of Woking Park but also generates surplus electricity which is exported to other Council sites to mitigate the authority's exposure to the Climate Change Levy and in conjunction with other Thameswey CHP and renewable energy projects in Woking Town Centre and elsewhere be supplied to further local sheltered housing residents and businesses under the Exempt Licencing regime to maximise income but still supply cheaper green energy to the local community demonstrating how such integrated green technologies can be made commercially viable.

The distributed generation system is planned to be further extended to connect new housing and business developments within the vicinity of Woking Park.

5.4 Sir William Grove Statue/Technology Information/Sponsorship Display

In commemoration of the fuel cell as a British invention a statue to Sir William Grove ('Father of the Fuel Cell') was erected in the Grove Garden adjacent to the fuel cell CHP. The Grove artist was Ulli Knall.

The fuel cell CHP is visible to the public and is provided with a technology information mural/display and viewing area for education purposes which includes the history of the fuel

cell, how the system works in Woking Park and how renewable energy can be integrated with the Hydrogen Economy to provide continuous renewable energy for the world's electrical, thermal and transport energy needs. The official biography for Sir William Grove, sponsored by the World Fuel Cell Council and the Royal Institution of Great Britain, is also included in the display.

5.5 Associated DTI Monitoring Project

Another DTI supported project is tracking the project from beginning to end, including the original conception, planning, development, procurement, financing and installation, as well as the subsequent operation and maintenance. This monitoring should provide detailed information on how such technologies can be successfully implemented. In essence, how Woking, as the most energy efficient local authority in the UK, achieves project 'firsts' through the monitoring of one specific project which is in itself another project 'first'. This project has important implications not just for the implementation of the UK's first fuel cell CHP but also how the UK's leading local authority in energy efficiency can achieve such project 'firsts' and how other local authorities and private sector organisations can learn from the way Woking does things.

The associated DTI monitoring project is being carried out by Advantica Technologies Ltd., with specific research and reporting being carried out by Professor Martin Fry. See www.dti.gov.uk/energy/renewables/publications/pdfs/f0300178.pdf.

5.6 Associated US Departments of Energy and Defense Work

The aims and objectives of the US Departments of Energy and Defense work was to design, install and operate a fuel cell CHP system in Woking Park, as the first fuel cell CHP system in the UK. A report was prepared as an account of the work sponsored by the US Government which also covers the benefits that were expected to accrue from the work in an understanding of the full technology procurement process, the economic and environmental performance in comparison with both conventional UK fuel supply and conventional CHP and the commercial viability of fuel cell CHP energy supply in the new deregulated energy markets.

The final report of this work is detailed in www.dodfuelcell.com/climate/reports/40609_Final.pdf.

5.7 Further Hydrogen Projects

Further hydrogen projects are being considered in the Borough, including a scheme based on anaerobic digestion/gasification plant and molten carbonate fuel cell technology.

6.0 DOMESTIC CHP

6.1 Residential CHP

Woking Borough Council is the only local authority in the UK with experience in supplying both heat and electricity from CHP/renewable energy directly to residents. The Council has gained valuable experience not only in the profiling and embedded generation back up systems for residential CHP but also with trading and other non technical issues. The smallest CHP used by the Council so far is 15kW_e (as part of a 45kW_e modular CHP system) and the smallest private wire local community energy system is supplied by a 22kW_e CHP integrated with a 67.7kW_p photovoltaic roof system to achieve an electrical as well as a thermal embedded generation balance.

The Council is investigating both stirling engine and fuel cell domestic CHP. However, the approach to and the utilisation of these technologies will be different for a number of reasons leading to different applications for public and private sector housing.

6.2 Public Sector Domestic CHP

Local authorities with their own housing stock, in common with other social and private landlords, are legally required to carry out annual gas safety inspections and servicing on gas fired boilers. Not only are the maintenance and whole life cycle costs per dwelling for

individual gas fired boilers more expensive than the costs per dwelling for community heating boilers, individual boiler systems also incur additional costs and resources in overcoming the lack of access or refusal to access to carry out the statutory annual gas safety inspections/boiler servicing.

Access problems can amount to typically 10% of the housing stock each year, depending on the nature of the community concerned. In Woking's case access problems have been reduced by incorporating several access visits at different times of the day and by out of hours appointments but there is still a rump access problem that has to be dealt with by the Council exercising its legal authority as a landlord to avoid the risk of prosecution through failing to comply with annual gas safety inspection legislation.

One of the Council's policy objectives for community energy is to replace individual boilers with community heating or energy systems so that the maintenance and life cycle costs are reduced and the access problems and costs eliminated. Domestic CHP by its nature would replicate the problem of individual boilers for social and private landlords so is unlikely to be used on Council housing.

6.3 Private Sector Domestic CHP

Domestic CHP for owner/occupiers would be supported by the Council as part of its Home Energy Conservation Act activities. In a place like Woking where 90% of the housing stock is in the private sector domestic CHP has potential and could make a significant contribution to the Council's annual energy conservation target. In support of these activities the Council may well develop a Thameswey Domestic CHP Scheme similar to its Thameswey Condensing Boiler Scheme for private sector homes when domestic CHP becomes commercially available. Thameswey may also consider an ESCO type approach to domestic CHP if the domestic export metering issues can be resolved.

6.4 Domestic CHP Technologies

The two domestic CHP technologies that the Council is considering are stirling engines and fuel cells. The former because of its base load application and potential for trickle heating for private sector housing and the latter because of its fuel cell stack flexibility to enable bespoke designs not for individual domestic CHP but for small scale private wire residential community energy systems for both public and private sector housing. Domestic fuel cell CHP is particularly attractive for ESCO projects providing the manufacturers design their systems not as stand alone individual boxed systems but as stackable systems with flexible enclosure designs.

7.0 MIDDLEHAVEN CHP

7.1 Sustainable Energy Projects Outside of Woking

Thameswey Ltd., is working with a number of developers and local authorities on new and existing development projects outside the Borough of Woking and Middlehaven is an example of one of these projects. Depending on the stage of development Thameswey is contracted to carry out either a first stage study and/or full feasibility study. The main difference between an ESCO study report and a consulting engineer study report is that the ESCO study report also includes a proposal to design, finance, build and operate the sustainable energy project. Thameswey projects are unique in that they cater for full load operation not base load operation based on private wire district energy systems (incorporating CHP and/or renewable energy) able to operate in island generation mode in the event of a failure of the grid.

This approach also maximises reductions in CO₂ and other greenhouse gas emissions which is particularly attractive to developers where the local planning authority requires a reduction in CO₂ emissions against current development standards and/or sustainable development requirements which the developer is addressing by the incorporation of a Thameswey local sustainable community energy system in the development.

7.2 Tees Valley Regeneration

Thameswey in conjunction with consulting engineer's Element Energy Ltd., were successful in winning a competitive tender for a sustainable energy system feasibility study for a development at Middlehaven, Middlesbrough as part of the wider Tees Valley regeneration and fuel cell applications in Tees Valley. The tender submission was unique in that the joint submission provided the client with a proposal not only for a feasibility study but with an ESCO proposal from Thameswey that would actually deliver the project with or without fuel cell application. The Thameswey proposal would also enable client stakeholders to participate as shareholders in a local Thameswey ESCO.

The proposed development at Middlehaven will be a new community and will comprise residential, supermarket, college, commercial, major leisure attractions, retail, cargo fleet retail, special/visitor/retail/leisure, hotel, schools, health centre, police HQ, etc. The first stage feasibility study works have been completed and the client stakeholders have agreed to move forward to a full Thameswey ESCO feasibility study to enable the project to be implemented.

8.0 RENEWABLE ENERGY

8.1 Introduction

Although generally too expensive to implement as a stand-alone technology on conventional payback criteria without grant support or subsidy renewable energy is included in the Thameswey concept where dilution economics and the advantages of private wire technology can be applied by integrating renewable energy with sustainable green technologies such as CHP, as applied to the photovoltaics for the Woking Park - Fuel Cell CHP project. The cost of renewable energy technologies should reduce in time, particularly if there is increased activity in this area by way of integrated green technology best practice.

8.2 Off-Grid Photovoltaics

The Council implemented 14 off-grid photovoltaic pay and display machines in Woking Town Centre in 1997 demonstrating that off-grid photovoltaics was more economical both in capital and running cost terms than conventional grid connected pay and display machines just by simply including the cost of grid connection with the tender for the supply and installation rather than carrying out these two activities separately. The alternative off-grid photovoltaic system was cheaper both in capital and running cost terms when the high cost of grid connection is taken into account, even in a highly urbanised town centre location. The off-grid photovoltaic system with solar batteries has not failed once in the last 7 years compared to several grid supply interruptions to other street furniture in the same period.

8.3 Off Grid Photovoltaics/Wind Energy

Following the success of this project the Council has implemented further off-grid photovoltaic pay and display machines in other parts of the Borough and participated in the development of an intelligent off-grid photovoltaic/wind turbine lighting column system with a renewable energy manufacturer to provide continuous night-time illumination, even during the darkest months of winter. The first 8 off-grid photovoltaic/ vertical wind turbine lighting columns have been manufactured and will be installed in Summer 2004 on three rural footpath schemes.

8.4 Integrated CHP and Photovoltaics

The Council has installed the largest domestic photovoltaic systems in the UK and the first such systems integrated with CHP on private wire networks. Woking now has the largest concentration of solar energy photovoltaics in the UK amounting to over 0.5MW_p, representing more than 10% of the total capacity of solar photovoltaics in the UK, with plans to increase this still further to over 1MW_p. These systems are unique in that they do not export their electricity into the grid but supply customers directly on private wire networks extracting the true economic value of green energy.

Further photovoltaic projects are planned, including the first photovoltaic glass/glass covered public streetscene in the UK at Woking Railway Station/Albion Square and a multi-storey car

park photovoltaic roof system interconnected to the Woking District Energy Station private wire system.

8.5 Woking's Unique Place in Power Generation History

Woking Electricity Supply Company (WESCO) was incorporated in 1889 and established one of the first public electricity supply systems in the UK. Coal was supplied by barge along the Basingstoke Canal and delivered to the power station in Board School Road via a short railway line. The generation capacity was 20kW increasing to 1.2MW by 1910.

Woking, along with Bournemouth, Oxford, Derby and Portsmouth, was included in the first Parliamentary Order in 1890 empowering the company to supply electricity for domestic use and for public lighting. According to EMA Network (the magazine for the electricity industry's Engineer's and Manager's Association) Woking had the UK's first fossil fuel burning power plant⁴. However, the earliest public electricity supply in the UK was in Godalming based on a small hydro electric system on the River Wey.

With the coming of nationalisation and the national grid in the late 1940's the power station, along with other local power stations throughout the UK, was decommissioned. Interestingly, the WESCO power station was one of the last power stations to be decommissioned in the UK in 1957 achieving nearly 70 years of local power generation in Woking. The power station was replaced by a new housing development called Wesco Court deriving its name from the old Woking Electricity Supply Company in remembrance of its unique place in history.

The photovoltaic roof at Wesco Court is the largest solar energy system in Woking, re-establishing a 'power station' at the original site of the old power station but this time a renewable energy power station instead of a fossil fuel power station.

8.6 Biomass CHP

Biomass CHP is being evaluated for the utilisation of biomass products and the sustainability of providing energy to local communities.

A waste/recycling project, also incorporating biomass, is planned for the Borough as part of the Council's Waste Management Strategy.

The project combines source and central waste separation, materials recovery facility, anaerobic digestion (for the organic waste stream), gasification (for the non recyclable inorganic waste stream) and CHP. This approach should achieve a recycling rate in excess of 66% and reduce the residual element of waste to landfill by some 90% to 98% of its original weight.

8.7 Geothermal Heat Pumps

A geothermal heat pump scheme is planned to be implemented for a remote sports pavilion complex with the intention to replicate this renewable energy technology for other pavilions and buildings remote from a gas supply. Standby and top up electricity will be provided by some of the Borough's solar photovoltaic systems via the enabling agreement for exempt supplier operation.

4. EMA Network Volume 2, No. 10, November 2001.

9.0 GREEN TRANSPORT

9.1 Transport Strategy

The Council's transport strategy is part of the Climate Change Strategy for Woking and includes:-

- Setting improved standards for taxi and private hire vehicles licensed to operate in the Borough incorporating a low carbon strategy to be achieved by 2010/11;

- Revising the Council's Transport Plan with a view to all Council owned vehicles, lease cars and cars used on Council business being low carbon vehicles by 2010/11;
- Promoting the use of low carbon vehicles and introducing from April 2004 a carbon offset charge for the use of the Council's car parks and the hypothecation of the carbon offset charge to the Climate Change Fund;
- Promotional campaign with fuel station operators in the Borough to encourage the provision of alternative fuels (LPG, LNG, CNG, hybrid, hydrogen) at local filling stations;
- Promotional campaign through Council publications to raise awareness of alternative fuel vehicles.

9.2 Natural Gas Vehicles

The Council replaced its diesel refuse fleet with liquified natural gas (LNG) vehicles as part of its new waste management contract in 2000. The LNG station is not connected to the gas grid demonstrating that an alternative fuel transport fleet can be operated independently of a grid infrastructure and how a future hydrogen transport system can be developed, particularly for these large niche markets. The natural successor to the Council's LNG refuse fleet on completion of the waste management contract would be a hydrogen refuse fleet in the Council's drive to further reduce CO₂ emissions.

Further Council vehicle contracts have been let for alternative fuelled vehicles, primarily based on liquefied petroleum gas (LPG) vehicles, to comply with the Council's Climate Change Strategy for Woking.

Liquefied Petroleum Gas (LPG) and hybrid LPG/petrol vehicles that comply with the Council's emission standards will also be permitted under the proposed taxi and private hire vehicles licensing scheme.

9.3 Electric Vehicles

A solar electric vehicle scheme is included in the Council's Energy Services Service Plan but may be overtaken by a hydrogen vehicle scheme, depending on the availability of hydrogen vehicles.

Electric/petrol hybrid vehicles that comply with the Council's Emission standards will also be permitted under the Council's transport strategy.

10.0 WATER

10.1 Water Efficiency

The Council has implemented a range of water conservation and efficiency measures, including cistern dams, tap regulators, flow controls, waterless urinals, water recycling, etc., run in conjunction with the energy efficiency programme reducing its water consumption by 43.8% over 14 years.

10.2 Waterless Urinals

Conventional urinals use an automatic flushing system using expensively produced potable or drinking water. Each urinal uses 9 litres of water per flush and flushes 4 times per hour consuming 25,000 litres of water a month. This water cannot properly treat the malodour connected with urinals caused by bacteria growth in the salts deposited from water which causes scale build up requiring regular treatment and maintenance.

Waterless urinals use a low cost replaceable fragrant bactericidal detergent rod, pad or cartridge, which is replaced as part of the normal cleaning regime instead of using water for flushing. 100% savings in water consumption is achieved as well as savings in scale treatment and pipe maintenance. Waterless urinals are installed in the Civic Offices, Pool In The Park, Leisure Centre and various other Council buildings.

10.3 Pool In The Park Re-circulation of Water

Conventional swimming pools chemically treat and heat mains water, circulate the treated water in the pool and then backwash the water to the sewerage drains. Backwashing is necessary to remove contaminants and can be performed several times a day depending on the number of people using the pool.

In Woking's Pool In The Park 50% of the cooling water is returned back to the break tank and 50% back to the balance tank instead of automatically backwashing to drain. The recovered water is then diluted with the incoming mains water and treated and heated again to the water quality requirements of the swimming pool saving both water and energy.

10.4 Water Conservation in the Private Sector

In addition to the various water efficiency technologies installed in its own buildings the Council has sold 1,540 subsidised home water butts to the Borough's residents.

10.5 Woking Park Fuel Cell CHP – Water Recovery

The Woking Park – Fuel Cell CHP generates approximately 1,000,000 litres of surplus 100% pure water each year as the clean exhaust of the fuel cell CHP. The water recovery system is currently used to irrigate the Park's plants but once tested and certified as potable the water will be evaluated for utilisation in the swimming pool complex but may well have a greater value as pure water in the drinks, pure water or chemical industries.

10.6 Water Recovery

To achieve its sustainable water resources objectives it will be necessary to employ the Thamesway concept for major water recovery schemes if the Council can find a suitable private sector partner. The first phase of a water recovery project in Woking Park, where the Council has three swimming pools and a large leisure complex, is in the course of development in conjunction with a water ponds project.

11.0 WASTE AND RECYCLING

11.1 Background

The Council recycled 19.2% of household waste in 2002/2003. The Council has 29 mini and 3 major recycling centres throughout the Borough. Each site has a range of facilities for the recycling of colour separated glass, newspapers and magazines, drinks cans and textiles. In addition, the major recycling sites have facilities for the collection of plastic bottles, books and cardboard and facilities for the collection of aluminium foil have been introduced at 7 sites and oil banks have been introduced at 3 sites. The Council also operates a kerbside collection recycling system and has sold 10,200 subsidised home composting units to residents.

The Government's recycling target for Woking is 26% by 2003/04 and 36% by 2005/06. In order to achieve a higher recycling rate and significant reduction of waste disposed to landfill the Council undertook a holistic review of reduction, recycling and recovery for both household and commercial waste regardless of who currently collects and disposes of the waste.

11.2 Waste Management Strategy

The Waste Management Strategy was approved by the Council in December 2002 with a view to reducing the requirement for landfill to less than 15% of its original weight in the context of the Council's Climate Change Strategy incorporating the following:

- A Zero Waste Strategy of 'an active programme of education and information to prevent the creation of waste;
- Complimentary action to minimise the levels of waste with a view to stemming the annual increase;

- Recycling the non organic materials where environmentally advantageous and where viable markets exist;
- Recycling the organic material through anaerobic digestion for use as compost;
- Reducing the volume of residual waste through gasification and promoting the re-use of the resultant material in the construction industry;
- Recovering energy where possible through combined heat and power thereby using it in the most environmentally advantageous way;
- A 'first stage' public consultation exercise to be undertaken in respect of the Zero Waste Strategy.

In determining the Strategy NGO's (including Friends of the Earth, Greenpeace, National Society for Clean Air, Forum for the Future, Green Alliance, etc), political parties (including the four main political parties, The Green Party and European Union), local regional and government regional offices (including Surrey County Council, Woking Local Agenda 21 and the Greater London Authority), the media (including The Times, The Guardian, The Telegraph, Washington Post, etc), think tanks (including The Institute of Fiscal Studies, etc) and commercial organisations/trade associations(including Thames Waste Management, Department of Health, Environmental Services Association, etc) were consulted.

A number of issues, including the application of fuel cell technology, arising from the consultation exercise have been incorporated into the Strategy.

The first phase of the Strategy implemented a twin alternate weekly collection pilot scheme in six areas of the Borough in February 2004. The second phase of the Strategy implemented a detailed feasibility study to implement the project as a Thamesway project.

11.3 Waste/Recycling Project

The project will combine source and central waste separation, materials recovery facility, anaerobic digestion (for the organic waste stream), gasification (for the non recyclable inorganic waste stream) and CHP. This approach should achieve a recycling rate in excess of 66% and reduce the residual element of waste to landfill to some 2% to 10% of its original weight.

12.0 LOCAL SUSTAINABLE COMMUNITY ENERGY SYSTEMS

12.1 Sustainable Energy

Sustainable energy is anything that enables energy supplies to be made sustainable, either now or in the future, by putting in place such energy systems or infrastructures necessary to achieve a renewable energy future. A prime example of this is combined heat and power where the fuel may initially be a low carbon fuel such as natural gas which can be replaced later by a renewable fuel such as biogas, biomass or even hydrogen as used in fuel cells. The important issue here is the heat, chilled water and private wire networks serving buildings on local sustainable community energy systems which enables the easy replacement or refuelling of the primary energy generators some time in the future when fossil fuels become scarce or non-existent. Combined heat and power is particularly important since 70% of the UK's non transport energy needs are thermal and most renewable energy technologies are intermittent electricity generation only.

12.2 Climate Change

The Royal Commission on Environmental Pollution study of energy and the environment commenced in August 1997 and culminated in the publication of its report 'Energy – The Changing Climate'. The main implication of the study was that atmospheric carbon dioxide CO₂ concentration of 550 parts per million by volume (ppmv) should be regarded as a limit which should not be exceeded if the risks of catastrophic alterations in the Earth's climate is to be avoided. The current concentration is some 370 ppmv.

For the UK, an international agreement along these lines which prevented carbon dioxide CO₂ concentrations in the atmosphere from exceeding 550 ppmv and achieved convergence by 2050 could imply a reduction of 60% from current annual carbon dioxide CO₂ emissions by 2050 and perhaps of 80% by 2100. This would mean that these targets would have to be met

before fossil fuels ran out, ie., the utilisation of zero or low carbon emission energy technologies being of primary importance over the need for sustainability from renewables since the Earth's climate could be irretrievably altered before the need for 100% sustainability in energy resources would be necessary.

Key amongst the Royal Commission's 19 key recommendations is the large scale construction of district heating networks, so that advantage can be taken of larger scale CHP schemes.

12.3 Local Sustainable Community Energy Systems

The distributed energy approach using mixed technologies and private wire for mixed communities is unique to Woking and can be found nowhere else in the UK. As part of its energy efficiency programme the Council implemented its first CHP system in 1992 and the UK's first small scale CHP/heat fired absorption chiller system in 1994 followed by a series of private wire residential CHP systems (the first and still the only systems of their type in the UK) and renewable energy systems. What marks these systems out from any other CHP system in the UK is the direct sale of cogenerated heat and green electricity to local customers at similar or lower price than for brown energy.

Local community energy systems can provide the full range of continuous energy services that customers would expect from an Energy Services Company or ESCO and achieve a substantial reduction in CO₂ emissions through a fully supported local sustainable community energy system.

Local community energy systems can be made viable by combining the non-residential and residential parts of the community together on a predominantly thermal energy system making use of thermal storage, heat fired absorption cooling for air conditioning/ refrigeration and other waste heat rather than using gas or electricity for heating and cooling. Electricity consumption can also be significantly reduced by eliminating electric air conditioning and refrigeration as well as cogenerating more electricity from the 'heat to cool' process via CHP/heat fired absorption cooling. With the right mix of residential and non-residential buildings and the different types of energy usage and duration, sustainability in electricity with surplus export available can be achieved as has been accomplished in Woking.

Such sustainability in electricity will enable island generation to be provided (but only on private wire networks, since this is not possible on public wire networks) which means the energy stations can continue to operate independent of the national grid in the event of a failure of the national grid, even for prolonged periods, unlike conventional CHP/renewables which have to be automatically disconnected from the grid to prevent reverse power flows into a 'dead' grid. This security of supply and independence from the national grid in the event of disruption of the grid due to bad weather, damage or technical interruption is particularly attractive to customers and a practical embodiment of what sustainable energy can achieve.

Of particular importance is the proximity of the new and existing industrial/commercial sites to each other. Hence the need to take a community led approach to such projects and the importance of the local authority understanding this concept and proactively assisting in delivering such projects.

12.4 Sustainable Energy Future

Even with a local sustainable community energy system grid connection (in practice the local distribution system, not the national grid) would be required to provide standby and top up supplies to guarantee energy supply to customers 24 hours a day all year round and to export surplus power over public wires to other customers.

This concept is also important to the future development of sustainable energy stations in the licensed distribution area since energy stations can be configured to supply standby and top up to each other under an enabling agreement for exempt supplier operation. With the development of further sustainable energy stations in the future it would be possible for such island networks to be completely independent of the national grid relying only on the interconnection between sustainable energy stations via the local licensed distribution system

which would enable the CHP units to be replaced by renewable cogeneration systems (most likely fuel cells because of the renewable fuel flexibility) in the future when the cost of such systems will be economically viable by the time the generation prime movers require replacing.

In this way, substantial reductions in CO₂ emissions and full independence of the national grid with local communities trading surplus power with each other on local lower voltage public wire distribution systems can be achieved with any shortfall in the residential/SME sectors being achieved by domestic CHP and/or renewable energy systems.

12.5 Security of Supply

By making use of a series of overlapping island networks customers are unaffected by power cuts in the national grid since embedded generation can continue to operate on private wire islanded networks. Although the UK already has a small amount of embedded generation, when the grid is down CHP/renewables are also down unless they have been set up as private wire island networks. Island generation able to supply full load in an isolated environment for prolonged periods of time provides additional security of supply taking advantage of distributed embedded generation that does not rely on the efficacy of the grid.

13.0 THE RENEWABLE HYDROGEN ENERGY ECONOMY

13.1 The Renewable Hydrogen Energy Economy Blueprint for Woking

Most renewable energy technologies are intermittent electricity generators only and even biomass has its practical and physical limitations. Government and most green groups tend to focus on renewable electricity only and yet 70% of the UK's building energy needs is thermal and transport energy is overlooked!

Nuclear energy cannot practically provide the nation's thermal and transport energy needs but renewable energy can provide continuous generation for the nation's electrical, thermal and transport energy needs through the application of the Hydrogen Economy. There is more than enough renewable energy resources to achieve this and the intermittent generation problem can be overcome by making use of biomass reforming, electrolyzers and other hydrogen generators enabling electricity to be stored in the form of hydrogen and the same process applied for fuelling hydrogen fuel cell transport, dispensing with the need for on board reformers. Hydrogen can also be used for fuel cell CHP systems, thereby achieving the renewable thermal energy as well as electricity aims.

13.2 Future Energy Strategy for the UK

Although Woking has avoided grid and NETA penalty costs by utilising private wire networks and a local trading system the existing regulatory regime limits the size of the local sustainable energy system and more importantly substantially limits the number of domestic customers than can be supplied with low cost green energy.

The embedded generation industry is capable of providing all of the country's energy needs and what is needed now is a progressive move towards this goal in parallel with using the existing centralised systems until they are no longer needed. Much of the national grid system would have to be replaced or refurbished within the Royal Commission's timescale for action in any case and it would be folly to replicate the existing national system which plainly would not be suitable for renewable energy which is of a much smaller scale than centralised power stations. The need will be for many thousands of renewable energy stations where electricity flows will be dissipated at the nearest loads and not lost in heating up the wires and transformers in the national grid.

Micro and mini scale embedded generation systems such as domestic CHP and/or renewable energy systems will play a valuable role in filling in generation gaps at the local domestic level (typically owner/occupier, small business units, isolated rural locations, etc.). These smaller systems, which may be small individually but large collectively, will be backed up by other local larger scale CHP/renewable energy systems, such as Woking is developing, where the electricity flows will be local and balanced out as part of a mixed technology local

embedded generation system approach and not backed up from the grid and centralised power generation which will become more unsustainable or non-existent in the future.

Government can take an easy first step to encourage the development of CHP, renewables, fuel cells and local sustainable community energy systems at the stroke of a pen – simply by increasing the supply limits for exempt generators/suppliers so that they are not burdened with centralised losses and use of system charges that unnecessarily increases the cost of green energy and which they are not making use of in any event. This will increase the economic value of green energy and put it on a competitive footing with brown energy by taking away all those unnecessary charges that are added to electricity supplied from embedded generation.

The current regulatory regime for exempt generators and suppliers should be changed to allow more customers to benefit from private wire systems. At the moment operators of stations as large as 100MW are exempt from generation licence requirements. However, of that 100MW only 1MW (about 1,000 households) is allowed to be supplied to domestic customers on private wire per generation site and only 5MW (of which only 2.5MW can be supplied to domestic customers) in aggregate export over public wires for all of its sites together!

Although more fuel-poor households could be provided with affordable energy this is prevented by this regulation. Given the interest in fuel poverty why has that limit been put in place? Is it because most of the profits of electricity companies are made in the domestic and SME sectors to make up for the very low cost dump electricity provided to power station base load customers in the energy-intensive industries?

The exemption limits should be further relaxed to enable the Kyoto and Royal Commission targets to be achieved. A lot of the extra money needed to stimulate renewables and CHP could be found by relaxing the exemption criteria and allowing local generators/suppliers to supply more electricity direct to local customers. Focus could then turn to bringing the Hydrogen Economy forward.

In environmental and sustainability terms the more island generation and local discrete ('private wire') networks that you have interconnected to each other the more a borough like Woking becomes sustainable in energy and if other towns and cities did the same thing there would be no need for large centralised power stations and a very high voltage national grid system because this would be replaced by a network of local embedded generation systems on local island networks interconnected to each other throughout the country. The future grid would be very much different than the one we know today operating on much lower voltage local island generation networks overlapping with other local island generation networks and so on.

Hydrogen will be the energy carrier of the future, deriving its energy from renewable fuels such as biomass, biogas, solar, wind, hydro (via electrolysers), etc. Fuel cells and the Hydrogen Economy are important, as used in conjunction with renewable fuels, is the only technology/fuel that can meet the UK's electricity, thermal and transport energy needs from renewable sources. Even if the long-term environmental impact of nuclear waste is ignored, nuclear energy can only address the UK's electricity needs not the UK's thermal and transport energy needs. Only fuel cells and hydrogen can deliver all three of the UK's primary energy needs. If Government looked at this issue in an innovative way as Woking have done then it would see that the Royal Commission on Environmental Pollution CO₂ reduction targets could be met as well as setting the foundation for a sustainable energy future. **The barriers to this are not technical but regulatory and vested interest.**

14.0 FURTHER INFORMATION AND WEBSITE LINKS

14.1 Case Studies

- (i) DTI/AEP/CHPA Electricity Trading in the New Market Issue No.4 - 1998 in Practice - Case Study No.1 Woking Borough Council - September 1998¹.
- (ii) DETR New Practice Profile 112 - Opportunities for Electricity Sales to Tenants from Residential CHP Schemes - January 1999².
- (iii) DTI Extended Renewable Energy Case Study 30 - Green Power: Local Sustainable Energy Systems - June 2000³.

- (iv) DTI Extended Renewable Energy Case Study 31 - Green Power: The Use of Off-Grid PV by a Local Authority for Pay and Display Machines - June 2000³.
- (v) Energy Saving Trust Energy Services Case Study 06 – Woking Borough Council’s Thamesway Joint Venture Project – April 2001⁴.
- (vi) Energy Saving Trust Practical Help for Local Authorities – Financing Energy Efficiency: Woking Borough Council’s Energy Efficiency Recycling Fund – November 2001⁵.
- (vii) CADDET Technical Brochure 174 – Sunny Outlook at Home for the Elderly – March 2003⁶.

For further information on these case studies, please contact:-

- | | |
|---|--|
| 1. ILEX, 104, Gloucester Green, Oxford, OX1 2RH
Tel. 01856 722660
Fax. 01856 722988
Email: ilex@atlas.co.uk | 2. BRECSU, BRE, Garston, Watford, WD2 7JR
Tel. 01923 664258
Fax. 01923 664787
Email: brecsueng@bre.co.uk |
| 3. New and Renewable Energy Enquiries Bureau
ETSU, Harwell, Oxfordshire, OX11 0RA
Tel. 01235 436747
Fax. 01235 433066
Email: etsueng@aeat.co.uk | 4. Energy Saving Trust
The Energy Services Office, First Floor
The National Energy Centre, Davy Avenue
Knowlhill, Milton Keynes, MK5 8NA
Tel: 01908 558209
Fax: 01908 662296
Email: energyservices@nesltd.demon.co.uk |
| 5. Energy Saving Trust
21, Dartmouth Street
London, SW1H 9BP
Tel: 0870 241 2089
Fax: 0870 130 8831
Email: info@practicalhelp.org.uk | 6. CADDET Centre, Future Energy Solutions
156, Harwell, Didcot, Oxfordshire
OX11 0QJ
Tel: 01235 432719
Fax: 01235 433595
Email: cadet.renew@aeat.co.uk |

14.2 Website Articles and Case Studies

1. www.woking.gov.uk/cgi-bin/archive.pl?item=988025744 (index to 20 case studies).
2. www.chpa.co.uk (use search engine for Woking for several internal sites).
3. www.futureenergies.com (see articles on Woking Town Centre District Energy System, Photovoltaics and Fuel Cell projects).
4. www.utcfuelcells.com/news/archive/090401.shtml (see press release on IFC’s Sale of PC25™ Power Plant to Woking, England gives United Kingdom it’s First Fuel Cell).
5. www.dti.gov.uk/NewReview/nr39/html/state_of_the_art_.html (UK’s First Fuel Cell CHP System article).
6. www.dti.gov.uk/NewReview/nr44/html/state_of_the_art_.html (A Fuel Cells First article).
7. www2.dti.gov.uk/renewable (use search engine for Woking).
8. www.energy-efficiency.gov.uk/enter.cfm (DEFRA website - use search engine for Woking).
9. www.publicservice.co.uk/pdf/pfi/spring2001 (PFI/PPP - Woking : New Ways of Cutting Costs on Power).
10. www.h2fc.com/news.html (see articles under 9/4/01).
11. www.fuelcelltoday.com (use search engine for Woking).
12. www.positivepower.co.uk/article.php?sid=28 (First Commercial Fuel Cell Installed for Woking Borough Council by International Fuel Cells article).
13. www.e4engineering.com/item.asp?id=42891&type=Reuters&ch=e4e_chem_process (Reuters article on UK: Leisure Centre gets UK’s First Fuel Cell System).
14. www.guardian.co.uk/Archive/Article/0,4273,4250725,00.html (Test Bed for Fuel Cell Project article).
15. www.publicservice.co.uk/pdf/detr/summer2001/p50.pdf (Power without Pain article).
16. www.btu-heating.com (click on fuel cell).
17. www.energy-markets.com/comment/986311932.html (Woking article).
18. www.insidecom.co.uk/eibi/editorial/eibi186.html (National Energy Manager’s Award article).
19. www.insidecom.co.uk/eibi/editorial/eibi504.html (Queen’s Award article).
20. www.est.org.uk/pdf/es_case_study_006.pdf (Woking Borough Council’s Thamesway Joint Venture Project article).
21. www.projects.bre.co.uk/CHP/ES%20Case%20Study%2006.Woking.pdf (Energy Services Case Study 06 – Woking Borough Council’s Thamesway Joint Venture Project).

22. www.practicalhelp.org.uk/cgi-bin/search.cgi/SIMPL/signposting/1 (Extended Case Studies on Green Power ECS24-31).
23. www.practicalhelp.org.uk/casestudies/finance/csf_wokin.doc (Case Study 06 -Woking Borough Council's Thameswey Joint Venture Project).
24. www.practicalhelp.org.uk/downloads/csf_wokin.pdf (Case Study - Financing Energy Efficiency – Woking Borough Council's Energy Efficiency Recycling Fund).
25. www.praseg.org.uk/POWERHOUSE%200ct2001.pdf (Click on Proposals for the Energy Review article on Woking).
26. www.lng-cng.com/chivefuels/customers.htm (Liquified Natural Gas: An Economic Transportation Fuel).
27. www.edie.net/news/Archive/5328.cfm (It's Real 'Rocket Science' as UK's First Fuel Cell Lands in Woking article).
28. www.doc.mmu.ac.uk/aric/eae/News/sustainability_issues.html (Local Authority Wins Queen's Award for CHP Scheme article).
29. www.bsee.co.uk/news/archivestory.php/aid/832/Html (CHP in Woking Exploits Fuel – Cell Technology article).
30. [www.cia.org.uk/Speak%20Out/Better%20future/Better_future%20\(more\).html](http://www.cia.org.uk/Speak%20Out/Better%20future/Better_future%20(more).html) (Forerunners of the Hydrogen Economy article).
31. www.climnet.org/news/September2001.html (Leisure Centre gets UK's First Fuel Cell System – UK: September, 2001 article).
32. www.york.ac.uk/inst/chp/has/rudlin.pdf (Autonomous UrbanDevelopment: 3.6 Energy Services and Case Study: Thameswey Energy Services – pages 39 and 40).
33. www.idea.gov.uk/lqip/reviews/woking.pdf (Local Government Improvement Programme Visit to Woking Borough Council: Innovation and Creativity – Item 52).
34. www.et.expo.com/page.cfm/Action_Press?PressID=15/t=m (UK's Largest Domestic Solar Technology Installation Will Mean Low Cost, Green Energy for Elderly Woking Residents article).
35. www.esd.co.uk/downloads/jpk_mar02_presentation.pdf (Implementing Low Carbon Solutions: Opportunities for Business – pages 30 to 37).
36. www.parliament.the-stationery-office.co.uk/pa/cm200102/364-ii/1111309.htm (Select Committee on Trade and Industry Minutes of Evidence – Memorandum by the Combined Heat and Power Association – Item 22).
37. www.fmb.org.uk/publications/masterbuilder/march02/22.asp (Light, Heat and Energy Savings Through a Roof article).
38. www.icwgb.com/02/02412.htm (Green Energy for Pensioners article).
39. www.praseg.org.uk/PRASEG%20News%202001/PRASEG%20News%20070901.htm (PRASEG News 7 September 2001 – Item 4: Test Bed for Fuel Cell Projects article).
40. www.jxj.com/magsandj/cospp/2002_03/index.html (Click on Woking: Energy Services, DG and Fuel Cells).
41. www.newbuilder.co.uk/newbuilder/news.asp?offset=10 (Private Wire Electricity and Heating article).
42. www.constructiontimes.co.uk/default.asp?channel_id=1962&editorial_id=6371 (Energy Methods Knock-On to Housing Market article).
43. www.pv-uk.org.uk/news/BritSol-15.pdf (Elderly Residents get UK's largest PV Installation article).
44. www.forumforthefuture.org.uk/aboutus/default.asp?pageid=307 (See under Generation H Conference and click on Allan Jones).
45. www.alanpotter-publicart.com/CurrentProjects.html (Current Projects - The Fuel Cell. See also Commissions).
46. www.utc.com/press/highlights/fuel_cell_europe.htm (UTC Fuel Cells Provides a Pollution-Free Solution to Europe's Energy Problems).
47. www.inreb.org/showpage.jsp?page=m.news.jsp&id=139 (UK's First Commercial Fuel Cell System Installed in Woking).
48. www.women2020.com/report/13.pdf (Chapter 13 - Energy Sources for Urban Extensions – What's Around: Micro Energy Supply Schemes).
49. www.bvfoe.freereserve.co.uk/newssummer02.html (Newsletter Summer 2002 New Renewable Energy – Local Solar Power!!!).
50. www.sd-commission.gov.uk/pubs/lowcarbonspaces/04.htm (Low Carbon Spaces - Area Based Emission Reductions: A Scoping Study – Exemplars of Low-Carbon Initiatives: 4.2.11 Ambitious Projects - Thameswey ESCO, Woking: Low Carbon Energy Services Project).

51. www.dti.gov.uk/energy/develop/bristolseminar_report.pdf (Energy White Paper - Regional Seminar – 8th July 2002, Bristol – see under Morning Session: Woking Borough Council).
52. www.lgib.gov.uk/policy/Woking_intro.htm (World Summit on Sustainable Development – Johannesburg: Energy and Climate Change Case Studies - Woking Introduction and Graphical Case Study).
53. http://search1.dti.gov.uk/energy/develop/non_gov_org/woking_borough_council.pdf (Energy Policy - Key Issues for Consultation Response).
54. www.climateequipment.com/pages/press/sept2002/woking-pool-in.htm (Climate Absorption Chiller Teams up with UK's First Fuel Cell Project).
55. www.parliament.uk/post/pn186.pdf (Parliamentary Office of Science and Technology – October 2002: Prospects for a Hydrogen Economy [see under Current Projects]).
56. www.brookes.ac.uk/other/uk-ises/autumn2002pdf.pdf (Solar News - see under Solar Power for Leisure Centres Conference).
57. www.woking.co.uk/news/article/article_id=637.html (Blueprint Sets 2090 Date for Green Target).
58. www.bpsolar.com (use search engine for Woking).
59. www.fuelcellmarkets.com/thameswey (Thameswey).
60. www.caddet.co.uk/assets/RE174.pdf (CADDET - Sunny Outlook at Home for the Elderly).
61. www.alanpotter-publicart/Fuelcell.html (Woking Fuel Cell and Mural).
62. www.woking.gov.uk/html/climate/index.html (An Innovative Climate at Woking).
63. www.futureenergies.com/print.php?sid=720 (UK: Space Age Technology Lifted Off in Woking Park).
64. www.chobham-online.co.uk/news/article/article_id=1385.html (True Wisdom in First Fuel Cell Enterprise).
65. www.solarbuzz.com/News/NewsEUPR104.htm (Woking Sheltered Housing adds More Power to Largest UK Solar System).
66. www.fuelcelleurope.org/article_default_view.fcm?articleid=977&subsite=847 (Woking Park – Fuel Cell CHP).
67. www.dti.gov.uk/energy/renewables/publications/pdfs/f0300178.pdf (Woking Park PAFC CHP Monitoring – Phase 1: Planning, Installation and Commissioning).
68. www.takingstock.org/Downloads/Case_Study_2-Woking.pdf (Case Study 2 - Woking Borough Council Energy Services).
69. www.est.org.uk/communityenergy/images/uploaded/documents/Woking.doc (Community Energy Case Study – Woking Borough Council).
70. www.bes-plc.co.uk/sub_page.cfm/section/about/editID/62/submenu/18 (Fuel Cells Europe - Fuels for the Future).
71. www.parliament.the-stationery-office.co.uk/pa/cm200203/cmselect/cmsctech/55/55ap60.htm (House of Commons - Science and Technology – Appendices to the Minutes of Evidence – Appendix 49: Memorandum submitted by Dr Nigel Brandon – see 2.3 Residential and Commercial Cogeneration).
72. www.f-e-e.org/cgi-bin/fee/cal/agendadetail.cgi?ActID=1954 (Fuel Cells: is Europe able to Compete? – see Reduction in CO₂ Emissions).
73. www.guardian.co.uk/uk_news/story/0,3604,1130972,00.html (Woking Shines in Providing Renewable Energy).
74. www.dodfuelcell.com/climate/reports/40609_Final.pdf (Woking Park - Fuel Cell Combined Heat and Power System – Final Report).
76. www.lda.gov.uk/uploaded_files/documents/18_491_SustainableEnergyNov03.pdf (Green Alchemy Turning Green to Gold: Powering London's Future – A Study of the Sustainable Energy Sector – see Appendix 3, page 40: Case Studies from Other Cities and Regions – A. Woking).
77. www.parliament.the-stationery-office.co.uk/pa/ld/lduncorr/eud2502.pdf (House of Lords Minutes of Evidence taken before the Select Committee on the European Union Towards a Sustainable EU Policy on Climate Change – Mr Allan Jones MBE).

Note: Type 'Woking CHP' and/or 'Woking Photovoltaic' and/or 'Woking Fuel Cell' and/or Woking Climate Change Strategy in your search engine for further website articles on the Woking and Thameswey sustainable energy projects.

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