# 5 Retrofitting energy solutions

## Insulation

5.1 Improvements to the building envelope include simple and direct measures that can be taken to significantly improve performance. Insulating roofs and walls in existing buildings is one of the most straightforward and economically least disruptive measures to reduce $CO_2$ emissions in the short-term in the UK. In recognition of this and in order to meet the new Carbon Emissions Reduction Target, in March 2008 the Government announced a £2.8 billion programme to fill 2.9 million cavity walls, insulate 2.7 million lofts, provide 110 million energy-efficient light bulbs and switch 90,000 homes from electric heating to gas.[1]

5.2 Millions of homes in the UK are known to be inadequately insulated but little information is available on the condition of non-domestic building stock as a whole. We have collected no data on the level of insulation in buildings in Soho, where the majority of the floorspace is in non-domestic use. We know that some of the larger landowners in Westminster operate a regime of good sustainable and cost effective practice in building improvements and have addressed this in properties subject to recent refurbishment.[2] However, as far as the majority of properties in Soho are concerned, there is little to go on, although, as already noted, incentives for landlords to carry out energy saving measures have been largely absent. Sample surveys would help establish the extent to which such measures have been carried out.

5.3 Roofs can be insulated, particularly inside pitched roofs or flat roofs where they are being re-covered. Where this has not already happened, it should be addressed. Care needs to be taken with the insulation of both pitched and flat roofs in historic buildings, and special attention needs to be given to potential condensation problems and the balance of heating and cooling loads. Although roof insulation design is not a straightforward matter, improvements can be achieved in most cases if good practice procedures are followed.



5.4 Lightweight roof insulation can improve thermal performance in the winter, but cause heat to be retained inside the building in the summer when cooling is required. The relationship between the thermal mass performance of the roof and its U value need to be considered (thermal mass is explained in 5.27 below). Soil-based green roofs, for example, can add thermal mass to the roof and help cool a building in the summer. Lighter, more reflective roof surfaces can also help to keep building cooler in summer.

5.5 The issue of cooling is dealt with below and, while heating is likely to remain the main source of energy use for both domestic and non-domestic properties for the foreseeable future, cooling requirements are likely to increase as the climate warms. In some types of building or areas within buildings, there are heat gains from large numbers of occupants, artificial lighting and equipment. In these instances, the use of mechanical cooling and ventilation is already a critical component of energy use.

5.6 Less attention will certainly have been given to insulating solid walls (or floors), because the hurdles are generally greater, although surveys will be necessary to confirm this. Floor insulation is effective where limited to a 1.5m perimeter strip around the building, with the remaining floor area uninsulated to make best use of the thermal mass properties of the bare ground.[3] However, for various reasons this type of specification is difficult to realise and, being internal, is disruptive of normal activities. Insulating the

1. House of Commons. 2008.
2. As evidenced by presentations by the Portman Estate, Grosvenor Estate and PDM Consultants at the Sustainable Westminster Symposium, April 10th 2008 – see Go Green, Project 12 (Westminster City Council c).
3. As advised by Brian Mark of Fulcrum Consulting.

pavement around the buildings has the same effect as perimeter floor insulation in reducing heat loss to the air.[4] Insulation of hot water pipes and cylinders can easily improve the efficiency of heating systems.

5.7 Where cavity walls exist (in relatively few instances in Soho), cavities can be insulated, where they have not already been treated. Solid masonry walls are best insulated externally, but this is not acceptable on Conservation Area grounds on the street facades of most buildings in the area. External insulation may be possible on walls facing onto internal courtyards and out-of-sight of the public but these are proportionately much smaller in extent than the street frontages.

5.8 If external insulation is not possible it may be possible to insulate external walls with an insulated dry lining to the inside face. However, this is more disruptive in terms of the works required, and it may also be problematic because internal features and details may need to be retained where listed buildings are concerned. There are also dangers of interstitial condensation arising if the works are not properly detailed and a vapour barrier incorporated at the appropriate location.

5.9 Weather-stripping and draught proofing of existing windows and doors is a cheap and effective way of reducing heat losses from buildings. However, from the conservation angle, historic buildings are more porous in their construction and need to 'breathe'. If the rate of ventilation is restricted too much, problems of condensation, mould and fungal growth may arise. Thus draught proofing of historic buildings may need to be combined with measures to maintain an appropriate level of internal ventilation.

5.10 Replacement double glazed windows can substantially reduce heat losses though existing window openings. There may be objections on conservation grounds in street facades of existing buildings, particularly those from the 18th and 19th century. Again, opportunities may exist on the facades fronting on to internal courtyards out of public view.



5.11 In the absence of double-glazing, it is possible to install secondary glazing (which may not be allowed in listed buildings or where the location of existing glazing close to the inside face of the wall, or the overall depth of existing wall reveals does not permit). This is not as effective in terms of reducing heat losses but can be particularly effective in reducing noise transmission from the street.

5.12 Many historic buildings have energy saving features that contribute to good thermal performance. Studies by the Energy Research and Development Administration in America, for example, show that the buildings with the poorest energy efficiency are those built between 1940 and 1975 rather than earlier buildings.[5]

5.13 Typically in historic buildings, the ratio of window to wall was kept to a minimum. However, this is not necessarily the case in Soho, given the generous window proportions of many Georgian and Victorian properties. Energy savings are achieved through the use of natural ventilation, in particular opening windows, but also in many cases the use of interior ventilation courts, rooftop ventilators, clerestories or skylights.

5.14 Heavy masonry walls used typically from the 18th century to the early part of the 20th century have the advantage of high thermal mass or inertia, which lengthens the time scale of heat transmission. Walls heated by the sun during the day release the heat absorbed over many hours. In winter, in residential properties, heat is released at night when outside temperatures are coolest. In the summer, in working premises, walls are coolest during the day when the building is in occupation, and warmest at night when it is empty. It is important to understand how existing buildings work in order to make the best use of inherent features and not inhibit those aspects that already work well.

**4.** ibid.
**5.** Smith, B. A.

### Ventilation and cooling

5.15 The intrinsic features of existing buildings, whether of historic value or not, can often be used or adapted to improve their thermal performance. While use of natural air movements to meet the requirements of ventilation and cooling in energy efficiency terms is clearly to be preferred, this is often not possible. As noted above, opening windows may not provide the level of ventilation required or the optimum solution in terms of energy efficiency, with the risk of heat loss through open windows in the winter.[6]

5.16 Typically, many of the older buildings in Soho have undergone substantial changes to their internal layouts, often reducing the possibility for cross-ventilation, or have been extended at the rear reducing the penetration of outside air to the spaces away from the outside walls.

5.17 Good environmental practice would suggest that modifications to the internal layout should be encouraged to facilitate natural cross ventilation as this would also provide cooling and reduce the need for air conditioning.[7] However, there may be good practical reasons why this is not always possible. Indeed many of the more modern, deep plan buildings in the Soho study area, shops and offices, theatres and restaurants have been designed and/or can only function on the basis of mechanically assisted ventilation and cooling. Also, in a dense 24/7 environment like Soho, noise is a major problem and any windows may need to remain closed to keep noise out or in.

5.18 Existing inefficient mechanical ventilation can be replaced with well-designed, and highly efficient systems making use of heat exchangers to minimise energy losses through heat recovery. Efficiency gains can almost always be achieved with new or replacement mechanical ventilation or air conditioning systems, with improved technologies continuously available. Ducting should be designed to minimise bends and junctions. Fans should be specified to meet the ventilation requirement that are often the critical element, and plant should be designed to operate efficiently over a range of thermal conditions, for example using variable speed controls.[8]



5.19 Air conditioning can account for over 30% of electricity use in an office over a year; 'the proportion of energy costs are even higher (as electricity is relatively expensive) along with greater capital and maintenance costs compared to an equivalent naturally ventilated building.'[9]

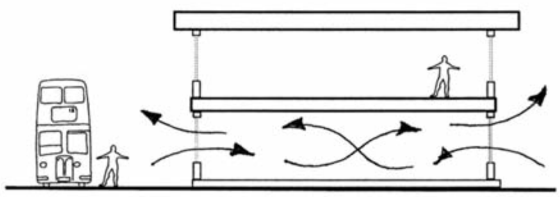
5.20 The greater attention being given to insulating buildings, along with more intensive use of buildings and equipment in them and higher comfort standards, is leading to an increase in the use of air conditioning. Higher temperatures due to global warming will intensify this trend with the Carbon Trust estimating that 40% of commercial floor space will be air conditioned by 2020, compared to just 10% in 1994.[10]

5.21 One of the problems of Soho is the noise and clutter arising from an increasing profusion of mechanical ventilation and air conditioning plant appearing on the outside of individual properties. Soho offers the potential of shared systems which, as well as improving the appearance of buildings, achieve efficiencies and economies of scale, although there are clearly major challenges in terms of property ownership, management and operation and, in the often cramped conditions.

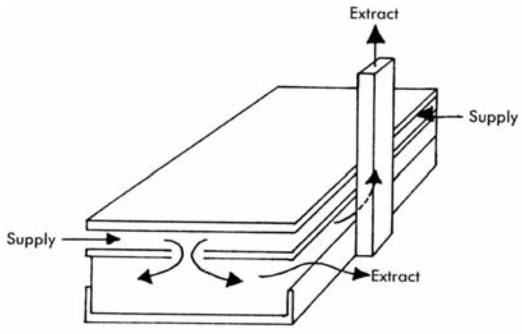
**6.** English Heritage, 2007
**7.** 'A rough guideline is that ventilation from one side is adequate up to 6 to 8m (and perhaps 10m) and cross ventilation is suitable for spaces 15-20m across.' Thomas, R, ed. 2003. p54.
**8.** Westminster City Council. 2003. p25.
**9.** ibid.
**10.** ibid.
**11.** Thomas, R. 2003. Op cit. p55.

5.22 Although there are many constraints, in major refurbishments it may be possible to make use of more sophisticated natural ventilation systems and mechanically assisted natural ventilation ('mixed-mode') approaches. The central areas of deep plan mid-rise buildings that are typical in Soho could make use of the stack effect (using rising hot air to exhaust stale air from the building).

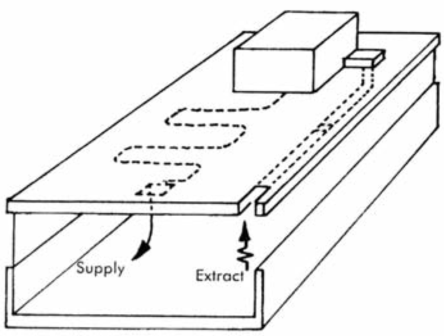
5.23 Randall Thomas, an environmental services engineer, illustrates a range of possible strategies using natural and naturally-assisted mechanical ventilation (see Figure 5.1).[11] Atria can be designed and internal courtyards adapted to make use of this approach or to combine mechanical supply with natural extract away from the noise facades of the street. The wind can be used at roof level to assist natural and mechanical ventilation. This type of strategy can even be used to employ naturally-assisted ventilation in a specialist building like a theatre (see Figure 5.2).



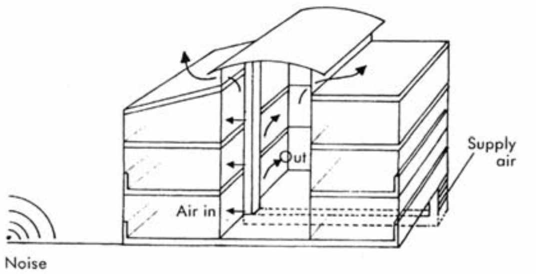
**Air in and out from perimeter**



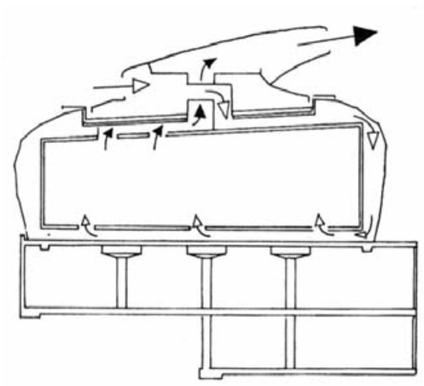

**High level supply: extract at mid level or high level, e.g.stacks**



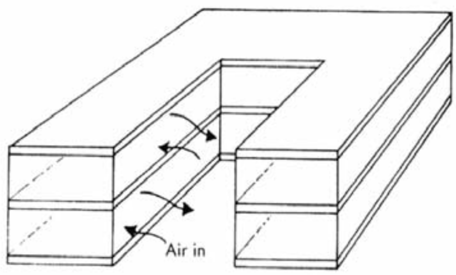

**Mechanical ventilation – supply air path incorporated in thermal mass deck**




**Ventilation from a protected area (possibly using stack effect)**



**Wind-assisted high level supply and extract**




**Ventilation via a quiet courtyard**

**Figure 5.1: Natural and mixed-mode ventilation strategies**

*(Source: Adapted from Randall Thomas/Max Fordham LLP in Thomas, R. 2003. p55)*

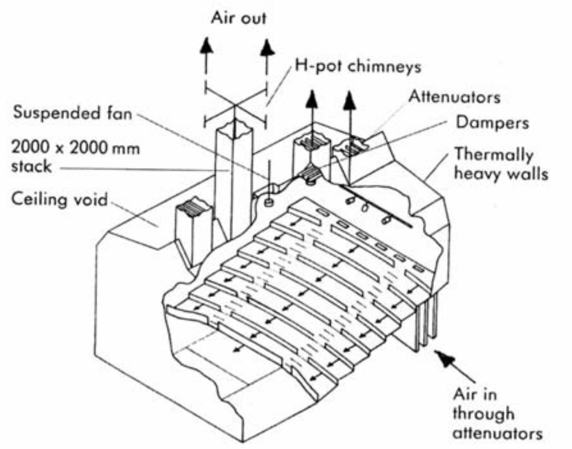



**Figure 5.2: Naturally-assisted ventilation of a small theatre**
*(Source: Adapted from Thomas, R. 2003. p54)*

*Nick Sweet, Barton Wilmore*

**Figure 5.3: Courtyard converted to atrium, 7 Soho Square**

5.25 The study area includes eight theatre buildings, seven along Shaftesbury Avenue and the London Palladium in Argyll Street. Places of assembly such as these and other smaller places of entertainment in Soho present a particular challenge because of the high ventilation requirements. Inventive approaches are necessary to retrofit sustainability in these particular, challenging cases.



### Natural lighting and solar gain

5.26 Windows are designed to provide natural light (and views), as well as ventilation, but also provide solar gain. This can be positively used (as in greenhouses) or cause problems of over-heating. South-facing windows offer the possibility of reducing heating loads through solar gain in the winter, although corresponding heat gain in the summer months can be problematic unless adequate shading and/or ventilation is available. Windows are better shaded on the outside with shutters, blinds, awnings or louvres, as internal blinds only work by reflection and most heat will have already passed through the window. Obviously there are constraints on the use of external shading devices in conservation areas.

5.27 The street grain in Soho is primarily north-south, limiting the extent of south facing facades and streets. Courtyards are frequently narrow with shading of one building by another. Apart from the few high-rise buildings, opportunities for making use of windows to improve building performance in terms of light and internal solar gain are limited. Where these opportunities do exist, existing solar gains should be retained and managed.

5.28 Thermal mass should be taken into account in affecting internal thermal conditions. In appropriate locations, it may be worth contemplating more sophisticated solutions such as ‘trombe’ walls where the heat gain from glazing is trapped in the mass of a backup solid wall during the day and released into the room at night when it is most needed. Again however, the opportunities to do this are limited.

5.29 Purpose-built office space is likely to have large areas of external glazing to maximise natural lighting to the interior. Apart from double-glazing, low emissivity (low-e) glass is effective in reducing solar gain in the summer and increasing the U value of windows. A low-e glass coating reflects or absorbs the heat energy in infra-red light. On the outside surface it reduces solar again, on the inside heat loss from inside the building. Although it is largely invisible, the coating can be seen from some angles and conservation requirements may prevent its use in some locations.[12]

5.30 Adequate natural lighting from windows for most purposes is limited to spaces about 5 or 6m deep. The potential conflicts between the need to provide natural light and the need to minimise wall openings and maximise thermal performance, in both heating and cooling have been noted. Beyond 5 or 6m, artificial lighting will be needed most of the time.

5.31 This constraint is difficult to overcome, although introducing (preferably north-facing) roof-lights on roof-level floors and atria to light the internal areas of deep plan buildings are possible solutions. According to the RICS Green Value publication, the Heschong Mahone Group (in California) 'found that adding sky-lighting to the average non-skylit retail store would be likely to improve its performance by 40%'.[13]

5.32 Tubular daylight or solar light ('sun') pipes transfer daylight from roof level to unlit internal spaces through 'light tubes' internally lined with reflective material. These systems are more flexible and easer to install where the roof surface is remote from the space to be lit (e.g. where there is an intervening roof space). They offer improved thermal insulation performance and are now commonly combined with artificial lighting (when natural light levels fall too low) and solar-powered mechanical extract systems. They are particularly useful for lighting and ventilating toilets, bathrooms and internal utility rooms on upper floors.

5.33 Where this is not possible, energy saving light fittings should be used often resulting in major savings in energy use and cost. Continuous improvements are being made in the energy efficiency of light fittings, including the introduction of new LED-based display lighting. Such fittings can cost more but the payback is significant, particularly given escalating energy costs.



5.34 According to Irish Energy in a study for the European Union, lighting in shops accounts for approximately 30-45% of total electricity used. 'Recent developments in lighting technology combined with planned lighting control strategies can result in very significant cost savings, typically in the range of a quarter to a third of the electricity traditionally used for lighting.[14]

**Figure 5.4: Tubular light pipe or solar light pipe**
*(Source: Solalighting Limited <www.solalighting.co.uk>)*

**12.** Westminster City Council. 2003. p25.
**13.** RICS. Reported as part of the California Energy Commission's Public Interest Energy Research (PIER) programme which also looked at physical comfort conditions in classrooms and how physical comfort conditions are related to office worker performance <http://www.h-m-g.com/projects/daylighting/projects-PIER.htm>.
**14.** Irish Energy Centre. 1995.

5.35 There can be additional savings in energy consumption where a retail store is air conditioned, as the new energy saving technologies produce less heat. In new installations, energy efficient lighting costs little more to provide than the older less efficient kinds. In retrofit situations, pay-back periods generally of between 1 and 5 years can be anticipated.[15]

5.36 Most of the buildings in the study area have deep plans and rely on artificial lighting for the majority of their floor-space. Often, this is unavoidable, for example, in shops and in many office locations. By the nature of the building form, the way it has developed over time, the uses to which buildings are put, and the building and health and safety regulations for ventilation, lighting and temperature, Soho is, in many instances, unavoidably heavily reliant on the use of electricity for ventilation, air conditioning and artificial lighting. However, rooflights, atria and other measures to make the best use of natural lighting and air flows could have a much stronger role.

5.37 The City of Westminster is experimenting with energy efficient street lighting in a pilot programme in Harrow Road. If this is successful, and where appropriate, it should certainly be rolled out as a retrofitting measure in Soho and other parts of the city.

**Boilers, appliances, equipment**

5.38 A major building refurbishment may take place every 20-30 years and a boiler has a typical median lifetime of 15-20 years. It is quite possible that boilers and other plant replacement cycles are out of sequence with other major building works cycles which, in any case, relate primarily to the outside of a building. Individual units within a single property may have boilers that were installed at different times and/or in different states of repair.



5.39 Modern boilers are considerably more energy efficient than previous generations. Therefore, replacement of boilers at the end of their effective life (or even before if they are particularly inefficient) should be regarded as a priority in terms of improving retrofitting sustainability to buildings. The seasonal efficiency[16] of a boiler varies significantly according to age and type. Typically, this is as follows:[17]

| | |
|---|---|
| Old boiler (heavy weight) | 55% |
| Old boiler (light weight) | 65% |
| New boiler (non-condensing) | 78% |
| New boiler (condensing) | 88% |

5.40 In residential properties the most efficient boiler can result in a reduction in annual fuel costs of up to 35% on the least efficient.[18] Top-rated gas-fuelled condensing boilers reach an efficiency rating of 91.5%. (Those fuelled with liquid petroleum gas, LPG, or oil are rated even higher, the highest oil-fuelled boilers reaching 97% efficiency).[19] Condensing boilers are 'A-rated' according to SEDBUK[20] ratings. Boilers for dwellings and small commercial premises range, and commercial boilers from 30kW upwards achieve comparably high A-rated efficiency levels.

**15.** ibid.
**16.** The weighted average of the efficiencies of a boiler at 30 and 100% of its output. Walker, R. 2007.
**17.** Defra a.
**18.** ibid.
**19.** ibid.
**20.** Seasonal Efficiency of Domestic Boilers in the UK: 'SEDBUK was developed under the Government's Energy Efficiency Best Practice Programme with the co-operation of boiler manufacturers, and provides a basis for fair comparison of the energy performance of different boilers.' Ibid.

5.41 Domestic appliances and office equipment can represent heavy use of electricity and the same logic should apply to their replacement – install new, more energy efficient replacements as soon as it is cost-effective to do so.

**Controls**

5.42 It is not only the type of boiler but the way that it is operated that is important and installing up-to-date controls can make a considerable difference. According to the Energy Saving Trust, this can save up to 17% of a domestic heating bill and, combined with a new condensing boiler, the savings rise to 40%.[21]

5.43 A domestic heating system should typically have a time programmer and room thermostat or a combined programmable room thermostat. It should also have a cylinder thermostat where a condensing boiler is used with a hot water cylinder and thermostatic radiator valves (TRV) – except where there is a room thermostat.[22]

5.44 In commercial properties, it is important to consider activity zones and incorporate localised control and zoning of services.[23] The aim should be to concentrate all the activities that require high levels of servicing (e.g. computer equipment) together so that they can be serviced accordingly (e.g. through mechanical ventilation with heat recovery and/or air conditioning). These should be separated off from the areas that can be managed with natural ventilation and lower levels of servicing (and with likely higher heating requirements).[24]

5.45 An integrated approach is needed to planning activities that have different heating, lighting, ventilation and cooling requirements, so that a building can operate efficiently in environmental as well as functional terms.



5.46 It is obviously important that occupants and building managers know how to use the controls properly and energy is not wasted in heating, cooling or ventilation when it is not needed. Controls need to be user-friendly and occupants need to be provided with appropriate information packs. There has to be an effective balance between automated controls and user control in both the living and working context. This is particularly the case where buildings are zoned to make use of natural ventilation in some areas so that reliance on mechanical systems can be reduced on an ad hoc basis.

5.47 Where people are not able to control their own working environment to meet specific circumstances and individual preferences, they may end up either becoming less efficient or taking additional measures to control their environments (e.g. installing desk fans in over-heated or under-ventilated offices) that undermine overall energy efficiency.

5.48 Effective monitoring and information about energy use is critical if users are to make the most efficient use of the environmental services and systems of a building. This can be facilitated though 'smart meters' which are the new generation of electricity and gas meters. They use 'two-way communication systems that display accurate real-time information on energy use in the home to the consumer and back to the energy supplier.'[25]

**21.** Energy Saving Trust b.
**22.** ibid.
**23.** Westminster City Council. 2003. p25.
**24.** ibid.
**25.** Energy Retail Association.

5.49 Smart meters enable better use of flexible tariffs and automatic, actual meter readings, rather than estimates. They will also facilitate the selling of electricity produced by micro-generation and feed-back into the grid and will also be able to display information remotely and more conveniently through TVs or mobile phones.[26]

5.50 Controls in larger and multi-occupancy buildings should allow sub-metering of individual tenants or departments to facilitate more accurate billing of, and monitoring and control by particular users.[27] The metering of heating and hot water can be combined with other forms of utility metering with which we are more familiar in this country, and remote reading is starting to become more readily available.

5.51 Similar management principles apply to the use of other building services such as lighting, or even sanitary fittings. Light sensors can be used to control artificial lighting according to ambient lighting levels and the levels required according to activity. Movement sensors can be used to turn lighting on and off according to whether occupants are there or not. This can overcome the problem of occupants neglecting to switch off lights when they leave a room. However, automatic systems can lead to irritating anomalies in use and thought has to be given to manual over-rides and combinations of automatic and manual controls.

**Box 5.1: Smart-metering in Helsinki and the Hague**

Since 2005, Helsinki Energy, using a single system solution from the Danish company, Kamstrup, have been reading electricity and district heating automatically and remotely, using a radio-based solution, in 8,500 households in two suburban districts served by their district heating service. Helsinki Energy expects to introduce remote reading on their service throughout the city within 10 years.

In another project in the Netherlands, Kamstrup products are being used for metering heat and electricity connected to the building management system. A student housing association, DUWO, is building 100 flats in a low, four story building and a tower with 209 flats. As student flats show a high turnover, billing of energy consumption has to be done frequently and it is not economically feasible to read the energy meters manually.

*(Source: Remote reading - a reality in Helsinki<http://www.kamstrup.com/2517/Case%20Helsinki>; AMR in high rise flats<http://www.kamstrup.com/2516/Case%20Den%20Haag>)*



**Alternative energy sources: CHP, district and community heating**

5.52 Retrofitting offers the opportunity of installing alternative sources of energy. Cogeneration, or Combined Heat and Power (CHP) as it is better known in the UK, is particularly important for this study, as it can be installed across a range of scales, from city or district-wide down, potentially, to single dwelling units (or small office or retail units).

5.53 However, it is currently best employed at a larger scale, for example in larger commercial units or developments, or on housing estates (housing associations are among the market leaders) in hospitals, schools and other institutional buildings, leisure centres, swimming pools, large offices or hotels.

**26.** ibid.
**27.** Westminster City Council. 2003. p25.

5.54 In commercial properties, particularly of the kind found in the Soho Study Area with deep floor plates, there is a high summertime demand for cooling and year round daytime electricity for artificial lighting and equipment in large retail and office premises. Heating output can be used for cooling through use of an absorption chiller. Where cooling is a component, the plant is referred to as Combined Cooling, Heat, and Power (CCHP or 'tri-generation').

5.55 Mixed-use development provides the most balanced demand for CHP and CCHP schemes and, in this respect Soho is well-placed to make advances in these techniques in the future. However, given the strong heat island effect in the area, it is far from ideal to be firing boilers and pumping heat into the air in the heat of summers to cool buildings in Soho.

5.56 District or community-level heating systems can employ any heating source and result in efficiency savings over more local and individually heating solutions. Carbon emission reductions can also be achieved through the use of alternative fuels such as biomass, although it should be noted that there is evidence that biomass emits substantially higher levels of particulates (PM10) and mono-nitrogen oxides than equivalent gas-fired plant.[28] Westminster City Council is developing policies to ensure that biomass does not exacerbate local air pollution.

5.57 They are equally well-suited to the application of dual-energy solutions like CHP and waste-to-energy incineration. EnviroEnergy in Nottingham, for example, is one of the UK's largest district heating systems, drawing its energy from a waste-to-energy incinerator. Initially built by Boots, it now heats 4,600 homes, and a wide variety of business premises, a concert hall, arena, baths and a shopping centre.[29]



5.58 The Energy Saving Trust has produced a guide to community heating which sets out the potential for energy savings and reduction in carbon emissions that CHP offers.[30] In residential areas it is most applicable in dense housing (high rise or medium-rise) and where an existing heat network can be retained and refurbished (or where electric heating can be replaced). It is suitable for individual tower blocks or large blocks of flats, as well as housing estates of various kinds.

5.59 The City of Westminster's Pimlico District Heating Undertaking (PDHU), is an example of good practice in this respect (see Box 5.2). The PDHU is of historical as well as current interest, being the first major CHP system in the UK. It was originally built as a community system for the Churchill Gardens Estate relying on waste heat from the now-defunct Battersea Power Station through a pipeline under the river. A 2500 $m^3$ heat storage accumulator 'enabled electricity to be generated independently of heat demand by storing excess heat in periods of low demand, which would be used when heat demand exceeded that being generated at the power station.'[31]

5.60 The Energy Saving Trust has identified central, high-density areas in major cities in the UK as having the strongest potential for the use of CHP, including London's West End (see Figure 5.6). The London Energy Partnership's London Carbon Scenarios to 2026 selects a scenario based on the large-scale take-up of CHP as the most cost effective in reducing carbon-emissions and the only one that would pay for itself. Large scale capital investment is implied, although this could be undertaken on a commercial basis.

**28.** AEA Energy & Environment. 2008.
**29.** Nottingham Green Energy.
**30.** Energy Saving Trust. 2004.
**31.** CityWest Homes.

5.61 Soho lacks a large, consolidated housing estate or large scale public buildings around which a community-based heating scheme could be built. The nearest large-scale public cogeneration scheme is the Government's Whitehall district Heating Scheme. This can provide 34GWh heat energy per year (enough for 3,000 homes) and has surplus capacity. The 24km of underground heat mains reached its full current extent in 1966.

5.62 Another constraint is the lack of space to construct a single central plant in Soho and the visual impact in a conservation area of the chimney that such a plant is likely to require. Heat energy could be fed through a mains supply from remote plant located outside of Soho, or even outside of Westminster. The capital costs for installing the insulated supply mains pipe from a remote location would be high and the political decision-making would have to be undertaken on a cross-borough scale. However, this would solve the excess heat problems associated with the use of boilers and absorption chillers located within the area in the summer.

**Community Cogeneration for Soho**

5.63 An alternative might be, over time, to gradually build a network of local cogeneration schemes linking together installations by individual commercial or public property owners. There are opportunities for installing the latest CHP technology in larger commercial properties, and The Crown Estate is making use of these in the energy centre of its proposed Quadrant Development (see Box 5.4)

5.64 There is potential for incorporating a CHP facility in the regeneration of properties in the Berwick Street Opportunity Area. The central street block offers a good mix of uses, including Westminster College, the large residential blocks of Kemp House and Ingestre Court (CityWest) and the former police hostel, Trenchard House. Trenchard House is proposed for redevelopment as a mixed-use, mixed-tenure development, including key worker and supported housing, private housing, retail and educational space. This is an excellent opportunity for a co-operative approach to retrofitting sustainable measures, although we have not had the scope, within the study, to establish what the status of current plans are.



5.65 Other opportunity areas have been identified by Westminster's planners, including a cluster of retail/mixed use sites in east Oxford Street and adjacent to Tottenham Court Road Station, in the north west of Soho, Marshall Street Baths, which already has developed proposals, and the Ham Yard/Great Windmill Street area in the south west tip. These and other opportunities, including the upgrading of existing heating systems in large retail and office buildings could provide a series of nodes for a future, district-wide, CHP network.

5.66 The larger the network, the greater the synergies and savings that can be achieved, and the more efficient the CHP scheme can become. This is particularly so where there is a wide range of different types of building use, and the majority of street blocks in Soho are mixed use.

5.67 Figure 5.7 shows how a distribution network of approximately 6.5 km could link together potential (and, in the case of the Quadrant, actual) CHP sites together to serve around half of the study area. A later phase could extend the network to serve the whole area and the scheme could have the added benefit of serving all properties fronting to the related sections of Oxford Street, Regent Street and Charing Cross Road.

5.68 Given the high energy use associated with cooling in Soho in the summer, ideally such a scheme could be extended to include cooling, in a Combined Cooling Heat and Power system, for example through the use of absorption chillers employing waste heat from the boiler plant. We have already noted that there are problems associated with this because if the heat island effect. An alternative

**Box 5.2: Pimlico District Heating Undertaking, CityWest Homes**

The Pimlico District Heating Undertaking (PDHU), run by CityWest Homes, aims to reduce carbon emissions and reducing fuel poverty through refurbishment and expansion of one of the UK's oldest community heating schemes, established in 1950.

With recent use of a £1.2 million grant from the Community Energy programme, it has been extended to include 3016 residential properties and 46 commercial properties in the area, as well as a school, home for the elderly and community halls. It also offers the opportunity for other property owners to join the scheme.

Existing boilers (originally coal-fired then converted to gas in 1989) have been replaced with three high efficiency gas boilers with a maximum capacity of 10MW. Heat is fed to 3.1 MWe/4.0 MWTh of CHP engines in a new Energy Centre. A computerised control station at the Energy Centre monitors and controls temperature throughout the network delivering the optimum amount of energy The project will save 1,900 tonnes of carbon per year, reduce bills in the area by £104,000 per year and reduce risk of fuel poverty for 1,000 households on housing benefit.

CityWest Homes, the housing management organisation of Westminster City Council, manages 22,000 tenanted and leasehold housing units - mainly flats and maisonettes. A stock survey in 2002, highlighted 9,500 out of 14,000 tenanted dwellings as being below the Government's Decent Homes standard. This led to a £12 million investment to improve the stock and has achieved a mean SAP rating of 60. CityWest Homes has set a target of improving energy efficiency by 30 per cent in the next 15 years.

*(Source: CityWest homes)*

**Figure 5.5: Accumulator of the Pimlico District Heating Undertaking (PDHU) in Churchill Gardens and map of properties now serviced by the PDHU**
*(Source: <http://www.flickr.com/photos/pixelhut/2381309076>; <http://www.cwh.org.uk/main.asp?page=495>)*

would be to make of use of Aquifer Thermal Energy Storage (ATES), whereby excess heat is pumped into aquifers in the summer months and extracted for heating in the winter. This would help overcome the heat island issue and achieves a higher seasonal efficiency than an absorption chiller-based system.

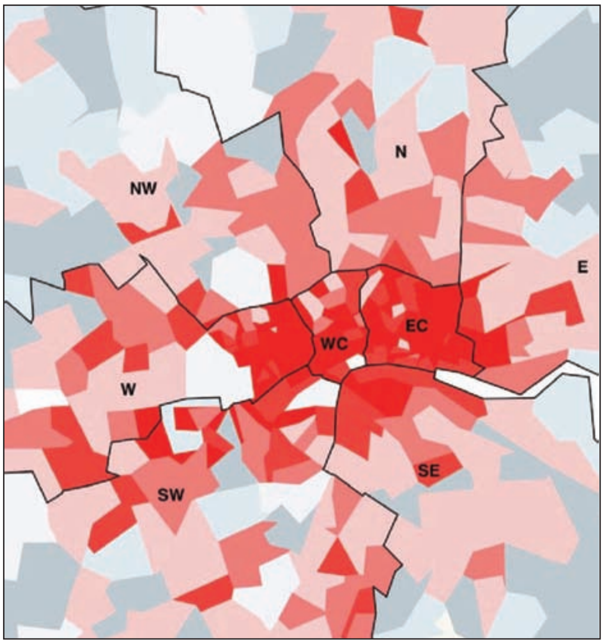



**Figure 5.6: Potential for CHP in Central London (dark red areas have highest heat demand)**
*(Source: Energy Saving Trust. 2004. p10)*

5.69 This approach is employed as part of a thermal master planning approach in the Netherlands and has been pioneered by Iftechnology and Fulcrum Associates in the Westway Beacon social housing scheme in West London.[32] It was also considered for use in Fulcrum Consulting's proposals for the Marshall Street Regeneration scheme in Soho.[33]



5.70 The system balances winter heat demands with summer cooling loads using ground water in deep aquifers with a minimum of two borehole wells, one for heating and one for cooling. Depending on local geology, to be effective these have to be at least 40m apart. This is why the approach was rejected by Fulcrum for Marshall Street. However, it is also possible to incorporate the boreholes in below manholes in the street pavement. If there was Council Agreement, this technology could be employed in Soho, independently or as part of a community-wide scheme in Soho.

5.71 This is purely an indicative proposal and we have not explored the technical feasibility of such a scheme (including the scale of the plant required) or how it relates to ongoing developments. Carbon Descent confirms that in principle it is workable and have developed software that could be used to model its flexibility. Further technical studies would be required with environmental engineers.

5.72 What is interesting about this proposal is that it would be carried out as a series of local area networks and interventions linked to the development over time of particular opportunity sites. Street disruption is localised accordingly. These are then tied together to form a district network.

5.73 Co-operative management would also be a challenge although increasingly sophisticated computerised building management services control and the smart metering solutions already commented on could help overcome this. A framework for partnership and co-operation between the key stakeholders would be required. Setting up a network of linked Combined Heat and Power or Combined Cooling Heat and Power (C/CHP) facilities could form the basis of a community-wide service but it would require buy-in from property owners, potential suppliers and potential consumers. All would need to be convinced it was in their financial interest to participate in such a scheme.

**32.** Clark, P. 2007.
**33.** Fulcrum Consulting, March 2007. Marshall Street Regeneration: Energy and Sustainable Options (Water) Appraisal. The ATES approach should be distinguished from the use of aquifers for cooling in the London City Hall building. Here the underground water is used to flush toilets and discharged. Arup UK. London City Hall (GLA building) Mechanical Services Design <http://www.arup.com/unitedkingdom/feature.cfm?pageid=310>

5.74 Jonathan Lane of Shaftesbury PLC has raised a concern that installing C/CHP schemes might inhibit the flexibility of property companies to deal in their assets by disposals of properties which were beneficiaries of energy from the scheme. His argument was that an individual property using power from such a scheme might be more difficult to dispose of or separate out from other properties surrounding it because of its shared use of the facility.[34]

5.75 This discussion was pursued with Ian Ramsey in the Glasgow office of Drivers Jonas. In Scotland, in multi tenanted buildings and tenements, each owner has their own freehold and shares common services. Ramsey did not foresee big problems with acquisition and disposal for properties participating in such a scheme. The more significant issues for owners and occupiers would be what would happen in the case of a failure or breakdown of the system, what would happen to the division of overall costs to other occupiers when individual properties were void and, finally, the competitiveness of the costs as against the open market for energy.

5.76 It was also suggested that a C/CHP scheme if properly structured could represent a commercial opportunity for landlords. An example is the case of a Glasgow industrial estate where the landlord had chosen to generate energy and supply it to the tenants on the estate at a cost less than the open market but more than his own generating costs leaving him with a surplus income stream. A suitably experienced property lawyer might be able to advise more on the risks and exposures of the various parties in such a scheme.

5.77 Commitment would need to be made before significant levels of investment in the street mains infrastructure could be allocated. Public funding could be possibly be employed as part of a public-private partnership. Alternatively, such a scheme could be managed as a partnership between the major property owners (those hosting the CHP plant) and a utility company such as a gas supplier.



5.78 The Energy Saving Trust promotes energy services schemes (‘Company energy services packages’) which are ‘either partnerships between housing associations, local authorities and energy suppliers (Energy Services Companies – ‘Escos’) or stand alone projects established by interested organisations.[35] They consist of a package of supply and efficiency measures, including advice and access to funding such as grants or interest-free loans.’

5.79 Although primarily targeted a housing associations, some of the same principles could be adapted to a group of private property owners and registered social landlords in partnership with the local authority. An existing Esco could take on managing and rolling out the scheme. The London Esco, a partnership of the London Climate Change Partnership with the energy company, EDF, has been set up to promote this kind of scheme.

5.80 A CHP ‘typically achieves a 35% reduction in primary energy usage compared to a power station and heat-only solution.’[36] Some manufacturers claim their plant can reduce energy bills by 40-60% with a 100% increase in efficiency.[37] Cogeneration plant is highly energy efficient compared to normal electricity generation where the efficiency is around only 30-40%. CHP and CCHP cut out the large losses in transmission.

**34.** Matthew Bennett, note of meeting between Jonathan Lane and Matthew Bennett, 11 September 2008.
**35.** Energy Saving Trust a.
**36.** Energy Saving Trust a. p27.
**37.** EC Power.

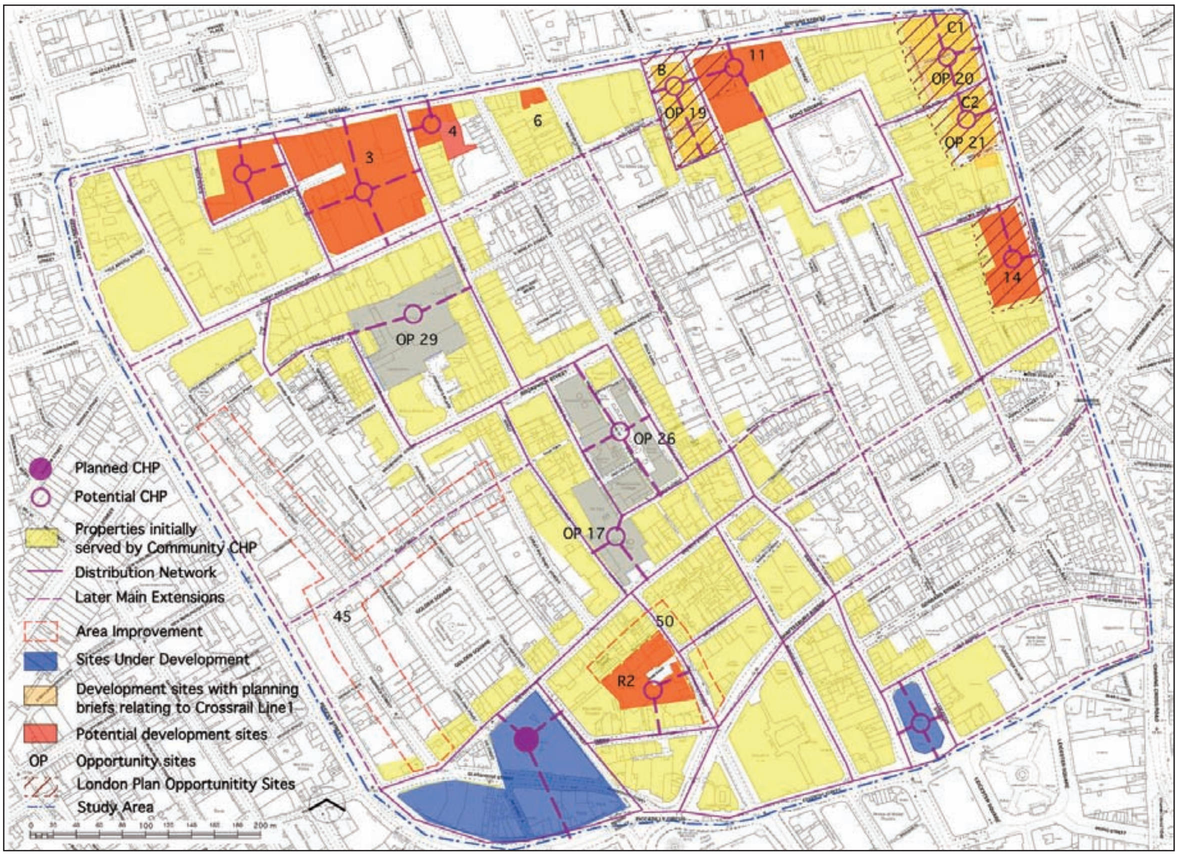





**Figure 5.7: Indicative proposal for a community heating network in Soho served by multiple CHP sites**

*((Source: Ordnance Survey, Max Lock Centre)*

5.81 The basic principle is that a gas (or oil) fuelled engine produces electricity and heat that is normally wasted, which is captured by a high efficiency heat exchanger. This energy, stored as hot water, is used for central heating, hot water, or indirectly for cooling/air conditioning. In general, the production of 1 kilowatt of power creates 2 kilowatts of usable heat energy.'[38]

5.82 Such systems normally have computerised controls and are open to the addition of boilers and heat pumps, depending on their size and degree of sophistication. There is a further potential for the use of alternative fuels besides natural gas. Possible fuel sources include biomass, biogas (from anaerobic digestion of organic waste) and methane gas from landfill sites.

5.83 Biomass fuel is bulky and its delivery on a large scale in central London would not be a welcome development. The problem with increased air pollution from biomass combustion has been previously noted and it would not be appropriate in a Statutory Air Quality Management Area. It would be better suited as a fuel to large CHP units located on the river, where deliveries could be made by barge (a reclaimed Battersea Power Station, perhaps). However, the existing gas mains might be used to deliver alternatives to natural gas (depending on the energy density of the fuel).

5.84 Helsinki Energy pumps heat from the sea as a source of pre-heating and started using heat energy from purified sewage in 2006. It supplies district heating to 12,000 premises, most of which are residential buildings, as well as supplying district cooling.[39] Its production plant is the largest of its kind in the world with a capacity of 90 MW of district heat and 60 MW of district cooling.

**38.** ibid.
**39.** Helsinki Energy.

**Box 5.3 Using a station to heat a building**

The Jernhusen company, owner of Stockholm's central station, plans to use passenger warmth to heat a 13-storey office block being built next to the station. Heat exchangers in the station's ventilation system will convert the heat into hot water pumped into the heating system of the building. It is hoped to meet 15% of the heating needs of the building, which will provide about 40,000 square metres of space for office, hotels, restaurant and retail space.[40]

5.85 Where water is trapped in an aquifer, it can be used, for example, for cooling through a heat exchanger, and returning it to the aquifer at a higher temperature. London's water level was rising as less water was being extracted from its Chalk Basin aquifers. It has been suggested that, through drilling new boreholes and activating existing ones, some of this water could be used to cool the Underground.[41] As has been previously suggested, water or ground source heat pumps could feed into a community CCHP for Soho or simply to new developments along Oxford Street.

5.86 Transport for London, using a system designed by engineers at South Bank University, has installed a cooling system in the Underground station at Victoria, with water from an underground river source feeding the air chiller. TfL are proposing to install a similar system at Oxford Circus. This suggests that a similar approach could be taken as with drilling into the aquifers.

5.87 It is proposed to employ air cooling shafts at the new Crossrail station at Tottenham Court Road[42] but the heat being generated by people and trains underground could be employed as a community resource for Soho rather than simply as waste heat to an already overheated area of London. Adapting an old technology, engineers in Sweden are using waste heat from Stockholm Central Station to help heat an office block (see Box 5.3). At a recent talk at the Building Centre, the Director of TfL's Cooling The Tube programme, Kevin Payne, said that he is very open to this idea, but nobody has yet asked him if they could have some of London Undergrounds spare heat. A Soho Community CCHP could be the first.[43]



5.88 According to LECI, CHP is now the only significant potential local source of power left in London but only accounts for around 8% of its electricity requirements.[44] Westminster has around 0.5% of the CHP heat and power output of London as a whole, and this meets less than 1% of its electricity needs.[45]

5.89 According to Defra, 'the Government is committed to increasing the UK's CHP capacity because of the considerable environmental, economic and social benefits it can bring together with its contribution to security of supply.'[46] By the end of 2005 there were 1,534 assured quality CHP Schemes in the UK with a capacity of 5,792 MWe (megawatt electrical), producing 7.5% of the UK's electricity requirements and saving an estimated 4.9 MtC (million tonnes of carbon) annually.[47] Defra has set a target of at least 10,000 MWe assured quality CHP Capacity for 2010. However, the UK still lags far behind some of its European neighbours (see Table 5.1).

**40.** Chazan, D. 2008.
**41.** Thomas, R. 2003. Op cit.
**42.** Crossrail. Crossrail Stations <http://www.crossrail.co.uk/pages/crossrailstations.html>
**43.** Pugh. Kake L.
**44.** Greater London Authority. 2006a.
**45.** ibid.
**46.** Defra c.
**47.** ibid. See Digest of United Kingdom Energy Statistics, Chapter 6.

| Country | Proportion |
|---|---|
| Denmark | 54% |
| Finland | 50% |
| Germany | 12% |
| Netherlands | 3% |
| UK | 1% |

**Table 5.1 Community heating as a proportion of the domestic heating market**
*(Source: Energy Saving Trust. 2004. Taken from Euroheat and Power. 2004)*

5.90 For C/CHP to be effective in terms of costs and fuel use, it needs to be running at a high rate of efficiency that is to be in use for a good proportion of the year. In general, an operating load of 4,000 hours per annum or just under 50% of continuous use is required for C/CHP to be feasible.[48] Heating loads are restricted to the winter months. Unless they are continuous over a 24 hours period – e.g. in hospitals – it may be cheaper to use electricity from the grid to meet summertime requirements. If plant is in use for only half the time, this doubles the payback period and it becomes uneconomic.

**Micro CHP**

5.91 CHP and CCHP works better at the larger scale and in mixed-use situations, where efficiency problems of over capacity or under-utilised capacity at different periods of the year are less likely to arise. However, 'Micro CHP' is also increasingly being employed. This refers to small-scale installations, producing up to 20kW of electricity and up to 40kW of heat.[49] A tighter definition of 10kWe is also used for appliances that can be used in single-family homes, small hotels, shops or offices, and small multi-family apartment blocks.



5.92 Domestic micro CHP units are undergoing commercial development and, according to manufacturers, 'have the potential to offer a 28% reduction in energy savings over an average new boiler, and a 12% reduction over an efficient condensing boiler by utilising electricity generated within the home and potentially selling it into the supply grid.' [50] Within the EU there were 8,000 internal combustion engine CHP installations in 2003 (mainly in Germany) and no doubt more now. Other technologies consist of, external combustion engines (Stirling engines, which are quieter) and fuel cells, which are at the development and demonstration stage.[51]

5.93 Micro CHP plant is quite economical in space terms and a small unit occupying 2 $m^2$ can produce 17kW of electricity and 24 kW of heat.[52] A typical Micro CHP unit of 13kWe can produce enough energy to service 30 flats, a small leisure centre or sheltered housing scheme.[53]

5.94 A preliminary assessment of micro and small cogeneration units by the Carbon Trust in 2006 suggested that manufacturer's claims on savings are exaggerated and some of the units tested only averaged only 18% reduction and sometimes much less.[54] The overall annual energy efficiency is lower than expected as not much heat is needed is summer, and not much electricity is generated then. Also, 'if switched on and off regularly to meet varying domestic heat requirements, this warm up time/heat loss can be significant'.

**48.** Westminster City Council. 2003. p27
**49.** Cogen Europe.
**50.** op cit.
**51.** Cogen. Op cit.
**52.** ibid.
**53.** EC Power. 2007.

5.95 The Carbon Trust's later interim report on field trials suggested that Micro-CHP systems can provide carbon savings of 15% to 20% in small commercial buildings, when installed as the lead boiler, and that long and constant heating periods provide the basis for clear savings.[55]

5.96 In smaller commercial premises in Soho, the lack of balance in the heating demand could be overcome if heat output were used for cooling in the summer, although it appears that the absorption chillers currently on the market are rather too large to be used in this context.[56]

5.97 Some manufacturers include heat storage in their CHP packages to help even out imbalances. Where there is a premium on space, as in Soho, larger space demands for plant could be a hindrance to take up.

5.98 In a 2006 report for the DTI covering micro wind, PV, micro-biomass and heat pumps as well as micro-CHP, the Energy Saving Trust is optimistic about the potential of micro-power in general. It suggests that by 2050 these technologies could provide 30-40% of UK electricity, reducing emissions by 15%. However, Micro-CHP Stirling engine systems are seen as contributing around only a 1.9% reduction compared to other alternative energy sources.[57]

5.99 Stand alone micro CHP could, therefore, be seen as a potential way of reducing carbon emissions in Soho, particularly in smaller commercial premises and larger residential blocks, although the jury is still out on its beneficial application to individual residential units. The main advantage over larger-scale cogeneration (or trigeneration) district or community heating and cooling schemes, is that they could make use of the existing gas mains and don't require digging up the streets to lay a new heating mains.

5.100 LECI recorded the use of CHP elsewhere in Westminster in hotels, leisure centres and large offices but no CHP capacity in the Soho study area in 2003 where there is immediate potential among the larger business units.[58] The Crown Estate are using CCHP and other energy and water savings measures in their ongoing Quadrant development (see Box 5.4).



**Box 5.4: CHP in the Crown Estate's Quadrant Development**

The Quadrant, being developed by The Crown Estate, is currently the biggest sustainable regeneration development in London's West End. A central energy centre at 185-191 Regent Street features the first tri-generation plant of its kind in central London, utilising hydrogen fuel cell technology. It will service the rejuvenated Regent Palace Hotel and Café Royal blocks.

Heating is provided by a combination of gas-fired boilers, conventional CHP and fuel cell CHP plants. Cooling is provided by a combination of chillers with air-cooled condensers and absorption chillers using waste heat from the CHP plants. Electricity is supplied from the grid, CHP plant and roof mounted PV panels. Rainwater harvesting, provides 150,000 litres water annually to reduce water use and assist in flood management.

The development over three blocks includes a hotel of 22,432m$^2$ (161 beds), 10,578m$^2$ of retail, 1,676m$^2$ of residential, 6,804m$^2$ restaurant and 37,852m$^2$ of offices

*(Source: The Crown Estate. The Quadrant <www.thecrownestate.co.uk>; Faber Maunsell/Aecom. Unpublished. Crown Estate Development – Central Energy Centre)*

**54.** *Renew. 2006.*
**55.** Carbon Limited.
**56.** Chamra, L.M. 2007.
**57.** *Renew, Op cit.*
**58.** ibid.

### Heat pumps

5.101 Ground or air source heat pumps can be employed for heating and cooling though their use in Soho is constrained by the lack of private external space (and access for drilling rigs) or, in the case of air pumps, plant noise issues.

5.102 A heat pump is an electrical device that extracts heat from one place and transfers it to another. It has been in use for decades, with refrigerators and air conditioners both making use of this technology. Heat pumps supply heat or cooling energy with low energy inputs, thus reducing carbon emissions.[59]

5.103 Normally the ground is used as a source because its temperature remains more stable than the air, acting as a heat source in the winter and cooling source in the summer. Heat pumps along with air conditioning plant most commonly use a refrigerant called R-22 or Freon, which is a hydrochlorofluorocarbon (HCFC). Although gradually being phased out, leaks of R22 from existing systems can contribute to ozone depletion.[60]

5.104 We are aware that heat pumps have been used elsewhere in the West End (e.g. for heating and cooling a restaurant in Mount Street, Mayfair).[61] Given the cooling demands in Soho, there would certainly be opportunities to look at possibilities for installing this technology where redevelopments of major rehabilitation are taking place. A ground source heat pump has the added value of being hidden, which is a definite benefit in a historic area (see Box 5.5). However, outside space is required to set up a drilling rig, which limits its application for retrofitting sustainability in most of Soho except when piling works are being undertaken.



**Box 5.5 New energy for old Edinburgh**

The Caltongate redevelopment Edinburgh's historic old town includes one of the UK's largest ground source heat pumps. The redevelopment will include 200 new homes, a five-star hotel and conference centre, office blocks, cafés, restaurants, bars, and a public square.

The Government allocated a grant of £789,000 towards a £3 million state of the art green heating and cooling system for the £300 million scheme.

The ground source heating system will reduce carbon emissions by up to 30% exploiting the difference between ambient temperature of the air and the warmer subsoil in winter. The reverse process provides cooling in the summer. A network of 90 pipelines at around 200m beneath the surface provides enough heat to keep the building temperatures at 18-21°C.

*(Green Futures. New energy for old Edinburgh <http://www.forumforthefuture.org.uk/greenfutures/articles/newenergyoldedinburgh>)*

5.105 The air can also be used as a source of heat or cooling energy. Ground source heat pumps have a relatively constant coefficient of performance while that of air source heat pumps declines with air temperature. Ground source heat pumps are more efficient at cooling than air-source (since the ground is cold) are quieter and have a longer life than air source pumps since they are not outside and exposed to the elements.[62]

**59.** Natural Resources Canada's Office of Energy Efficiency. 2004.
**60.** Thomas, R. 2003. p71.
**61.** Meeting with Nigel Hughes, Grosvenor Estate 23rd May 2007
**62.** Green Shop.

5.106 Air source heat pumps may be more appropriate to Soho where large areas of flat roof are available to install coils and other related plant. However, any additional relatively noisy equipment is likely to be unwelcome and conflicts with the City Council's commitment to reduce noise pollution.

**Renewable energy sources: solar and wind**

5.107 The installation of on-site, small-scale local electricity generation is normally referred to as micro-generation. Typically this includes wind power, active solar heating and photo-voltaics as favoured sources of renewable, low carbon emission energy (carbon being emitted in their production and installation, if not in their production of energy).

5.108 Small-scale wind turbines can be largely ruled out in Soho as wind conditions are generally too poor. The relatively high and constant wind speeds required to make wind generators efficient would not be available except perhaps on the tallest buildings, where great care would need to be taken to make them visually acceptable.

5.109 Both active solar heating (solar thermal) and photo-voltaics, however, potentially have widespread application in Soho. Very visible south, southeast or southwest facing roof slopes fronting on to the streets can probably be ruled out for conservation reasons. In reality, however, many of such sloping roof surfaces are hidden from view, fronting on to internal courtyards. Moreover, our preliminary visual survey indicates that the extent of flat roof surfaces in the study areas is far larger than we anticipated. Hidden flat and sloping roofs probably account for well over 50% of the total roof surface in the study area.



5.110 Where there is no shading from adjacent buildings, there are clear opportunities for using solar energy, with tilted panels orientated to get the optimum results. High level, vertical wall surfaces can also be used, depending on orientation and location.

5.111 Active solar heating is currently the most cost effective method of using solar energy in buildings in the UK. It is primarily used for water heating, particularly in dwellings (around 3-4$m^2$ of solar collector is typically required).[63] A house in London was shown to meet 47% of its annual hot water demand, although obviously there is a greater reliance on the main heating system in the winter.[64] However, it can equally be used in non-domestic premises and to preheat boilers as well and provide hot water.

5.112 Shaftesbury's Longmartin regeneration scheme in nearby Covent Garden makes use of both photovoltaic cells and solar water heating panels at roof level and on exposed wall surfaces (see Box 5.8). Soho Housing Association are installing solar panels in dwellings they are building over Marshall Street Baths.[65]

5.113 Interestingly, the interview with Chris Best of the Soho Housing Association highlights the kind of attitudes, and confusion, on the part of landlords that conservation restrictions on retrofitting engender. On the one hand she says 'we can't do solar panels in the conservation areas' but, on the other, solar panels are actually being provided in the Marshall Street development.

5.114 Active solar heating systems usually work by heating a fluid that goes to a heat exchanger to heat the water indirectly. Photovoltaic (PV) cells convert solar radiation directly into electricity. South-facing panels tilted 30$^{\circ}$ maximise year-round electricity production but panels orientated 30$^{\circ}$ east or west of

**63.** Energy Saving Trust c.
**64.** ibid. p66.
**65.** Appendix 3. Interview with Chris Best, Soho Housing Association.

south with a tilt of 15º to 45º will give a performance within 95% of the optimum.[66] Grid-connected PV systems are more cost effective because they supply excess energy to the electricity grid rather than store it in batteries.[67]

5.115 Retrofitting solar thermal panels to a typical residential property can cost £3-5,000.[68] There are various types of PV system but a high quality one might be expected to produce 100kWh/m$^2$/year at a cost of 25-35p/kWh for a small or medium-size system. In the domestic context, it cost around £8,500 to £15,000 in 2003 to install a system meeting around 50% of a home's electricity requirements.[69] However, on top of these costs there are likely to be the costs of scaffolding and other increased installation costs. Obviously the electricity demands of commercial buildings in Soho are considerably larger.

5.116 Costs are likely to come down as manufacturing capacity expands and operating efficiency improves. As a consequence, there is a disincentive to invest in PV technology now, when future cost effectiveness is likely to be that much greater. To accelerate the growth of the market, grants have been made available through the BERRs Low Carbon Buildings Programme Phase 1 covering a proportion of costs for homeowners, businesses and not-for-profit organisations[70] and local schemes (see Westminster's Solar Scheme).[71]

5.117 However, as the example of Germany and other European countries has amply demonstrated, a feed-in tariff scheme would give a huge boost to this technology. The main European PV markets of Germany, Spain, Italy, Portugal, France and Greece accounted for 1,125 megawatts of PV demand in 2006, of which Germany accounted for 968 megawatts, the largest in the world. Private residential installations accounted for 41% of that total. Spain was in second place with 110 megawatts and revisions to feed-in tariff programmes are providing the basis for rapid demand growth in Spain and Italy, now categorized as the 'second tier' Major European PV markets.[72] By contrast UK installed PV power in 2006 was a little over 14 megawatts.[73]



**66.** Thomas, R. 2003. Op cit.
**67.** ibid.
**68.** Low Carbon Buildings Programme, BERR. Solar Thermal hot water <http://www.lowcarbonbuildings.org.uk/micro/solartherm/>.
**69.** Westminster City Council. 2003. p27.
**70.** BERR.
**71.** Westminster City Council. 2008a.
**72.** Solarbuzz.
**73.** iea-pvpsuk. 2006.