SOLAR CITIES

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ABSTRACT

Over the last decade, climate change has moved from being the concern of few to a widely recognised threat to humanity itself and the natural environment. The 1990s were the warmest decade on record, and ever-increasing atmospheric levels of greenhouse gases such as carbon dioxide (CO_2), could, if left unchecked, lead to serious consequences globally, including increased risks of droughts, floods and storms, disruption to agriculture, rising sea levels and the spread of disease. The contribution of anthropogenic emissions of carbon dioxide has been recognised as the principal cause of the atmospheric changes that drive these climate trends. Globally, buildings are the largest source of indirect carbon emissions.

In 2000, the UK Royal Commission on Environmental Pollution estimated that in order to stabilise carbon emissions at levels, which avoid catastrophic alterations in the climate, we would have to reduce emissions from the built environment by at least 60% by 2050 and 80% by 2100 relative to 1997 levels. Studies of the Oxford Ecohouse have demonstrated that it is not difficult to reduce carbon emissions from houses by 60% or more through energy efficiency measures, but it is only possible to reach the 90% level of reductions required by using renewable energy technologies. Solar energy technologies have been the most successfully applied of all renewables to date largely because they are the only systems that can be incorporated easily into the urban fabric. In addition, the short fossil fuel horizons that are predicted (c. 40 years left for oil and 65 years for gas) will drive the markets for solar technologies. For these reasons, the cities of the future will be powered by solar energy, to a greater or lesser extent, depending on the city form and location. In recognition of the need to move rapidly towards a renewable energy future, a group of international cities, including Oxford, have started the Solar City Network. In this paper we outline the programmes and strategies of the Oxford Solar Initiative developed to meet the three aims of reducing CO_2 emissions from the buildings of the city, to stimulate local industry and to ensure that the citizens of Oxford are future-proofed, in safe and comfortable homes, against the risks posed by both climate change and increasingly expensive fossil fuels.

1. INTRODUCTION

The climate is changing. The Third Assessment Report of the Intergovernmental Panel on climate change (IPCC) released in 2001, confirmed that there is compelling evidence that the Earth's climate has undergone a period of rapid warming over the last 50 years as a result of human activity. The rate of warming is now perceived to be increasing, a trend demonstrated by the extreme climatic events that have killed so many people around the world in 2003, the hottest year on records, with second being that of 1998. World-wide in the last decade, there have been increasingly violent storms, floods

and droughts, with the UK, Europe and the world experiencing unprecedented rainfall and flooding(DETR, 2000, p. 4; Smith, 2001, p. 9; Hulme et al., 2002, p. 11). Climate models indicate that in the coming century we will live in a progressively warmer, wetter world, with raised sea levels and increased coastal and fluvial flooding and extreme weather events. Global average temperatures, it is projected, will rise by 1.4 – 5.8°C (IPCC, 2001, p. 13; Hulme et al., 2002, p. 17).

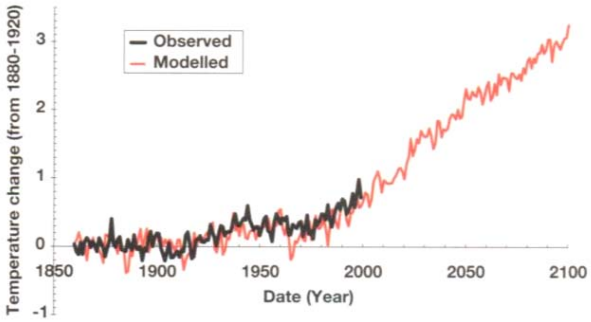


Figure 1. Observed and predicted global temperature change. (Source: IEMA, 2000, pp. 7; DETR, 200, p. 14)

The scientific evidence that the increasing atmospheric concentrations of human- induced greenhouse gases has been well rehearsed (Houghton et al., 1990; IPCC, 1996; Hulme and Jenkins, 1998; Graves and Phillipson, 2000, pp. 2-3; DETR, 2000, pp. 12-14; IPCC, 2001, p. 7). Of all the human-induced greenhouse gases, carbon dioxide appears to be the most important one resulting from humanity's growing use of fossil fuels. It is currently responsible for around two thirds of the global warming effect (MetOffice, 1999, p. 5; UNEP and UNFCCC, 2001). The atmospheric concentration of CO_2 has increased by 31% since 1750 and has probably not been exceeded in the last 20 million years (IPCC, 2001, p. 39).

The extent of the CO_2 problem was recognised by the UK Royal Commission on Environmental Pollution (RCEP), which proposed in 2000 that since some human-induced climate change now seems inevitable, there is a real need to halt the rise in CO_2 concentrations produced by burning fossil fuels in order to reduce the risks of catastrophic alterations to the climate (RCEP, 2000, pp. 2-3). For the UK this implies a reduction of 60% of CO_2 emissions by 2050 and 80% by 2100, relative to 1997 levels (RCEP, 2000, pp. 3-4).

For industrialised countries the most effective actions to effect reduction of CO_2 emissions, lie in the building sector, largely because buildings, in use or construction, are the biggest single indirect source of carbon emissions generated by burning fossil fuels. They account for over 50% of total emissions (Shorrock and Henderson, 1990; Watson et al., 1996; Smith, 2001, p. 15). The building sector can most realistically accommodate fairly rapid change without pain (Smith, 2001, p. 15). Studies of the Oxford Ecohouse have demonstrated that it is not difficult to reduce carbon emissions from houses by 60% or more through energy efficiency measures, but it is only possible to reach the 90% level of reductions required by using renewable energy technologies (Roaf et al., 2001). Even the Government's Interdepartmental Analysts Group (IAG) and Performance and Innovation Unit (PIU) conclude that to achieve a 60% reduction in CO_2 emissions, there is a need for a combination of energy efficiency improvement and carbon-free electricity generation (PIU, 2002, p. 8; IAG, 2002).

In addition, with the relatively short fossil fuel horizons that are predicted (40 years left for oil and 65 years for gas), globally humanity needs to move rapidly away from the use of greenhouse gas producing fossil fuels towards a greater dependence on clean renewable energy. In fact, reducing carbon intensity (carbon per unit of energy) can occur independently of a reduction in energy intensity (energy per unit of economic activity), e.g. through use of renewable energy. Sustainable energy supplies require a reduction in both carbon intensity and energy intensity.

For these reasons, renewable energy systems, must become the major source of the world's energy supply sooner rather than later, and a shift away from conventional fossil fuel energy systems must be begun as soon as possible. It is also recognised that to minimise greenhouse gas emissions during the transition it is important to improve the efficiency of energy use, i.e., through the rational use of energy. In order to achieve such a rapid transformation from fossil fuel to renewable energy powered built environments, the concept of the Solar City has been developed.

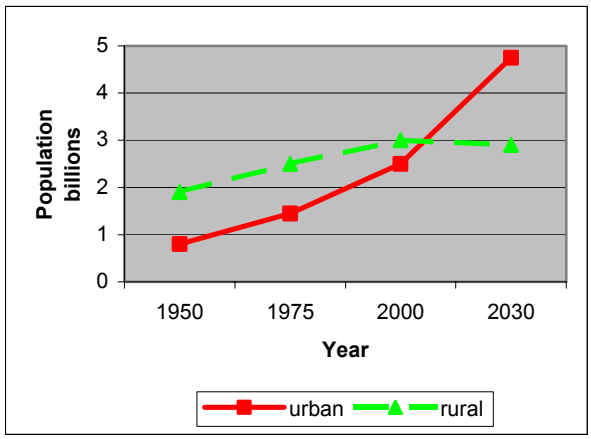


Figure 2: Growth in the last 50 years and projected future 30 year growth of global urban and rural populations. (Source: http://www.jhuccp.org/pr/urbanpre.shtml).

The International Solar Cities Initiative (ISCI) has been formed to address climate change through *effective measurable action* at the urban community level in the rapidly growing cities of the world. The members of ISCI are cities, institutions, and individuals from all countries who want to help each other in this task. Ultimately, all cities must meet radically different environmental standards for our world to avoid severe climate chang. ISCI believes that there is a real need, right now, for pathfinder cities who wish to become leaders in the 'how to' of per capita emissions reduction.

Some of the concrete goals of the ISCI Solar Cities are to:

- Develop clear targets for greenhouse emission reductions
- Scientifically validate methodologies for reducing emissions
- Develop technical innovations that can effect emissions reduction
- Create individual short term action plans which are consistent with meeting their 50 year IPCC emissions targets
- Implement significant actions which achieve the required reduction with minimum economic cost and high social and economic benefits
- Include all stakeholders in their Solar Cities programme

The use of renewable energy and micro-power systems is already on the rise today but the current speed of change is still too slow to meet the global goals for CO_2 reduction in time to avert the pending serious crises threatened by Climate Change and Fossil Fuel depletion (See for instance the list of related websites at the end of this paper). Cities and towns are increasingly regarded as settings for co-ordinated policy implementation programmes aimed at global renewable energy technology introduction. Against this background a number of 'Solar City' projects and initiatives have been established as global or regional networks in Europe and America, where in the latter small scale municipal grids can work in favour of solar communities. In Ashland, Oregon, the municipal utility supported a 1996 net metering law that established a simple grid-interconnection policy that guarantees the purchase of exported electricity at full retail price of up to a 1000 kilowatts of excess

electricity per month. On a larger scale San Francisco, spurred on by the power crisis of 2000/2001, plans to place as much as 50 megawatts of PV panels on city rooftops, financed by the sale of revenue bonds agreed by the electorate (www.e-coop.org/news529.cfm). In Europe the strong coalition of Solar Cities, reinforced by European research funding (www.solarcitiesineurope.nu) includes London, Berlin and Barcelona, a city where every new building must have a solar hot water system and where the local municipality has invested heavily in PV systems on public buildings. In 2002 a group of local Oxford Councillors, council employees, consultants and academicians put together a team to promote Oxford as a leading Solar City in the UK and the following sections detail their approach to this challenge.

2. THE OXFORD SOLAR INITIATIVE

The Solar Oxford Initiative emerges from a new generation of research and development that seeks city-wide applications of renewable energies and other means of greenhouse gas emissions reductions and absorption that will be applied in a coherent spatial and social context, as well as within community-wide framework.

The Solar Oxford Initiative proposes three areas of focus. They are to be advanced simultaneously. These are

(a) CO_2 reduction focused urban planning strategies

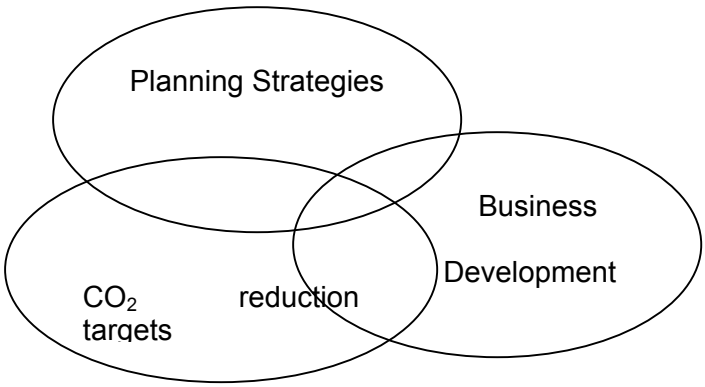
In part due to restrictions imposed by clients, construction, design, architecture and development firms can, but rarely do, have a major influence over the embedded carbon in new developments. Local authorities, through planning strategies, should reverse this situation.

(b) Targets, baseline studies and scenario development

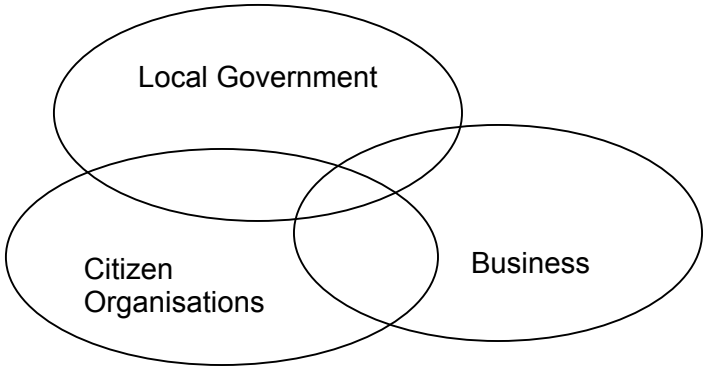
Ambitious long-term targets for carbon reduction are valuable, but often best seen as 'aspirational' given that the target formulators rarely have the agency to deliver them. Milestones can be used to monitor and manage the achievement of long-term targets over shorter time scales. The reason for realistic short-term targets is that expectations about reductions in energy use have been raised before, but not met, breeding disappointment and scepticism. The development of tools to evaluate and assess individual initiatives needs to be done with scientific rigour.

(c) Urban energy technologies, industry and business development

This group of actions includes job creation, attracting green industry, creating a new “green” economic sector, promoting entrepreneurship in the green sector, efficiency improvements that reduce expenses and improve profits, etc.



The Solar Oxford Initiative recognises that its success will depend upon a collaborative approach among all involved parties. Oxford is fortunate in having an elected local authority which has made a *commitment* to tackling these issues strategically. The main role of the local authority in the initiative will be as a catalyst in the creation of a local "Oxford Team". This team will draw together the relevant stakeholders who will in turn develop a co-ordinated approach to energy efficiency and renewable energy solutions.



The overall objective of the Solar Oxford Initiative is to find the best ways to introduce Solar Energy Technologies (SET) and the Rational Use of Energy (RUE) in Oxford. The initiative contains several clear objectives. Some of these are:

Goal One: 10% of all houses in Oxford will have solar systems by the year 2010.

Goal Two: To implement a capacity building programme to the local government for the provision of information, training, and other services oriented to CO_2 mitigation strategies.

Goal Three: To establish strategic alliances, and participation, of the local government, households, business organisations, energy supply companies and community organisations to fulfil Oxford's CO_2 reduction targets.

Goal Four: To initiate and implement a solar campaign to support local CO_2 reduction initiatives at every level within the Oxford community from primary school children to business leaders.

3. THE OXFORD FEASABILITY STUDY

The aim of the Oxford Solar Initiative (OSI) Phase I: Feasibility study was to lay the foundations for the establishment of a Solar Street and a Solar Suburb in Oxford. As part of the feasibility study, a survey of 700 householders was carried out in Oxford to investigate customer attitudes towards installation of PV, solar hot water and/or passive solar features in combination with energy efficiency measures on houses in North Oxford. The survey showed that 68% of respondents had solid brick/stone walls without insulation. 26% did not have any draught proofing on their doors and windows, while 50% had some draught proofing. Only 2% of the respondents had 200 mm thick loft insulation, while 29% had no hot water cylinder insulation. The results showed that there is scope for improvement in terms of fabric insulation. And since only 10% of the respondents had condensing boilers, there was scope for improving heating systems.

A large percentage of respondents (91%) agreed or agreed strongly that they would consider applying energy efficiency measures. 65% of respondents also agreed to consider using solar energy. And among these, 41% agreed to pay £1,000 - £1,500 for solar hot water systems and £1,500 - £2,500 for solar electric systems.

In summary, the survey demonstrated that there is a high demand for energy efficiency measures and solar advice; properties were typically in poor condition and therefore offered a high potential for

improvement; the buildings services offer an additional opportunity for emission reductions as the socio-economic profile of the majority of the properties surveyed were commensurate with that of the early adopters of central heating. These boilers are now ready for replacement and could be replaced with gas condensing boilers; and solar hot water systems are a popular choice and people are willing to install them installed, if they perceive them to be reasonably priced. Furthermore the survey confirmed that there is an excellent opportunity to pursue the implementation phase of the project, and that it made sense to prioritise energy efficiency measures before solar hot water systems and consider photovoltaics as a final (and not inexpensive) add on in the Low Carbon Homes package.

4. IMPLEMENTING THE OXFORD SOLAR INITIATIVE

The implementation plan for the Solar Oxford Initiative is based on the need for an inclusive process involving all stakeholders and the strategic use of fiscal incentives to promote the early uptake of solar systems in the city. Strategic alliances have been established between local government, households, business organisations, energy supply companies and community organisations to advocate and implement Oxford's CO_2 reduction targets. A core group has been established with the participation of the Oxford Brookes University, elected Oxford Councillors, the local Authority and leading UK consultants specialised on RUE and SET.

Since its inception the OSI team have held a number of public open events, one with stalls set up one Saturday on a busy city thoroughfare, a Solar School teaching programme, a Solar Fair with a wide range of displays of solar hot water systems and a Solar Hot Line has been set up so that members of the public can ring in to discuss energy efficiency and installing solar systems on their own home. In addition substantial subsidies from Central and Local government on the cost of individual systems are being offered, with pamphlets advertising them delivered door to door to each house in the city. Over 150 new systems have been installed as a result of this programme and more are in the pipe line.

In particular the issue of Fuel Poverty has been identified as a key driver for the OSI project. Solar hot water systems and PV systems have been installed on the council bungalows of the elderly that face south to ensure that the most vulnerable, the poor elderly have considerably reduced energy bills at a time when in the UK gas and electric prices are rising fast due to the rapidly widening gap between available gas and oil supplies and rapidly rising global demand for them. Last year alone gas prices went up 40% for some companies in the UK. The issue of Peak Oil, the idea that we are over the peak global output of oil, is being taken increasingly seriously as affect Fuel Security nationally by the UK government and others around the world.

5. CONCLUSIONS

The Oxford Solar Initiative has been designed to use both top-down and bottom- up strategies to develop the Historical city of Oxford as a pioneering Solar City in Britain, Europe and the World. The ultimate aim of the project is to build local partnerships to implement actions to reduce CO_2 emissions from the buildings of the city by up to 90%. The project aims in turn to stimulate local industry and to ensure that the citizens of Oxford are future-proofed, in safe and comfortable homes, against the twin challenges of climate change and increasingly expensive fossil fuels.

As a direct result of our work on the Oxford Solar Initiative Oxford has been chosen by ISCI to host the 2nd International Solar Cities Congress on the 3-6 April 2006 at which we expect over 50 cities from around the world to help us lay the foundations for the Low Carbon Economies and the Solar Cities of the 21st Century. You are all invited to join us in Oxford for that event. See www.solarcities.org.uk .

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SEE ALSO:

http://www.martinot.info/solarcities.htm

http://www.solarcity.org/solarcity/contents.htm

http://sc.ises.org/

http://www.californiasolarcenter.org/solareclips/2003.09/20030930-3.html

http://irecusa.org/articles/static/1/1080056751_1018302029.html

http://www.greenhouse.gov.au/solarcities/

http://www.peakoil.net/

http://www.energycrisis.com/