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Education, Sustainability

Abstract

South England is going through a transformative time due to the severe housing shortage that it faces. Southern England is facing such a severe shortage of housing that it will need to create nearly two million residential homes before the year 2016, indicating that there is a serious need for quick action on the part of developers. However, there is also a need for sustainable housing to be created in South England, as global climate change and other environmental problems loom large on the horizon. Determining the ways to maximize sustainable housing solutions while still providing fast, cost-effective housing options that fit the growing need of the English population is addressed in depth in this paper.

Keywords: Sustainable house, refurbishment, energy efficient, Passivehaus, BREEAM, Code for Sustainable Homes, Renewable energy, Post-occupancy evaluation, life-cycle cost, operational energy

Research Question: How to deliver a quick, cost-effective, sustainable residential building at the same time?

I. Introduction

Green building solutions are the new front line in architectural development and city planning. Sustainable development-- the official term for " green building"-- is a mode of development that aims to meet all necessary human needs while making a minimal impact on the environment as a whole (Chiu, 2003). Chiu (2003) notes that one of the primary goals for sustainable development is taking into account the different necessities insofar as the local ecosystem is considered-- the carrying capacity and the balance of the

local ecosystem is of the utmost importance when designing a sustainable development project. Because every geographical location is unique, every solution and sustainable building project must also be unique.

Residential buildings offer particular challenges to development planners and architects who are attempting to take into account green building standards when designing and creating their buildings (Chiu, 2003). This is because residential buildings have different requirements than commercial buildings, and must comply with a different set of codes; in addition, heating and water access can change the carbon footprint of a residential building substantially. The specific problems regarding the sustainable development of residential buildings and adherence to code will be discussed in the Literature Review section of this paper.

The Passivhaus Project

There are a variety of different projects that focus on sustainable development in Southern England, and the Passivhaus Trust is one of these projects. According to the Passivhaus Trust, the purpose of the project is " [to] provide a high level of occupant comfort while using very little energy for heating and cooling. They are built with meticulous attention to detail and rigorous design and construction according to principles developed by the Passivhaus Institute in Germany, and can be certified through an exacting quality assurance process" (Passivhaus Trust, 2013). Currently, in South England, there is a housing shortage that has resulted in the need for two million new homes by the year 2016.

Clearly, the cost to the environment from the creation of traditional housing

developments will be serious; thus, a need for sustainable residential housing solutions has been recognized. However, because of the housing shortage, there is also a need for new housing that can be built at a relatively quick rate. This poses a significant problem for housing developers, leading to the use of principles developed in Germany at the Passivhaus Institute (Passivehaus Trust, 2013). According to the Passivehaus Trust (2013), the use of these principles results in a 75% reduction in space-heating requirements, helping developers to meet their required carbon emission reduction requirements.

II. Background Literature Review

Terms and Definitions

When discussing sustainability in residential housing, it is important to understand that there is a new lexicon necessary that encompasses the concepts of sustainability and development. First, the concept of sustainability itself is important. Sustainability is the idea that a certain building practice has the ability to endure over time (Bartlett and Howard, 2000). This means that using materials like lumber culled from old-wood forests is not a sustainable practice; the wood will eventually become scarce, and replacing it within a short span of time is impossible (Bartlett and Howard, 2000). However, the practice of sustainability also encompasses cost-effectiveness; without being cost-effective, a use of a “ sustainable” resource is not truly sustainable. If a company cannot afford a resource or material over a significant period of time, then the resource or material cannot be considered a sustainable resource, even if it is an

environmentally-friendly one (Bartlett and Howard, 2000). This is an important distinction to make, as many use the terms environmentally-friendly and sustainable interchangeably; in reality, they are different concepts, although linked (Bartlett and Howard, 2000).

Another concept that is often discussed regarding sustainable development is the concept of energy-efficiency; this is particularly important for the Passivhaus Trust projects (Passivhaus Trust, 2013). Passivhaus (2013) reports that its energy-saving techniques reduce space-heating requirements by approximately 75% for residential homes. In addition, Passivhaus has independent corroboration that it is operating to standard; usually, according to Chiu (2003), aspirations in design and energy-saving technologies fall short of their mark by approximately 50-60%, a significant reduction.

The life-cycle cost analysis of a home is a tool that determines the most cost-effective option for creating a home over a certain period of time, usually the life cycle of the home (Bartlett and Howard, 2000). For homes using sustainable or energy-saving materials which may have a greater starting cost, this is a particularly important metric, as it takes into account the costs that the homeowner or landlord pays over a long period of time versus the development costs of the home (Bartlett and Howard, 2000). For instance, a home using energy-saving appliances may have a higher starting cost than a home that does not use energy-saving appliances, as those appliances are newer and have a higher initial cost, but over the life cycle of the home and those appliances, the owner may end up saving more money because of the energy-saving nature of the appliances (Bartlett and Howard, 2000). The life-

cycle cost analysis is one of the fundamentally-important tools for determining whether or not an energy-saving building material is cost-effective and sustainable as a building option in the long run. Without this metric, determining what materials are cost-effective would be essentially left to guesswork and assumption.

Sustainable Residential Development

Sustainable residential development in England is fundamentally important in the coming years. Because nearly two million new homes must be built before 2016, the homes that are to be built must be simultaneously easily and quickly built, profitable for developers, and sustainable for the environment. If these criteria are not met, then the housing shortage in Southern England will continue to be problematic. The need for sustainable homes is also important, as global environmental sustainability becomes more of an issue around the world (Forbes, 2007). Forbes (2007) writes: The application of sustainability principles to development projects involves integrating and balancing economic, environmental and social criteria. Eco-houses built in accordance with the principles of sustainable development which use resources and technologies that capitalise on renewability, are a fast-development industry in the UK whether they are individual projects, or designed to accommodate and create a new community The relationship between sustainability and housing is two-way. Incorporating principles and refurbishment will [contribute] to achieving general sustainability objectives, but will also improve the quality, durability and cost-effectiveness of housing. A change of culture is needed so that there is a different approach to

housing maintenance and development which places sustainability in the centre Sustainability objectives, such as the government target for reducing carbon emissions by 60% by 2050 will only be achieved if they are taken into account at all stages, from design through to construction to long-term use, maintenance and eventual disposal of recycling. (Forbes, 2007)

In short, the housing issues within the United Kingdom cannot be met using traditional housing solutions; the only solutions for the housing issues within the United Kingdom are sustainable housing solutions. Choguill (2007) suggests that the key to encouraging sustainable housing solutions, particularly in residential developments, is to encourage government participation in the project, as well as business and institutional participation. The Code for Sustainable Homes, discussed here, is fundamental to the creation of sustainable housing developments in South England.

The Code for Sustainable Homes is a building code that is in effect for England, Wales, and Northern Ireland (Edwards and Turrent, 2000). The Code for Sustainable Homes allows for six different levels of sustainability in homes, measured on a number of different criteria. The nine sustainability criteria are analyzed and then combined to give the home a numerical rating from level one to six. The nine criteria to be assessed by homes falling under the Code for Sustainable Homes are:

- Energy emissions and carbon dioxide footprint
- Ecology-- the level of protection that the architect or developer considered in regards to the surrounding ecosystem
- Management in construction
- Water-saving measures

- Run-off of surface water

- Waste management

- Pollution management

- Sustainability of building materials

- Provisions for occupant health and well-being, such as daylight, sound insulation, heat circulation, and so on (Forbes, 2007).

The criteria set forth in the Code for Sustainable Homes are analyzed at a different standard for each level of sustainability. A Level One sustainability, for instance, has a much lower rating for energy emissions and carbon dioxide footprint than a Level Six residence (Forbes, 2007). The Code for Sustainable Homes is being phased out in England, but for now, the standards remain set; the new Building codes, according to Forbes (2007) will have similar but more detailed standards set forth.

III. Methodology

There are a number of sustainability measures that can be taken to assist developers in creating sustainable homes in Southern England. It is the responsibility of developers of these new sustainable communities to create buildings that are environmentally-friendly, but also to create spaces that facilitate environmentally-friendly, sustainable communities. Areas (2009) writes:

Developing sustainable neighbourhoods should be guided by the principle of universal design. Universal design is the design of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability. By considering people's diverse needs and abilities throughout the design process, which

reflects the life cycle approach, environments that meet the needs of all can be achieved. (Areas, 2009)

In practical terms, this means a variety of different things. First, in developing a certain area or creating a community, a developer must use sustainable materials that are created in an environmentally-responsible manner. This means that things like hard wood from old wood forests should be recycled or refurbished if used at all; if the recycled option is not available, then other building materials should be used (Areas, 2009).

In addition, these projects should promote the efficient use of energy and reduce the consumption of fossil fuels; this will simultaneously help reduce the production of carbon dioxide and other greenhouse gases (Choguill, 2007). Passivhaus, for instance, includes super insulation that reduces the amount of energy needed to heat a particular space by 75%; in addition, buildings built under the Passivhaus criteria are stringently airtight, have minimal thermal bridging, optimize passive solar gain, and have mechanical ventilation and heat recovery (Passivhaus, 2013). All of these features indicate that houses built under these strict standards will be much more efficient when it comes to energy loss and energy consumption; in addition to these standards, the Passivhaus Trust also produces water saving products for new and refurbished homes, further adding to their high level of sustainability and relatively low carbon emissions level (Passivhaus, 2013).

In addition to using these energy-saving measures, developers can use city and community planning measures to create spaces that reduce the need for vehicle transport (Areas, 2009). This means that certain spaces should be developed into community spaces, with ease of access from new

development areas (Areas, 2009). Areas (2009) writes, “ The shape and form of the small town or village concerned and in particular patterns of streets should be analysed Priority should be given to connectivity for pedestrians and cyclists and the potential for car-free developments should be actively considered” (Areas, 2009). This connectivity and permeability is fundamentally important for the creation of sustainable and organically-growing communities in South England. There is a very real concern for the future growth of the community as well as the future of the housing created; the housing projects need not be slapped together haphazardly, but must be designed quickly, efficiently, but also with aesthetics and functionality in mind as well as the ease of construction and sustainability of the units.

IV. Results

Sustainability Measures and Strategies

There are a number of sustainability measures and strategies that have been found to be effective in England and globally. Discovering strategies that work in a particular community can take some analysis of the community and its needs, but it can easily be done. Most solutions need only a little tweaking before they can be applicable to communities regardless of location. As Forbes (2007) suggests:

The recommended approach outlined is holistic and carried through from the carbon footprint analysis to renewable energy technology selection The analysis is to show how base loads of a house are determined and reducing the energy loads by analysing when and where energy is used and, by employing low and zero carbon heating and power equipment for the

development of new homes. The analysis undertaken in this study suggests that the recently revised Part L of the Building Regulations leads to a significant reduction in carbon emissions from dwellings. (Forbes, 2007).

Sustainability has often been discussed in terms of “ circles of sustainability,” which come in four different categories: ecology, economics, politics and culture (Chiu, 2003). The sustainability of a project can be defined by its success in each of these circles, or domains. Here, we will focus on the domain of ecology within the home, although a truly sustainable home will be sustainable across all four domains.

As far as ecology of the home is concerned, there are a multitude of different areas that need to be addressed. The first area of concern is the issue of light. Lighting a home can be an expensive and energy-consuming task; thus, sustainable housing options make good use of daylight and alternative lighting options to help avoid the high energy requirements of lighting the home. The sustainable residence and the sustainable community provides proper orientation for the residence that ensures that the residence does not need to be excessively well-lit during the day. In parts of the country where it is feasible-- like south England-- the orientation of buildings and the lack of shadow can also be used to improve the use of solar panels on the roof of residential dwellings. Larger buildings casting smaller buildings into shadow negates the use of solar panels, but careful design of communities can help to alleviate the problem.

Another important sustainability measure for housing in the south of England is the issue of building materials during the construction phase. Sourcing building materials properly and choosing materials that are environmentally-

friendly is an important and remarkably efficient sustainability measure. This can be done through utilizing one of the many building companies that specialize in building or refurbishment of properties in a sustainable manner; Passivhaus, for example, utilizes materials that are relatively local, and do not use excessive amounts of energy or resources in transportation or transit of these materials.

In their homes, Passivhaus also provides reduced space heating costs and necessities to the home owner. This means that less energy is taken to heat the same amount of space, and that homes and residential buildings are designed with the application of energy-saving techniques specially in mind by the designers. This is an incredibly easy but very effective method for saving energy; without implementing some or all of these measures, the new homes that are built in South England will not be very sustainable in the long term.

The final consideration that will be discussed here is the consideration of waste, water, and surface water run-off. Waste collection and control in these new sustainable communities should be carefully monitored, and recycling programs instituted early on in the inception of the communities. Waste systems, like sewage systems, should be chosen and designed for their sustainability capabilities. Water-saving techniques and appliances should be chosen and installed in the new homes-- as can be seen in the next section, water-saving appliances are one of the most cost-effective ways to reduce the carbon footprint and “ green” score of a home, while still remaining a relatively easy and low-maintenance approach to sustainability measures. Surface water runoff, on the other hand, must be closely

controlled, trapped and treated to ensure that it does not pollute the ocean; this is an often-overlooked but important aspect of sustainability in newer housing developments.

Cost and Operational Savings Regarding the Passivhaus Project

Research indicates that sustainability measures may increase the starting price of a home, appliance, car, or other consumable item, but that the savings overall usually offsets the initial investment price (Choguill, 2007). Choguill (2007) writes, “ By increasing the opportunities for affordable housing for low-income groups social tensions can be decreased and community stability, social interaction, and security increased. On the individual level quality of life, adequate housing standard, and access to a secure income, basic urban services, and infrastructure are important matters of social sustainability that should be facilitated through housing strategies. Additionally, housing construction can help in job-creation and building skills” (Choguill, 2007). Choguill also notes that one of the most important aspects to sustainable building is that the buildings must be affordable to the consumer. This means that a building or residence with a higher sticker price must have some kind of incentive for those who do not have the money to spend at will. MIddle class, upper-middle class, and upper-class people who have the money to spend on a residence may spend their money on a sustainable residence due to ethical or moral responsibilities; however, those without excess money will need an extra incentive. This is why it is so important to include government in the creation of these projects and encourage government to provide incentives for people

choosing to live in or purchase residential homes or flats that are sustainable and environmentally-friendly.

The Passivhaus project does increase the sticker price of a home, as the heavy-duty insulation that is required to insulate the house as heavily as is necessary can be expensive. In addition, Passivhaus has patented a number of technologies on windows and doors, meaning that there are no other options; the developer must buy the brand name, increasing the sticker price. However, according to the Passivhaus, the use of their products reduces the space heating necessities of a space by approximately 75%, a reduction that is immensely significant and will save the average consumer a significant amount of money over time-- even over a single year (Passivhaus Trust, 2013).

The Passivhaus Trust's many projects are focused on building a community that fosters an environment of environmentalism and sustainability, particularly from the inception of the community. The Passivhaus projects are designed to have the smallest ecological footprint possible, and the leaders of the project have created an algorithm that helps their technicians and architects design buildings that fit the local ecosystem most closely. The Passivhaus standard has a number of key features:

- Total primary energy consumption (for heating, cooling, hot water and electricity) of the building must not be more than 120 kWh/m² per year
- The peak load of energy demand for heating or cooling a Passivhaus-compliant building must be less than 15 kWh/m² per heating or cooling cycle
- The air cannot leak more than 0. 6 times the house volume in air per hour (Passivhaus Trust, 2013).

In practical terms, this means that the Passivhaus Trust project is a highly-specialized project, designed to help builders and residents reduce their ecological footprint; however, there are many other potential solutions that can and should be explored to help community designers create the most ecologically-friendly, sustainable communities that are possible.

Considerations for Sustainable Housing Outside the Passivhaus Approach

There are a number of considerations for sustainable housing programs outside of the Passivhaus approach. The Passivhaus approach is an excellent starting block for sustainable housing programs, but other considerations must be taken into account if housing programs are to be truly sustainable (Edwards and Turrent, 2000). Building a sustainable community begins in the planning phase of the community, while developers and builders are determining what materials are necessary for the build site. One of the newer building materials that has been shown to be functional with the Passivhaus projects is hemp; hemp is relatively inexpensive, easy to manufacture and grow, and an excellent insulator (Edwards and Turrent, 2000). In addition to being a sustainable resource, hemp has excellent durability, particularly against insect activity, mold, dry rot, and moisture, which is an excellent quality for a house in southern England to have (Edwards and Turrent, 2000).

Powering these homes is another consideration for community planners, and installing community-wide solar panels to at least offset the energy requirements for the communities in question is an excellent option. This will reduce the amount of carbon emissions that the homes create and will

certainly help make whatever community is built a more sustainable one. Solar power may not be able to be used for the entirety of the project, depending on the weather and the type of solar paneling that is determined to be the most cost-effective, but it is a relatively low-cost option insofar as reducing the energy cost of a building project.

Once the housing project is completed, amenities must be installed; this is another way that developers and builders can create sustainable homes for those living in these new housing projects. Low-flow amenities like toilets and washers can seriously reduce the water requirements per unit (Edwards and Turrent, 2000). In addition, energy-saving measures like switching from incandescent bulbs to LED lighting and low-energy alternatives creates an environment of sustainability that continues to encourage this type of activity long after homes have been completed.

Building developers can further encourage sustainability and environmentally-friendly practices by creating communities that encourage walking and alternative forms of transportation from community members; in addition, creating communities with recycling and composting programs can help significantly reduce waste within those communities, and the energy needed to remove the waste from communities to the landfill.

V. Conclusions and Recommendations

Because the need for sustainable housing in the south of England is so great, it would be easy to choose an option for sustainable housing that is less than ideal. However, because the problem will only escalate and become larger without proper attention, it is important to choose solutions that are workable for the foreseeable future. Determining a workable solution

involves taking into account a number of different factors regarding sustainability, and addressing numerous goals. Without addressing the multitude of different goals that the government has for the growth of the real estate development in Southern England, the development that occurs will be a small fix for a growing problem, rather than a foundational fix that can continue to whittle away at the problem.

The first recommendation that will be made is the recommendation of utilizing sustainable building materials for the development of real estate in the south of England. There are many different building materials that can be used--some of them new, and some of them recycled from old or refurbished materials-- however, the materials that are used should be both cost-effective and environmentally-sound. In addition, new building projects must take into account the environmental surroundings and the local ecosystem of the area. Disruption of the local ecosystem can cause problems in the environment in the long run, and avoidance of disruption of the local ecosystem should be a primary goal for building sustainable housing developments in a particular area.

Energy should also be saved in construction, whenever possible. This may mean using local services and materials, but it may also mean prioritizing recycled materials over new materials, once a life-cycle cost analysis of the materials has been performed and the cost over time has been ascertained. Certain materials may have pros and cons insofar as using recycled versions of the materials are concerned; recycled metals, for instance, have a tendency to create a lot of pollutants, whereas glass is easily recycled with minimal waste (Choguill, 2007).

Sustainable housing projects may have a larger sticker cost than traditional housing projects, as they may require specialized personnel, skillsets, materials, and so on. However, over time, the amount of energy consumed or required by these housing projects will be significantly less than traditional housing projects. Providing options for those individuals who are interested in investing or purchasing sustainable housing units is another aspect to sustainable housing that is often overlooked; because of the higher price tag, sustainable housing options can be made accessible to more people through the use of vouchers or other payment-help programs. Governmental involvement in sustainable housing projects is very important to the success of the projects.

Finally, sustainable housing projects must do more than merely create residences for people to exist in. They must be designed to create communities; the structure of these residences and housing projects is very important. Designing housing projects that encourage the use of public transportation, bicycle, or foot traffic can help significantly reduce the carbon emissions of the people that live in these projects.

References

Areas, U. 2009. Sustainable Residential Development in Urban Areas.

Bartlett, E. and Howard, N. 2000. Informing the decision makers on the cost and value of green building. Building Research & Information, 28 (5-6), pp. 315--324.

Beavis, M. 1992. Colloquium on Sustainable Housing and Urban Development. Winnipeg, Man.: Institute of Urban Studies.

Chiu, R. 2003. 12 Social sustainability, sustainable development and housing development. Housing and social change: East-west perspectives, p. 221.

Choguill, C. 2007. The search for policies to support sustainable housing. Habitat International, 31 (1), pp. 143--149.

Council, W. 2011. Code for Sustainable Homes. West Lancashire District Council.

Edwards, B. and Turrent, D. 2000. Sustainable housing. London: E & FN Spon.

Forbes, R. 2007. Code for sustainable homes: an evaluation of low carbon Dwellings. University of Strathclyde Department of Mechanical Engineering Energy Systems Research Unit.

Gidlof-Gunnarsson, A. and Ohrstrom, E. 2007. Noise and well-being in urban residential environments: The potential role of perceived availability to nearby green areas. Landscape and Urban Planning, 83 (2), pp. 115--126.

Hastings, R. and Wall, M. 2007. Sustainable solar housing. London: Earthscan.

Hostetler, M. and Noiseux, K. 2010. Are green residential developments attracting environmentally savvy homeowners?. Landscape and Urban Planning, 94 (3), pp. 234--243.

Hunt, D., Lombardi, D., Farmani, R., Jefferson, I., Memon, F., Butler, D. and Rogers, C. 2012. Urban futures and the code for sustainable homes. Engineering Sustainability, 165 (ES1), pp. 37--58.

Kohler, N. 1999. The relevance of Green Building Challenge: an observer's perspective. Building Research & Information, 27 (4-5), pp. 309--320.

Lockwood, C. 2006. Building the green way. harvard business review, 84 (6),

pp. 129--137.

Lovell, H. 2004. Framing sustainable housing as a solution to climate change. Journal of Environmental Policy & Planning, 6 (1), pp. 35--55.

Maliene, V. and Malys, N. 2009. High-quality housing—A key issue in delivering sustainable communities. Building and Environment, 44 (2), pp. 426--430.

Maliene, V. and Malys, N. 2009. High-quality housing—A key issue in delivering sustainable communities. Building and Environment, 44 (2), pp. 426--430.

Mayagoitia Witrón, F. 2008. Green building in North America. Montréal, Québec: Commission for Environmental Cooperation.

Priemus, H. 2005. How to make housing sustainable? The Dutch experience. Environment and Planning B: Planning and Design, 32 (1), pp. 5--19.

Rovers, R. and Klinckenberg, F. 2008. Sustainable housing projects. Amsterdam: Techne Press.

Sfakianaki, A., Pagalou, E., Pavlou, K., Santamouris, M. and Assimakopoulos, M. 2009. Theoretical and experimental analysis of the thermal behaviour of a green roof system installed in two residential buildings in Athens, Greece. International Journal of Energy Research, 33 (12), pp. 1059--1069.

Todd, J., Crawley, D., Geissler, S. and Lindsey, G. 2001. Comparative assessment of environmental performance tools and the role of the Green Building Challenge. Building Research & Information, 29 (5), pp. 324--335.

Wang, W., Zmeureanu, R. and Rivard, H. 2005. Applying multi-objective genetic algorithms in green building design optimization. Building and Environment, 40 (11), pp. 1512--1525.

Webb, M. 2005. Innovation in sustainable housing-- Tango. New York: Edizioni Press.

Winston, N. and Eastaway, M. 2008. Sustainable housing in the urban context: international sustainable development indicator sets and housing. Social Indicators Research, 87 (2), pp. 211--221.

Zhou, W., Troy, A., Morgan Grove, J. and Jenkins, J. 2009. Can money buy green? demographic and socioeconomic predictors of lawn-care expenditures and lawn greenness in urban residential areas. Society and Natural Resources, 22 (8), pp. 744--760.

Zhu, Y. and Lin, B. 2004. Sustainable housing and urban construction in China. Energy and Buildings, 36 (12), pp. 1287--1297.

Appendix A

(Chiu, 2003)