HEALTH + SUSTAINABILITY

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FACT SHEET 2:

PUBLIC HEALTH ASPECTS OF SUSTAINABLE BUILDINGS

MAY 2009

KEY POINTS

- sustainable buildings are energy, water, waste and material-efficient structures with low carbon emissions
- in the UK, traditional buildings are responsible for about 40% of national CO^2 emissions, 30% of the UK's total energy consumption and about 50% of total water consumption
- traditional buildings also have high indoor emissions of noxious substances such as volatile organic compounds, NO^x and CO
- sustainable buildings are primarily aimed at reducing the adverse human and environmental impacts caused by these emissions
- sustainable buildings provide good overall design and indoor quality which have been found to improve work performance, children's learning abilities, general household comfort and hygiene
- eco towns are settlements of sustainable buildings designed and managed to reduce environmental impacts and promote wellbeing, social cohesion and inclusion, and minimise the risk of crime and prevent unhealthy behaviour such as alcohol and drug misuse
- the UK Government plans to build one million houses with zero carbon emissions and ten new eco-towns by 2020
- all new homes will be zero carbon from 2016
- criticisms about sustainable buildings and eco towns revolve around the isolated location of these new settlements; how affordable these homes will be to a wider population; and whether these plans will distract the Government from improving current housing conditions
- at present, a comprehensive evaluation of the real health and social benefits that sustainable buildings and eco towns can bring is in progress

SUSTAINABLE BUILDINGS

Sustainable buildings, often also known as green buildings or eco-homes, are structures designed, built and operated in an ecological and resource-efficient manner. They aim to reduce the adverse human and environmental impacts, while improving our quality of life and economic well-being, and that achieve sustainability and environmental goals [1,2,3].

Sustainable buildings are typically characterised by [1,2,3,4,5,6,7,8]:

- **energy efficiency**, through better insulation, the use of renewable energy (solar panels, wind turbines and ground source heat pumps) and the adoption of more efficient appliances (e.g. energy saving bulbs)
- **material efficiency**, through the use of recycled, reused or low-energy products that promote efficiency and resource conservation, in particular during construction and demolition phases
- **reduced indoor and outdoor emissions** by adopting efficient heating, lighting and cooling systems and by avoiding construction/finishing materials that may contain toxic substances such as volatile organic compounds (VOCs)
- **efficient waste management**, through minimisation of waste generated in the construction and demolition phases, and by reducing, reusing, recycling and composting domestic waste
- **efficient water management**, by minimising domestic and industrial water usage and reducing wastewater
- **adaptation to climate change**, by providing flexible and more resilient buildings, capable of dealing with events such as flooding and heat-waves that may result from climate change
- **high quality design** that encourage social inclusion through provision of open urban spaces, and reduce the distance to public transport routes, amenities and places of work

According to the UK Government's strategy for delivering new and more decent homes, sustainable buildings must be affordable for a wide section of the population, and their construction should provide opportunities for local employment [3,6,9].

In the last five years, the Government has taken several important steps in the housing sector such as the introduction of the 'Code for Sustainable Homes', mandatory for all new houses since May 2008. Government also announced that all new homes must be zero carbon rated from 2016 and that one million new zero carbon houses and ten new eco-towns will be built by 2020[1] [6,10,11,12].

The 'Code for Sustainable Homes' is a six star system which replaces a previously used voluntary environmental assessment. It gives an indication of how sustainable the house is and covers nine rating categories:

1. energy and CO^2 emissions
2. water
3. materials
4. surface water run-off
5. waste
6. pollution
7. health and wellbeing
8. management
9. ecology

Specifically, health and wellbeing is measured against:

- daylight
- sound insulation
- private outside space
- accessibility to the dwelling and its potential future adaptability

The final score depends on how well the property measures up in all categories and may be recorded on a certificate used as part of the Home Information Pack (HIP) [10,12,13].

[1] A description of twelve locations likely to be suitable as an eco-town has been published by the Department of Communities and Local Government and is available at http://www.communities.gov.uk/planningandbuilding/planning/planningpolicyguidance/planningpolicystatements/planningpolicystatements/ppsecotowns/ppssustainabilityappraisal/

BOX 1: DEFINITION OF ZERO CARBON BUILDINGS

Zero carbon buildings are those that achieve zero net emissions of carbon dioxide (CO^2) from all energy used in the property. This includes emissions from heating, cooling, hot water systems, fixed lighting, appliances and any centralised energy networks [7].

This definition varies slightly according to the source/reference and so in December 2008, the Department of Communities and Local Government launched a general consultation on the definition of zero-carbon homes and non-residential buildings [11,14]. As well as the above, the document suggests adding that zero carbon emissions should not be achieved to the detriment of occupants' health and wellbeing, i.e. a satisfactory standard in terms of temperature, ventilation, air quality and noise must always be guaranteed [11,14].

HOUSING, CLIMATE CHANGE AND HEALTH

Climate change and resource consumption are major forces driving the UK sustainable buildings agenda.

Traditional buildings mainly contribute to climate changes through the production of greenhouse gases, in particular, carbon dioxide. In the UK, buildings are responsible for about 40% of national CO^2 emissions; and the residential sector accounts for between 25% and 27% of the overall figure [9,11,15,16]. Domestic building emissions come mainly from residential heating and hot water systems [9,17] using gas (48%) and electricity (42%), although 10% of emissions come from consumption of other fuels [9,18].

In total, the housing sector is responsible for 30% of the UK's total energy utilisation [15], and for about 50% of total water consumption [17]. In 2005, about 8% of waste produced was from households, and 24% from the construction sector [17]. Building materials, along with minerals, accounted for 15% of all road freight on UK roads [19].

Climate change was estimated to be responsible for approximately 0.3% of mortality and 0.4% of the burden of disease, globally in 2000 [20]. In the UK, the effects of climate change on human health have been monitored and quantified by a report published by the Department of Health [21]. The updated (2008) report highlights the potential increase in risk of extreme weather conditions, flooding, heat waves, air pollution and UV radiation exposure, and recommends improving building design to tackle climate warming and minimise its potential consequences [21].

BOX 2: QUANTIFICATION OF POTENTIAL HEALTH EFFECTS OF CLIMATE CHANGE IN THE UK (21)

Estimations of potential health effects include:

- the number of people at a high risk from flooding will rise from 1.5 million in 2004 to 3.5 million in 2100
- a 1°C increase in temperature will probably result in about a 4.5% increase in food poisoning, with Salmonella infection being the most common
- by 2012, there will be a 1 in 40 risk every year of a 9-day heatwave at 27°C in South-East England, with the potential for 3,000 immediate deaths and another 6,350 heat-related fatalities throughout that summer
- between 2003 and 2020, the anticipated increase in ozone concentrations could result in a 15% rise in attributable deaths and hospital admissions for respiratory diseases
- new atmospheric ozone levels would also increase the incidence of skin cancer in North-West Europe from 9% to 15%, approximately. However, a 2°C increase in ambient temperature could potentially bring the above figure up to 21%

Residential energy consumption produces gases such as SO^2 (linked with acid rain) NO^x and CO, which are all poisonous [22,23,24]. Long term exposure to these gases can be linked to: cardiovascular, neurological and pulmonary effects, and stillbirths. However, these are also precursor pollutants of ozone, which can have significant impacts on pulmonary function and is estimated to be responsible for 21,000 premature deaths annually in 25 European Union countries [25].

Sustainable supplies of resources are fundamental pre-requisites for health and well being [26]. Global competition over scarce natural resources, such as water and fossil fuels, can increase local poverty, health inequalities, and social conflicts [27,28].

"With climate change comes more extreme weather conditions, with drought decreasing the amounts of water available, reducing its quality and increasing demand. In UK, the development of new housing in areas of water stress and a doubling in the number of single person households since 1971 have also added to the increased demand for water" [29]. It has been estimated that in England, approximately four million households (around one household in six) is affected by water poverty [30]. Water poverty is defined as a situation where a household needs to spend more than 3% of net income on water charges, to have a reasonable amount of water, each day, for healthy and hygienic living. In England, an average person uses approximately 150 litres per day [29].

Similarly, 3.3 million households in England were registered as living in fuel poverty in 2006, one million more than 2005. A household is in fuel poverty if "it needs to spend more than 10% of its income on fuel to maintain an adequate level of warmth", which usually corresponds to a temperature of 21°C for the main living area, and 18°C for other rooms[2] [31]. It has been estimated that five per cent of households spend more than 30% of their income on fuel [32].

Among the factors affecting fuel poverty are [31]:

- the scarcity of solid fuel, which contributes to the increase in consumer energy prices
- extreme weather conditions due to climate change
- poor energy efficiency of the buildings

The latter, in particular, is the result of inadequate home insulation and heating, and can lead to poor health.

SUSTAINABLE HOUSING QUALITY AND HEALTH

Poor housing is a well-known determinant of health [20,33,34]. Several studies have demonstrated that exposure to cold and damp housing is associated with increasing risk of ill health [23]. Vulnerable groups, such as the elderly and children are most affected and consequences last longer, even if conditions improve [23,34,35].

BOX 3: HEALTH CONSEQUENCES OF POOR HOUSING CONDITIONS (ADAPTED FROM 23)

Housing circumstance	Physical health consequences	Mental health consequences
Cold	reduce resistance to respiratory infection hypothermia bronchospasm ischaemic heart disease, myocardial infarction and strokes	
Damp and mould	respiratory problems asthma, rhinitis and alveolitis eczema	unpleasant indoor environment may result in/contribute to depression, particularly in women
Indoor pollutants and infestation	asthma	
Overcrowding	increased risk of infectious or respiratory disease reduced stature	emotional and educational problems, in children social tension and relations disruption
Poor housing quality in each residence		lower mental well-being
'Difficult-to-let' housing		poorer emotional well-being than people in 'better' areas
Housing typology		Accommodation developed as flats increases social isolation and psychiatric disturbance mainly among women, and increases GP consultations for emotional symptoms

[2] The definition of fuel costs also includes charges for water heating, lights, appliances and cooking [30]

According to the 2007 English House Condition Survey, there are 7.7 million non-decent homes in the country, representing about 35% of the housing stock [36]. The UK Government is committed to creating healthier and sustainable communities by providing more affordable and decent homes[3] [6,37,38].

Urban regeneration and building improvements can provide an effective health benefit, which in 2000 was quantified as a seven-fold reduction in the average number of days of illness per person [39]. Good overall design and indoor environmental quality can also contribute to sustainability by improving wellbeing, work performance and further reducing the incidence of minor health problems. This is true even in buildings that already meet standard requirements [4,40,41].

BOX 4: SICK BUILDING SYNDROME

Sick building syndrome (SBS) is a term used to describe a temporary situation of acute discomfort characterised by a range of symptoms that tend to disappear after leaving the building. They may include: headache; eye, nose, or throat irritation; dry cough; difficulties in breathing; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odours [14,40,42,43]. SBS appears to be caused by a combination of the following: inadequate ventilation, biological contaminants, such as moulds from air conditioning systems, extreme indoor temperature conditions, poor light quality, noxious odours, hypersensitivity to some chemicals (mainly VOCs) released by furniture, light partitions, cleaning agents and photocopy machines, as well as general indoor pollution, mainly due to particulates, carbon monoxide and nitrogen dioxide generated by inefficient heating and cooking systems [14,42,43].

Sustainable buildings can boost indoor comfort [4,22,40,41] by:

- utilising non-toxic finishes and materials: many building materials and cleaning/maintenance products emit toxic gases, such as VOCs, formaldehyde, toluene, naphthalene and limonene, which can have negative impacts on occupants' health and productivity [40,44], and cause a 'building related illness' – BRI [42] Common symptoms may include: cough; chest tightness; fever, chills and muscle aches
- providing adequate ventilation systems: inadequate ventilation can be responsible for 3 % of absenteeism and can reduce productivity by 8% [45]. It can trigger allergies and significantly contribute to BRI [22,23,24,44]
- providing efficient lighting systems and wherever possible abundant daylight: inefficient lighting can affect concentration and eyesight. Good artificial and natural lighting can improve productivity by up to 20%, reduce absenteeism in offices by 15%, and boost children's learning in schools by 10% [45,46]
- providing the occupants with adequate controls on heat: extreme temperature conditions can reduce productivity by 30%, boost allergies and respiratory diseases and have a significant role in BRI [22,45] [24,46]
- reducing any unnecessary noise pollution: noise affects sleep and has other non-auditory stress effects, such as elevated blood pressure. It has been shown to have significant adverse affects on the performance and learning abilities of workers and children [24,48]. Adequate noise comfort can improve productivity by 38% for simple tasks and 27% for complex ones [45]
- providing an adequate interior design and space plan: adequate balance between private and open spaces and density of occupation of buildings can have a significant impact on work performance, children's learning ability and general occupant comfort and hygiene [22,45].

[3] For a dwelling to be considered 'decent' it must [36]:
- meet the statutory minimum standard for housing (i.e. free from the most substantial hazards set by the Housing Health and Safety Rating System [38])
- be in a reasonable state of repair
- have reasonably modern facilities and services
- provide a reasonable degree of thermal comfort

SUSTAINABILITY AND HEALTHY SETTINGS

The settings that buildings exist in can also contribute to the development of a more sustainable and healthier community [48]:

- sustainable settlements are planned and built in such a way that travel is reduced to a minimum, to cut down noxious emissions from transport. Housing is ideally located in the proximity of workplaces, and close to schools, social and health services and public transport [5,6,40,48]
- alternative transport options, such as cycling and walking, are also encouraged through the provision of bicycle lanes, pathways and pedestrian areas [5,48] to boost a more sustainable and healthier lifestyle. Moderate physical activity can help prevent heart disease, diabetes, strokes, some cancers (including colon cancer), osteoporosis, depression, anxiety and sleep problems [47,49]. Current advice from the Department of Health is to do thirty minutes moderate exercise, if possible outdoors (e.g. brisk walking), five times a week [50]
- a well-designed and managed neighbourhood with variations in the tenure, income level and age of the local population and adequate public spaces and amenities promotes socialisation, social cohesion and inclusion [48] and reduces the risk of crime [6,40]. Attractive public spaces can help create a sense of pride in the community and build up self-esteem in its individuals, minimising unhealthy behaviours such as smoking, and alcohol and drug misuse [51]
- a more rational use of land is achieved by improving dwelling density. Brownfield sites[4] are also preferred to greenfield sites, to safeguard natural habitats and biodiversity [5,38,40,48], which may have beneficial effects on human health [52,53]
- the provision of more green spaces is a key component of these new developments. These can provide recreation and amenity, but also green infrastructures for preserving and possibly enhancing urban biodiversity [5,40,48], which is an important factor in controlling the spread of diseases [52,53]. Furthermore, green areas can mitigate the effects of climate change by [54,55]:

- storing large amounts of carbon in trees, plants and soil
- reducing atmospheric pollution
- reducing the risk of flooding by increasing ground permeability
- mitigating the microclimate through the shade of the tree canopy and by helping to reduce the ill effects of heat waves
- mitigating noise pollution.

[4] Brownfield sites are lands that have been previously used or developed. Whereas, greenfield sites are lands which have not been developed [61].

BOX 5: EXAMPLES OF GREEN BUILDINGS AND ECO TOWNS IN THE UK

The Bed ZED Project, built in 2002 in Wallington, South London, comprises 82 residential homes, which are energy and resource efficient. The settlement has a legally-binding transport plan, which includes pedestrian and cycling networks and a car pool system for residents. Further information can be found at:

http://www.bioregional.com/programme_projects/ecohous_prog/bedzed/bedzed_hpg.htm

http://www.cabe.org.uk/case-studies/bedzed

http://www.sustainablebuild.co.uk/EcoHousingUK.html

The Greenwich Millennium Village, completed in 2000, is a wide regeneration project of a former brownfield site in the Greenwich peninsula. It comprises 1400 new green homes, community facilities, shops, offices and an ecological park. The settlement promotes sustainable modes of transport, such as walking and cycling, and other public transportation means.Further information can be found at:

http://www.sd-commission.org.uk/communitiessummit/show_case_study.php/00032.html

http://www.englishpartnerships.co.uk/gmv.htm

Slateford Green, in Edinburgh, is a mixed tenure residential development built on a brownfield site. It includes 69 flats for social rent, 39 for shared ownership and 12 for private sale. All houses are 'super insulated' and benefit from passive stack ventilation and photovoltaic panels. The estate is car-free. Further information can be found at:

http://www.scotland.gov.uk/Topics/SustainableDevelopment/CaseStudies/SlatefordGreen

http://www.sustainablebuild.co.uk/EcoHousingUK.html

Fairfield Housing Co-operative, in Perth. It is a regeneration project of a former residential area with high level of multiple deprivation. After a series of public consultations with the local population, in 1984, the estate was renovated using healthy and energy efficient materials and energy saving measures. The housing regeneration resulted in a reduction in fuel poverty and respiratory-related illnesses and in a reduction in crime in the area. Further information can be found at:

http://www.scotland.gov.uk/Topics/SustainableDevelopment/CaseStudies/FairfieldHousingCo-op

http://www.fairfieldhousing.co.uk/index.htm

Other examples and case studies on sustainable buildings and eco towns can be found at:

http://www.sd-commission.org.uk/communitiessummit/case_studies_all.php

http://www.cabe.org.uk/case-studies/listing?tag=Sustainable%20development&tagId=52&type=case-studies

http://www.scotland.gov.uk/Topics/SustainableDevelopment/CaseStudies

CONCLUSIONS

Sustainable buildings impact positively on public health in many ways. The evidence available about the potential impact of new sustainable buildings suggests that:

- provision of new high quality buildings with improved indoor comfort can have a significant direct effect on residents' health [23], particularly in terms of respiratory diseases, which can be quantified as a seven-fold reduction in the average number of days of illness per person [39]
- good overall design and indoor comfort can also further reduce the incidence of SBSs and minor health problems, such as allergies [8,40,42,44], and contribute to sustainability by improving occupant's wellbeing, children's development and adults' work performance in non residential buildings [45,46,56]
- a drastic reduction in resource consumption and carbon emission of green buildings and eco towns can have long-term indirect benefits on the wider population by reducing climate change impacts, such as extreme weather conditions, flooding, heat waves, air pollution and higher UV radiation exposure [16,17,18,21]
- energy efficient buildings, with adequate thermal insulation and heating systems help reduce fuel poverty, which can have significant effects on the social determinants of health [31,32,33]

However, and despite wide literature on the topic, several criticisms have also been raised, in particular about sustainable eco town settlements. These are mainly related to:

- the Government plans to build new eco towns in the countryside, which could become 'dormitories' for other larger conurbations, encourage urban sprawl, damage natural habitats and reduce natural environments [58,59,60,61]
- whether these new homes will effectively contribute to a healthy and sustainable society, as they represent less than 5% of the housing provision outlined by the government [59,61]
- whether new eco settlements may in reality increase traffic and, therefore, bring more noxious emissions and nuisances [58,59,61]
- whether these settlements will effectively be more affordable, help reduce poverty and promote social inclusion; as new plans can trigger an increase in the cost of land and new settlements can hide secondary costs for transportation and social services, such as schools [59,60]
- whether the plan to build new eco towns will distract the Government from improving the condition of present homes [60,61]
- whether the high density of the settlements, such as blocks of flats, would prevent sunlight and warmth from reaching the flats [63]
- whether better window insulation may in reality reduce indoor ventilation and increase condensation and mould problems. There is a high risk of this, if it is not associated with good ventilation systems and good occupier habits [22,64]

At present, the number of new sustainable buildings in the UK appears to be very limited [57] and a comprehensive evaluation of the real health and social benefits that these buildings can bring is still in progress [57]. In particular, there is limited research regarding the positive health impacts of the new sustainable technologies.

New research and activities should include:

1) evaluation of the overall benefit that new sustainable buildings/settlements can bring, considering both medium and long term effects

2) careful examination of the location of new settlements, with particular attention to the social and economic implications for the local population

3) cost-effectiveness analysis of new sustainable homes, in comparison with different options, such as that of improving the condition of present homes

4) assessment of the potential health benefits that each type of new technology can bring to the occupier

5) analysis of the effects that new high density settlements can have on physical and mental health.

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THIS HEALTH + SUSTAINABILITY FACT SHEET WAS WRITTEN AND EDITED BY PAOLO LURIA, MARY LYONS, SANA EL AZZEH AND MARJAN SARSHAR

Acknowledgements:
Clare Perkins, Keith Osborn, Jane Harris

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ISBN: 978-1-906591-72-4 (Print version)
ISBN: 978-1-906591-73-1 (PDF version)

Published May 2009

THE NEXT ISSUE WILL FOCUS ON SUSTAINABLE COMPOSTING

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