Green Jobs Creation Through Sustainable Refurbishment in the Developing Countries

A Literature Review and Analysis Conducted for the International Labour Organisation (ILO)

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ABSTRACT

This report provides a review of literature on energy efficient sustainable refurbishment in developing countries. To this end it provides an overview of climate change and its impact on built and natural environment within the context of sustainable development. In particular it will show the impact of human activity, focusing on role of buildings, on Carbon Dioxide (CO2) emissions and therefore greenhouse effects. The report will go on to consider the main elements of sustainable development. In this we will pay special attention to conditions for attaining social sustainability and the role of employment therein. The report will examine the role of construction in development and in particular its contribution to pro poor employment generation and social development objective as well as meeting CO2 mitigation targets. An important aspect of this is the role of sustainable refurbishment in the context of developing countries.

The report utilises four case studies in Brazil, South Africa and the Netherlands to examine the social, economic and environmental effects of adopting sustainable refurbishment. As two of the most advanced developing countries in their own regions the former two serve to illustrate the potential for sustainable refurbishment activities in developing countries while the latter serves as exemplar particularly for institutional and policy development purposes. As part of this we shall examine on a general level the country specific conditions for detailed energy use patterns and trends, the institutional framework for implementing energy efficient and sustainable refurbishment policies and the scope for sustainable refurbishment. This analysis is complemented by detailed examination of four exemplar case studies covering one case from the Netherlands and Brazil each and two from South Africa that will show what is the potential for sustainable refurbishment in meeting different aspects of sustainable development in practice at a project level.

The report identifies that buildings are the second largest contributors to greenhouse gases (GHGs) in terms of CO2 emissions. At the same time, they provide the greatest economic potential for CO2 mitigation. This is particularly evident in developing countries that have the highest potential (at net negative costs) for mitigating CO2 emissions in buildings. This is due to the fact that many of the low cost opportunities for CO2 abatement have already been captured in the more developed economies due to progressive policies in place or in the pipeline whereas in developing countries we are still at the beginning of this process. At the same time it is worth noting that in developing countries the largest CO2 mitigation potential results from electricity savings where as in developed countries this saving is gained from heat-oriented measures. The former is seen to be rather less complicated in terms of switching to more efficient appliances with quick payback periods while the latter involve shell retrofitting and fuel switching that are often more expensive and require longer payback periods.

In terms of employment generation the report presents different skills requirements and potential for greater employment creation. It shows that there are significant opportunities for creating new employment in developing countries as a result of adopting sustainable refurbishment. This can be through a range of activities from general refurbishment of residential stock to specialist work such as installation of photovoltaic (PV) equipment for heating, water pumps and insulation activities. Such an approach also provides the opportunity for skills development and training far beyond traditional building skills due to added requirement for sustainable retrofitting and systems installations. In addition the report shows that in practice sustainable refurbishment provides major opportunities for meeting other aspects of social sustainability particularly community development and participation as well as contributing to the broader
local and city/national economic development through local employment generation and multiplier effects on other sectors of the economy. Nevertheless, there is a great deal of work that must be done for developing the institutional framework to facilitate sustainable refurbishment activity.

The report finally concludes by providing a number of policy considerations that would facilitate the wider adoption and implementation of energy efficient sustainable refurbishment in developing countries as a whole.
1 INTRODUCTION

1.1 BACKGROUND

It is now widely acknowledged that the Earth’s climate is rapidly changing due to the increasing emission of greenhouse gases (GHG) into the atmosphere. The IPCC (1997) and Stern (2006) have assessed the impacts of climate change with respect to various economic sectors and future trends of these impacts. The projected trends are quite frightening and as argued in Thornton et al (2006), it is quite likely to impede the achievement of the Millennium Development Goals by 2015. Targets are being set for maximum allowable levels of emission of GHG. Depending on the path taken, global emissions would need to be around 25% lower than the current levels by 2050 (Stern, 2006). The IPPC Fourth Assessment Report (IPPC, 2007) on mitigation of climate change identifies a wide range of benefits for socio-economic development arising from possible mitigation measures. The report stipulates that sustainable development and mitigation policies can stimulate technological innovation and generate local employment. According to the IPCC (2007) report the building sector was responsible for about 30% of the global total of energy related emissions. Consequently, urgent mitigation action is needed to reduce energy use in buildings – both in the design of new buildings and through the refurbishment of existing buildings. Indeed the IPCC Report (2007) concludes that among all sectors, the greatest low-cost mitigation opportunities are in buildings.

It is for these reasons that various governments are implementing innovative sustainable refurbishment measures for improving the energy efficiency of existing buildings. Central to these measures have been the way stakeholders have been involved in the execution of projects. The direct implications have been: astute contractors have reshaped their business models to incorporate sustainable refurbishment, unskilled workers have undertaken new training for particular tasks, there have been increase of sales of related building materials and components used in the refurbishment projects and above all increase in employment creation. The creation of jobs as a result of executing sustainable energy efficiency refurbishment projects is undoubtedly aligned with the objectives of the “Green Jobs Initiatives” being advocated by the International Labour Organisation (ILO), United Nations Environment Programme (UNEP) and the United Nations agencies and partners for fighting climate change and at the same time contributing to sustainable economic growth and lifting people out of poverty. Developing countries are characterised by deplorable states of buildings known in more general terms as “slum dwellings”, and application of unsustainable construction practices. Therefore, sustainable refurbishment could be a key solution in overcoming the above problems challenging the developing countries and at the same time providing jobs to the community. By undertaking this study it is hoped that policy makers, energy experts, program implementers and advocates of energy-efficient refurbishment will exploit fully the opportunities that exist in the sustainable refurbishment of existing buildings in developing countries.

This report reviews some existing refurbishment or retrofit projects, identifies their successes, challenges, lessons learnt and the benefits including community involvement, energy efficiency policies implications and above all the jobs created for the community as a result of executing sustainable energy efficiency refurbishment projects. Furthermore the report discusses the current trends of sustainable energy refurbishment in developing countries, identifies the demand and end-uses of energy in buildings, and the role of stakeholders in the energy efficiency market.
In this report energy efficiency measures have been identified in selected projects in both the developing and developed countries with a focus on South Africa and Brazil, using the Netherlands as the reference best practice exemplar for considering the policy framework that can facilitate sustainable development. The report identifies challenges facing developing countries and proposes relevant policy considerations. Though the report focuses on South Africa and Brazil, the recommendations and conclusions that are drawn from it remain valid for other developing countries.

The main purpose of this study is to investigate the extent to which the possible refurbishment of the existing building stock for the purposes of energy efficiency can lead to the creation of employment, paying particular attention to the situation of developing countries. The intention was to conduct a desk-study with the view to addressing the following questions:

a. What are the main current trends in developing countries regarding refurbishment of the existing building stock for the purposes of energy efficiency?

b. What renovation/improvement measures have best technical and economic efficiency?

c. What are the main challenges for developing countries to improve the energy-efficiency of the building stock? Obstacles or barriers which prevent measures which are cost-effective according to IPCC from being taken?

d. What elements of policies and programmes are essential to trigger a move towards energy efficiency?

By addressing these questions this study aims to contribute towards informing the broad framework of the “green jobs” and the “Decent Work for Sustainable Development” (ILO, 2007a) initiative of the ILO. The phrase “green job” has recently emerged and is being used to describe employment created from measures adopted in response to mitigating the effects of climate change. There is still a lack of clarity in the existing literature as to what exactly constitutes a green job. Most reports usually state the number of jobs created on various projects without describing the constituents of the job. It has been acknowledged that defining the term “green job” can be quite a complex methodological issue (Annandale and Morrison-Saunders, 2008). This report adopts the ILO (2008) definition of a job and for the purposes of the international Standard Classification of Occupations to mean “a set of tasks and duties performed or meant to be performed, by one person, including for an employer or in self employment”. Assuming this definition and considering the definitions from Annandale and Morrison-Saunders (2008) and UNEP (2008) have been considered in the definition offered below.

“\textit{A green job is one which makes minimum negative impacts on the environment relative to the status quo, thereby making enterprises and sectors more sustainable}.”

In the context of sustainable energy refurbishment, installing solar systems, insulating the building envelope are tasks undertaken by individuals performing green jobs. A summary of building refurbishment activities performed in response to climate change worldwide involving green jobs are presented in Table 2.2.
1.2 AIM AND OBJECTIVES

The main aim of this study is to investigate the extent to which the possible renovation of the existing building stock for the purposes of energy efficiency will impact on employment creation, with particular attention on the situation of developing countries.

The objectives of this study are:

i. To identify the current trends in the refurbishment of the existing building stock to improve energy efficiency, with a particular emphasis on developing countries;
ii. To identify the range of improvement measures being used and those with the best technical and economic efficiency;
iii. Provide a number of case studies of good practice in sustainable refurbishment in developing countries;
iv. To identify the main challenges for developing countries to improve the energy-efficiency of the existing building stock; and
v. To identify elements of policies and programmes which are essential to trigger a move towards energy efficiency.

1.3 METHODOLOGY AND SCOPE

This report is based on a desk-based literature review of publications and reported case studies on residential refurbishment projects that have some elements of energy efficiency amongst their objectives, in selected developed and developing countries. Particular attention is given to projects implementing different energy efficiency measures with employment creation implications. We conducted a critical analysis of this literature and case studies in order to identify the employment yields of these projects. The Netherlands was selected as representative of best practices in developed countries from which policies adopted and lessons learnt could be used to inform policy considerations in developing countries, adapted for context. South Africa and Brazil were selected as case studies in the developing countries. The choice of Brazil and South Africa as the geographical context of our study was guided by the fact that they had relatively more published information on their construction sectors in comparison to other developing countries.

One objective of the study was to identify good case study projects. A number of examplar case study projects involving the implementation of energy-efficiency improvement measures were identified within the selected case study countries. The criteria for selecting these projects were as follows:

- **Sample size and regional distribution**: At least one project from each of the case study countries was to be selected. This, however, would be based on reviewing a number of major projects from each country. The main constraint was lack of data sources as information on most projects executed in the developing world is rarely published.
- **Building types**: The focus was to be on residential buildings due to greater availability of literature and its greater contribution to greenhouse gas emissions and potential for mitigation.
- **The clarity and objective of the project**: Only projects with clear initial objectives and well documented were considered.
- **The impact of the project on the community**: The project must have impacted positively upon the community, such as community participation and/or job creation.
- **Energy efficiency**: Energy efficiency was the predominant criteria in terms of satisfying environmental sustainability concerns.

Based on the above criteria a number of exemplar case study projects were selected and information was analysed and presented under the following headings: project title, country, sector targeted, reference, project summary, sustainability issues, barriers, lessons to be learnt and general comments. In respect of project cases in the Netherlands and Brazil we could not find data on their employment effects. Nevertheless, they have been included for their holistic approach to sustainable refurbishment, particularly in terms of social sustainability effects through community development and public participation in the executed projects.

The combination of literature review and case study analysis allowed us to identify the energy improvement measures being implemented; the extent to which employment was being created; barriers to the implementation of energy improvement measures in developing countries; policies that were being adopted and potential policies that could be implemented in developing countries, by learning from the experience of developed countries.

Our exclusive focus on the residential sector was informed by the resources that were available to us in this research and the complexity of the domain, even though in some instances it has not been possible to explicitly isolate the statistics on residential outputs. Limited resources had an inevitable influence on the scope of the work as we had to limit our review to secondary material that was available. The lack of data and resources to collect data within the scope and time frame of this study meant that it was not possible to develop a model to forecast the employment potential of refurbishment for energy efficiency in the developing countries as explained in section 4.3.

### 1.4 REPORT STRUCTURE

The work undertaken is presented in the ensuing sections in this report.

In Section 2 we present an overview of climate change and its impact within the context of sustainable development. A brief introduction to the global anthropogenic greenhouse gas (GHG) emissions in the economy in general is provided. A more detailed discussion of sustainable development and relationship between social development and employment is presented. The extent to which construction industry activities contribute to climate change is examined. The significance of the construction sector and role of the industry in responding to the mitigation of the impacts of climate change through sustainable construction and refurbishment are examined. This is followed by a more focused overview of CO₂ emissions from the various end-uses of energy in buildings and the potential for mitigation globally. The energy-efficiency improvement measures currently being advocated globally to combat the impacts of climate change through sustainable refurbishment are identified through a comprehensive review of the literature and presented. Finally, a review of reported activity involving sustainable refurbishment and the potential for job creation in developing countries is presented. This presents the background knowledge against which to examine energy efficiency
policies and the overall potential for employment creation in detail through the case studies in the ensuing section.

In section 3 we present a detailed examination of energy efficiency policies and the implications for job creation. This is done by using the Netherlands as a best practice exemplar from which key policy measures and lessons learnt can be used to inform policy considerations for developing countries. A detailed examination of the existing policies in the Netherlands is presented together with an exemplar best practice project which demonstrates the outcomes of the application of these policies in practice. Armed with this best practice policy framework, an analysis of the existing situation in Brazil and South Africa together with three best practice case study projects is undertaken. This allows us to identify the types of refurbishment projects that are being undertaken with a focus on the types of jobs generated, the energy efficiency measures and overall implications on social, economic and environmental pillars of sustainable development. Elements of applicable policies that may trigger the move to energy-efficiency are suggested. Finally, we distil the results of the case studies to provide a brief overview of the barriers hindering the uptake of sustainable refurbishment in the developing countries.

In section 4 we utilise the preceding discussion to provide a detailed examination of the different types of work and skills involved in sustainable energy refurbishment activities in developing countries. This allows us to provide a number of inferences on potential levels of job creation. This is done through the detailed consideration of the different energy-efficiency improvement measures identified. Some thoughts on the potential of conducting a detailed modelling and forecasting exercise on the number of jobs that can be generated from implementing sustainable refurbishment measures, subject to the availability of data are presented. Finally, we provide a summary of the debate to show the degree to which sustainable refurbishment can provide a win-win scenario in terms of green construction, CO₂ abatement and employment generation. Through this a condensed debate is presented on the potential of sustainable refurbishment and challenges that need to be addressed in order to facilitate the greater adoption of sustainable refurbishment in developing countries.

In section 5 we bring the entire debate together by first providing a summary of the discussions undertaken and then identifying specific policy considerations for facilitating energy efficient sustainable refurbishment in developing countries and providing general concluding remarks on the overall findings, implications of the study and shortcomings of existing literature and areas for future study.
2 CLIMATE CHANGE AND THE CONSTRUCTION INDUSTRY

2.1 CLIMATE CHANGE AND CO₂ EMISSIONS

There is an overwhelming body of scientific evidence that indicates the Earth’s climate is rapidly changing due to the increasing emission of greenhouse gases (GHG) into the atmosphere. The ultimate cry from the international community has been to stabilise GHG emissions at acceptable concentration levels. This is evidenced in outcomes of a number of international conventions such as: the Kyoto Protocol and the Article 2 of the United Nations Framework Convention on Climate Change, just to list a few. For the objectives of the above conventions to be attained, sustainable policies must be put in place to manage in a sustainable fashion, human processes, practices and exploitation of natural resources. There are so many constraints rendering the implementation of policies and regulations difficult and complex. How is the stabilisation of GHG possible in a country whose interest is to boost its economy? How is the stabilisation of GHG possible in a world with a growing population and changing lifestyles with independent life styles quite common? Partial answers to these questions rest in the close examination of various sectors’ activities contributing to the emission of GHG. From recent studies by IPCC (2007), the global anthropogenic GHG emissions by sector are as follows: - waste and wastewater: 2.8%, energy supply: 25.9%, transport: 13.1%, agriculture: 13.5%, forestry: 17.4% industry: 19.4%, and residential and commercial buildings: 7.9%.

However, focusing on carbon dioxide as the least potent but by far the most plentiful and the largest contributing compound in the greenhouse effect we can note that globally at 33%, the building sector is the second largest emitter of CO₂ gases after industry (Urge-Vorsatz and Novikova, 2008). This share rises to about 40% of CO₂ emissions across EU and about 50% in UK (BRE 2007; CIBSE, undated). Partly because of its large share of total consumption of energy, the Commission of the European Communities (2006) believes that residential households have the largest cost effective savings potential of energy use. Therefore we may assume that with increasing urbanisation and rising standards of living the direct share of buildings, particularly residential dwellings, CO₂ and therefore GHG emissions in developing countries will in fact rise to a far greater extent than that indicated in the IPCC global figures. Furthermore, globally dwellings yet to be built will only constitute 15% of the total housing stock in 2020 (Beerepoot and Sunikka, 2005). Therefore, not withstanding the need for more environmentally friendly new dwellings, the greatest potential for CO₂ mitigation in fact lies in green refurbishment of existing stock rather than new build.

The developed countries generate more than half of the amount of GHG emitted into the environment. At the same time there is increasing awareness of the impacts of buildings upon the physical, social, biological as well as aesthetics environments. Therefore while we may not have yet reached the ideal state in terms of sustainable building practice in developed economies there are major institutional changes towards this goal. The latest example of this can be seen in the enforcement of the Energy Performance of Buildings European Directive (EPBD) in the European Union in 2006. In developing countries, lax environmental regimes, structural social

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1 It should be noted that different sources provide slightly different figures for shares of buildings in CO₂ emissions. For global emissions, for example, these range between 30-33 percent. In this report we have used these figures as reported by the original authors and may vary slightly in different sections. This should not detract from the overall message in terms of the importance of the building sector to CO₂ emissions and consequent mitigation policies.
and economic problems, particularly severe poverty, lack of resources and underdeveloped institutional milieus, contribute to unsustainable building practices (Melchert, 2007). This has lead to unplanned urban growth often leading to overcrowded and under serviced informal settlements, illegal occupation of land and a general neglect for environmental care issues. The resulting consequences are pollution, congestion, flooding, lack of proper sanitation, power cuts, lack of green areas and environmental-related diseases.

The emission of GHG into the atmosphere is as a result of human activities and the desire for a more comfortable life. Unfortunately, these GHG are having undesirable long-term and persistent impacts on the society as a whole (Stern, 2006; Commonwealth Foundation, 2007; Winkler, 2005; IPCC, 2007). As such sustainability concerns are no longer the pre-occupation of academics and pressure groups but have gained acceptance internationally involving heated debates on ways for devising and implementing sustainable development policies that can eventually halt and reverse global warming.

2.2 SUSTAINABLE DEVELOPMENT: WHAT DOES IT MEAN?

Yet, there are also concerns as to what does sustainable development really entail. The use of the term sustainability has now become so ubiquitous in both public and private policy discourse that it can sometimes be viewed as becoming almost meaningless in practical terms due to the many different interpretations and definitions of the terms and/or its adoption as politically expedient gestures. Indeed, it has been noted that there are over 200 different definitions of the term (Parkin, 2000). Consequently, there is a serious concern that the issue has become so vague, contested and indeterminate a concept that it is open to wide spread abuse by politicians and business people alike (Porritt 2005; Warner and Negrete, 2005). Often the term is used more as a rhetorical charade to justify status quo or absolute minimum measures that may be required by law rather than a real intention of changing their ways.

In fact the phrase “sustainable development” first came to notice in the “World Conservation Strategy: Living Resource Conservation for Sustainable Development” published in 1980 (Lee, 1994). It was, however, propelled to the front of the international policy agenda in 1987 following the publication of the report of the World Commission on Environment and Development “Our Common Future” otherwise known as the Brundtland report. However, it was five years later at the 1992 Rio Earth Summit that more than 170 countries ratified the Brundtland report and offered a more refined definition that has become the main currency in terms of sustainable development until today:

“To equitably meet developmental and environmental needs of present and future generations” (United Nations, 1992).

This definition provides direction for the subsequent inclusion of environmental considerations into broader areas of policy decision-making.

Perhaps one of the more useful and holistic definition of sustainability is that of “triple bottomline”, a phrase that was first coined by Elkington (1998) and can be defined conceptually as economic prosperity, environmental quality and social justice. While the triple bottom line was originally proposed as a form of institutionalising reporting of wider impacts of corporate activity it has proved a useful concept for examining sustainable development policy and practice at the wider societal level. This is represented in Figure 2.1 below.
Figure 2.1: ‘Three Pillars’ model of sustainable development

An important question to ask, however, is who benefits from sustainable development? The social sustainability pillar specifically points to social justice and urban equity as an important principle of sustainable development. In practice, however, social sustainability has received least attention both in the development of the conceptual discourse and praxis. Colantonio (2007) argues this is due both to the origins of the sustainability debate arising from ecological concerns of economic activities and difficulties in accurate measurement of what social sustainability actually means. As such Colantonio brings evidence from Organization for Economic Co-operation and Development (OECD) (2001) to show that up to early 2000 social sustainability was largely a peripheral adjunct as social implications of environmental politics rather than “an equally constitutive component of sustainable development (Ibid, p4).” In addition Littig and Griessler (2005) also note that the unequal treatment of the pillars is also a reflection of their treatment in the real world, that economic arguments often tend to be more convincing, and that the equal ranking of priorities is rarely an issue in the political context. Another reason can be seen in the central and local political structure and priorities and the power relations there in. In the context of UK, Hatter (2007) argues that while at the regional level major strides have now been taken to mainstream sustainable development due to the specific mandates of regional agencies, at the local level the picture is much less rosy. This he notes is due to lack of political priority sidelining and subsuming Local Agenda 21 concerns to other policy drivers with more financial and political clout, often reducing it to recycling. This is in spite of new and unprecedented powers granted to local authorities in 2000 for the economic, social and environmental well being of their areas. This he adds is largely due to the centralized nature of state in the UK reducing local governments to essentially a delivery arm of the central government.

Colantonio (2007) goes on to provide a good summary of different conceptual approaches to social sustainability and finds that there is not a set of agreed characteristics. For example some commentators such as Littig and Griessler (2005) focus on the role of work satisfying human needs while others, e.g., Stren and Polese (2000), highlight the tension between economic efficiency and social disintegration while also noting the importance of the physical environment including housing, urban design and public spaces. Yet we have other scholars such as Bainies and Morgan (2004 cited in Colantonio, 2007) that have identified thematic areas of social
sustainability as being basic needs and social wellbeing, social capital, equity and social and cultural dynamism. Other variations include (Bramley et al, 2006 cited in Colantonio, 2007) with a focus on social justice/equity and sustainability of communities’ core issues, in particular noting the importance social networks, community participation, pride/sense of place, community stability and security (crime). Some others such as Biart (2002 cited in Colantonio, 2007), however, have specifically focused on the importance of minimal social requirements for long term development or functioning of social systems while essentially ignoring the physical dimension (see Colantonio, 2007 for a more detailed review).

Considering the disparity of views on what actually constitutes social sustainability it is even more difficult to specify objectives and indicators for it. Here we agree with Littig and Griessler (2005) in that such indicators have not been grounded on theory but rather on a practical understanding of plausibility and current political agendas” (Ibid, p68). Social sustainability, therefore, is particularly context driven. This is the main reason that the international community has not adopted a single universal definition nor ascribed to one conceptual framework (World Bank, 2004).

In spite of lack of clarity on the precise definition and components of social sustainability the increasing number of studies dealing with the subject and its inclusion in the policy arena shows that in the first decade of the new century social sustainability may finally find its deserved place as an equal pillar of sustainability alongside that of environmental and economic spheres. This is reflected in Figure 2.2.

(Figure 2.2: Relative importance of main pillars of sustainable development through time)

Focusing more specifically on the urban scene we can also see the same trend is evident in the cities. Here the conceptual debate on sustainable development has now moved to fully incorporate the social dimension in a broader sense. Specifically we must highlight the concept of “just sustainability” with its emphasis on social justice in the implementation of environmental policies that was specifically developed in respect of place building in the UK and the US (Agyeman and Warner, 2002). The main argument is that the lives and communities of the poor and minority people should receive equal attention in all aspects of environmental policy, and that past injustices redressed. The point being that in their attempt to address the
bigger picture traditional approaches can “lose sight of the social and equity dimensions that are critical in meeting the needs of the present and future generations” (Agyeman and Warner, 2002, p14). In effect just sustainability propels the social pillar of sustainable development to the fore, measuring the success or failure of initiatives in the other two pillars in terms of their impact on social and equity principles. The issue addressed here, therefore, is not only sustainability but also sustainability for whom?

For example while both the developing and developed countries are being affected by global warming, there is little similarity in the level of impacts and the perception of the phenomenon. According to IPCC (2007) study on regional impacts, poor countries and communities are most vulnerable to the consequences of climate change. Among the poor communities, Africa stands to be most affected, even though the continent is the least emitter of GHG (ILO, 2007a). It is worth noting that in 2004 all developing countries together (excluding Central Asia) only produced 38% of the global CO2 emissions (CDIAC, 2008). If we exclude China and India this share is about 12%. At the same time Africa as a whole is only responsible for about 4% of the global CO2 emission. Yet it is the poorest countries, particularly Africa and Asia that are facing the worst environmental crisis manifested in droughts, rising sea levels and severe storms that are often directly impacting the cities as well as rural areas. The reasons for this are existence of limited mitigation policies, poor adaptation strategies, and high sensitivity to climate change disruptions. Consequently, internationally agreed remediation measures must take account of this disparity and provide necessary support for developing countries both to allow for their economic development needs and provide financial and practical support for implementing environmental remediation measures.

At a more local level, however, environmental justice means supporting low income and disenfranchised groups to gain better access to resources, employment and livelihood opportunities. An important facet of this is access to employment opportunities that can address poverty alleviation and access to livelihoods. Littig and Griessler (2005) provide a convincing argument for inclusion of work as a central objective and an indicator of social sustainability. They point out:

“Work – in the broadest sense (paid and unpaid labour, care work) – plays a central role for sustainability, since the satisfaction of needs—and thus the exchange between society and nature—involves mainly some sort of work. It is also the foremost organisational and structural principle of society, which is also subject to historical transformation processes” (Ibid, p71).

Social sustainability, therefore, is only achieved if work within a society and the related institutional arrangements:

- “satisfy an extended set of basic human needs,
- are shaped in a way that nature and its reproductive capabilities are preserved over a long period of time and the normative claims of social justice, human dignity and participation are fulfilled.” (Ibid, p72).

This is illustrated in Figure 2.3.
In policy terms the importance of work in social sustainability is in fact recognised by the international community in the commitments of the Copenhagen Summit 1995 that is otherwise known as the World Summit for Social Development. Significantly we can see that employment is the third most important commitment, among the ten main commitments of the summit, promoting employment as a basic priority of economic and social policy. For World Bank (2004) this means growth must lead to sustainable job creation in order to ensure that the poorer groups of society can share in its benefits.

This theme is picked up in sustainable communities currently advocated in the UK and Europe relating to thriving and diverse local economies that provide the scope for more inclusive economic development and employment for all (ODPM, 2006; Colantonio, 2007). Similarly in their discussion of social sustainability in cities Stren and Polese (2000) identify employment and economic revitalization as one of the six key policy themes that need attention by local authorities to ensure optimum employment generation both in terms of attracting investment and also ensuring that employment locations are not unduly segregated through ill thought planning, urban development and zoning policies that effectively exclude lower income and informal groups and traders from livelihood opportunities. This issue is also elaborated by Drakakis-Smith (1995) who identifies employment generation and poverty alleviation as a priority concern at the city level. Noting that in fact environmental protection is directly related to employment generation since the primary concern of poor people is to earn a living rather than look after the environment. This does not mean that poor people are not concerned with the environment rather that their priorities are firstly ensuring their own survival. Therefore without addressing the issue of employment and poverty it would be impossible to address environmental concerns.

In this context creation of increased employment opportunities through green refurbishment can be seen as a virtuous circle contributing directly both to environmental protection through
remediation measures for reducing GHG emissions and also addressing social and economic development through greater employment and income generating opportunities.

2.3 SUSTAINABILITY IN THE CONSTRUCTION INDUSTRY

The sustainability of the built environment is being addressed internationally through research, and sustainable construction initiatives. Two important cases are the Agenda 21 for Sustainable Construction in Developing Countries and UNEP Sustainable Building and Construction Initiative. The former focuses on development of a framework that can guide international and national investment in research, stimulate debate, and encourage the exchange of learning on sustainable construction within the developing world. The latter aims at addressing sustainability in the building and construction sector by: establishing global baselines for sustainable development, developing tools and strategies enabling companies to meet the afore-mentioned baselines, implementing projects, promoting and supporting the adoption of these tools and strategies by governments and other sectors influencing the conditions for the building and construction sector. The construction industry has a significant role to play in contributing to sustainable development. Thus, it is worth looking at the significance of the sector and how it is currently responding to the challenge of sustainable development through sustainable construction and refurbishment of buildings. This provides the context within which to conduct this study.

2.3.1 The significance of the construction industry

The construction sector is a key sector for sustainable development as it has a huge contribution to make to our quality of life. The construction, use and demolition of buildings generate substantial social and economic benefits to the society, but may also have significant negative impacts, particularly on the environment if appropriate considerations are not given to the entire life cycle of buildings.

The role of construction in economic development has been addressed by various writers and international bodies with many focusing on the developing countries (Wells, 1996; Wells, 2001; Ofori, 1990; Ofori, 2001). In these publications, indicators measuring construction industry development have been investigated and proven positive for developing countries. In fact the construction industry is an engine to development in both the developed and developing countries. There is a strong correlation between the per capita construction value added and the per capita gross domestic product (GDP). Construction accounts for about 45 to 60% of fixed capital formation in many countries with annual worldwide investment in the sector valued at US$ 3000 billion. However, this is particularly significant for developing countries as construction output grows particularly fast, often exceeding the rate of growth of the economy as a whole, as countries put their basic infrastructure in place during the early stages of development (Wells, 2001).

The construction sector generates 5 to 15% of the Gross Domestic Product at the national level, contributing approximately 10% of global GDP and providing approximately 7% of the world’s workplaces (ILO, 2007a). This accounts for 5 to 10% of employment at the national level, amounting to over 111 million people directly employed worldwide, with 75% in developing countries and 90% in micro firms (less than 10 employees) (UNEP, 2006a). In the UK for example, construction, building materials and associated professional services together account
for some 10% of GDP and provide employment for around 1.5 million people (DTI, 2006). Importantly for our purpose the industry is well known for absorbing unskilled labour by employing those in the lowest income brackets (Tipple, 1994). In fact the employment intensity of construction is much higher in poorer developing countries which overall are responsible for about 23% of output but 75% of the employment (Wells, 2001). As such Wells (2001) observes that the poorer and less developed countries rely more on the construction sector in terms of share of total output and employment. Noting, for example, that in India 16% of the working population rely on construction for a livelihood and in sub-Saharan Africa while precise figures are not available evidence suggests a substantial reliance on the construction sector even in the absence of economic growth. The construction sector could make an even higher contribution to the economy and social development in developing countries when the employment potential of mitigation measures for climate change is considered.

The IPPC Fourth Assessment Report (IPPC, 2007) on mitigation of climate change identifies a wide range of benefits for socio-economic development arising from possible mitigation measures. The report stipulates that sustainable development and mitigation policies can stimulate technological innovation and generate local employment. The adoption of efficient electricity production in developing countries could lead to higher employment and income generation. It further states that a 20% savings of present energy consumption in the EU by 2020 can potentially create directly or indirectly up to one million new jobs in Europe, especially in the area of semi-skilled labour in the building sector. Though the report acknowledges the lack of empirical studies on climate change, mitigation measures and its impacts on employment and incomes, literature reveals that globally, more than 100,000 workers are presently employed in solar photovoltaics. In the domain of solar thermal more than 600,000 workers are employed in China, the USA and Europe. In the domain of biomass almost 1.2 million workers are employed in just four countries i.e. Brazil, the USA, Germany and China. Overall, the number of workers employed in the domain of renewables is presently at 2.3 million (UNEP, 2008). In the absence of detailed employment information, the above figures are likely to be very conservative.

Employment prospects of building refurbishment activities are likely to be higher than those above, especially in developing countries. There are two main reasons behind this proposition: 1) the high input-output ratio between investment in construction and the total labour volume that this investment has created in some cases; and 2) initiatives driven by international commitments such as Millennium Development Goals. In their input-output modelling of the European SAVE study, Jeeninga et al. (1999) have identified that investment in the construction sector yielded twice as much labour volume than the electrical equipment sector. Moreover, one of the aims of the Millennium Development Goals is to achieve significant improvement in the lives of at least 100 million slum dwellers by 2020. This entails large scale settlement upgrading programmes for a range of activities from infrastructure and service provision to housing/building retrofits and refurbishment to improve the living environment of the residents. Given current levels of international policy attention on environmental sustainability this provides an important opportunity for including energy refurbishment activities in settlement upgrading programmes that can play a major role in new job creation. Generally, studies have revealed great potential in building refurbishment in developing countries. In Yiu Yim Chung (2007) a sensitivity analysis of the impacts of housing depreciation on sustainable development in Hong Kong reveals that a 10% reduction of housing depreciation would yield about 14% increase in GDP in a decade, and it would cost only about 2.3% of its GDP.

Construction also provides the delivery mechanism for many aspects of national government policies aimed at the provision and modernisation of a nation’s built environment – for example,
transport, housing, schools, hospitals, water, sanitary infrastructure, flood defences, and communication infrastructures. Thus, the sector is responsible for creating the foundations for sustainable development, by delivering a built environment that provides the context for social interactions as well as economic development. Hence, the economic, social and environmental benefits which can flow from a more efficient and sustainable construction industry are potentially immense.

Unfortunately, as a direct consequence of its activities, the construction industry exerts enormous demands on global non-renewable natural resources, thereby contributing significant negative impacts on global environmental concerns. The provision of buildings and structures change the nature, function and appearance of cities, towns and the countryside. Their construction, use, repair, maintenance and demolition consume energy and resources and generate waste on a scale which dwarfs most other industrial sectors. According to UNEP (2006a), taking into account its entire lifespan, the built environment is responsible in each country for: 25 to 40% of total energy use; 30 to 40% of solid waste generation; and 30 to 40% of global greenhouse gas emissions. Areas of key concern also include production of construction materials, use and recycling, consumption of hazardous materials, integration of buildings with other infrastructure and social systems, water use and discharge, etc.

Consequently, the construction sector is increasingly under pressure from society to address environmental and social concerns. In response to these demands, the sector is developing and adopting sustainable construction practices which build upon the principles of sustainable development.

2.3.2 Sustainable construction

In the main, sustainable construction must be seen in relation to the concept of sustainable development discussed in section 2.2. There are numerous definitions for sustainable construction in existing literature. One definition is that it is ‘the creation and operation of a healthy built environment based on ecological principles and resource efficiency’ (Kibert, 1994). This was an outcome of a Conseil International du Batiment (CIB) conference on sustainable construction. The CIB is an international construction research networking organization. The CIB articulated the following seven Principles of Sustainable Construction, which would ideally inform decision making during each phase of the design and construction process, continuing throughout the building’s entire life cycle:

- reduce resource consumption (reduce);
- reuse resources (reuse);
- use recyclable resources (recycle);
- protect nature (nature); eliminate toxics (toxics);
- apply life-cycle costing (economics); and
- focus on quality (quality).

The principles of sustainable construction apply across the entire life cycle of construction, from planning to disposal. Furthermore, the principles apply to the resources needed to create and operate the built environment during its entire life cycle such as: land, materials, water, energy, and ecosystems (Kilbert, 1994).

Hill and Bowen (1997) later developed the principles of sustainable construction under four ‘pillars’ - social, economic, biophysical and technical - with a set of over-arching, process-oriented principles, to be used as a checklist in practice. du Plessis (2002) takes a development
perspective and states that sustainable construction means that the principles of sustainable development are applied to the comprehensive construction cycle from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. du Plessis sees it as a holistic process aiming to restore and maintain harmony between the natural and built environments, while creating settlements that affirm human dignity and encourage economic equity.

In existing literature, the concept is usually articulated by enumerating a number of defining characteristics which if adopted by the construction industry can contribute to the sustainability of the earth. For example, the UK Department for Business and Regulatory Reform (BERR, 2007) presents its vision for a sustainable construction industry by enumerating a long list of defining features under the following headings:

- sustainable consumption and production;
- climate change and energy;
- natural resources and enhancing the environment; and
- creating sustainable communities.

Whilst there is no commonly accepted definition of the concept of sustainable construction, it encapsulates the comprehensive application of the principles of sustainable development throughout the lifecycle of build assets.

The sector has embarked on projects and partnerships in several countries to improve sustainability performance. A number of tools and rating systems have been created in order to assess and compare the environmental performance of buildings, such as LEED, developed in the United States, BREEAM, in the UK or HQE, in France. These initiatives are already having considerable impacts on how buildings are designed, constructed and maintained. For example, activities of the United States Green Building Council have contributed to support the expansion of the green building market in the USA to an estimated US$ 33 billion in 2004 (UNEP, 2006a).

Currently, energy saving measures and the reduction of CO₂ emissions are at the top of the global political agenda. With buildings accounting for more than 40% of all CO₂ emissions, the construction industry has an important role to play in ensuring energy efficiency in the built environment. Over the last decade, the sector has largely focused its sustainable construction endeavours on projects involving the construction of new buildings but the sustainability focus is now shifting to sustainable refurbishment of the existing building stock for reasons presented in the ensuing section.

### 2.3.3 Sustainable refurbishment

It has been widely recognised that the greatest potential to reduce carbon emissions is in the existing building stock. The reason for this is that existing buildings will comprise the vast majority of buildings far into the future and the majority of these are not of a high environmental or energy efficiency standard. The United Nations’ Intergovernmental Panel on Climate Change report (IPCC, 2007) indicates that there are significant opportunities for carbon emissions mitigation in both new and existing buildings. According to IPCC, 30% of the expected global growth in emissions related to buildings before 2030 could be avoided with economic benefit. The report also finds that, although new buildings present opportunities for the most energy savings per building, existing buildings represent a greater opportunity for energy savings overall.
In the UK domestic building sector for example, there are currently around 21.8 million homes in England across all tenures (CLG, 2005) and contributing 27% of all emissions. New building makes up less than 1 per cent of the total stock in any given time (CLG, 2005). At least 75 per cent of the homes that will exist in 2050 have already been built (SDC, 2006). Carbon emissions from existing homes are therefore seen to be of greater significance than those from all the new homes that will be built by then (CLG, 2007). It has been estimated that refurbishment of existing homes to high environmental standards is relatively low-cost, representing between a tenth and a quarter of the cost of new build (CAR, 2003). Homes need periodic reinvestment and modernisation plus major refurbishment every 20-30 years, requiring about 1% of capital value at current market levels each year to be spent. Energy efficiency has been identified in the UK Government’s Energy White Paper (DTI, 2003) as the cheapest, cleanest, safest way of reducing carbon emissions. Existing housing may be refurbished to a high standard of energy efficiency and this has clear benefits to occupants through improved comfort and reduced running costs. Refurbishing properties back into use has fewer environmental impacts than building new homes and such properties will also be located near to existing facilities and infrastructure (HMT-ODPM, 2005).

In the UK non-domestic building sector, the rate of replacement of the building stock is also slow. Rates of replacement vary widely from place to place and are driven by local economic conditions and regeneration policies. It is difficult to estimate how much of the existing stock would be replaced by 2050, but at current demolition and new-build rates it is likely to be around 30 per cent (UKGBC, 2007). Existing building stock must be tackled if currently stipulated targets for carbon reduction are to be met. In addition, there are carbon implications associated with water usage and treatment, waste production and treatment mechanisms, the embodied energy of the materials used, construction strategies, the recyclability of the materials used at the end of the life of the building and the carbon implications of the logistics of servicing the building.

2.4 GLOBAL CO₂ EMISSIONS FROM ENERGY USE IN BUILDINGS AND POTENTIAL FOR MITIGATION

Climate change is a major concern to the construction industry because energy use in buildings is a significant source of GHG emissions and the resulting extreme climatic conditions will result in significant impacts on buildings. According to the IPCC (2007) report the building sector was responsible for 8.6 GtCO₂ emissions in 2004. The report presents two scenarios which project these emissions to 11.4 GtCO₂ (the B2 Scenario of lower economic growth) and 15.6 GtCO₂ (the A1B Scenario of rapid economic growth, particular in developing nations) emissions in 2030, representing an approximately 30% share of total CO₂ emissions. In OECD countries, buildings account for about 35–40% of national CO₂ emissions from the use of fossil fuels. In developing countries, coal and biomass are significant sources of energy for heating, invariably with significant adverse effects on the building occupants. The significant fluctuations in extreme hot and cold temperatures, with increases in the intensity of tropical storms or in the intensity of heavy rainfall events, will directly affect buildings. Although heating energy use will decrease in cold climates, the demand for cooling will increase. At the same time, many of the passive and low-energy techniques for cooling buildings that are needed to reduce the contribution of buildings to GHG emissions (such as evaporative cooling, or night ventilation) will become less effective as heat waves become more intense and longer-lasting (Urge-Vorsatz et al., 2007).
Urgent mitigation action is therefore needed to reduce energy use in buildings – both in the
design of new buildings and through the refurbishment of existing buildings that together
provide the greatest low-cost mitigation opportunities among all economic sectors (IPCC Report,
2007). Thus, the construction sector is fundamentally important for any climate change
mitigation effort.

A recent study by Urge-Vorsatz and Novikova (2008) indicates that the greatest economic
potential (at net negative costs) for mitigating CO₂ emissions in buildings in fact lies in
developing countries. This is due to the fact that many of the low cost opportunities for CO₂
abatement have already been captured in the more developed economies due to progressive
policies in place or in the pipeline. As such the report estimates that by 2020 globally 29% of the
projected baseline emissions can be avoided cost effectively through mitigation measures in
buildings. However, developing countries have the largest cost effective potential abatement with
up to 52% of the total reduction, transition economies with up to 37% and developed countries
up to 25% (ibid). It is also worth noting that in developing countries the largest CO₂ mitigation
potential results from savings in use of electricity appliances where as in developed countries this
saving is gained from space and water heating-oriented measures. The former is seen to be rather
less complicated in terms of switching to more efficient appliances with quick payback periods
while the latter involve shell retrofitting and fuel switching that are often more expensive and
require longer payback periods.

2.4.1 An overview of energy end-uses in buildings

In order to assess the potential areas of energy efficient refurbishment of buildings, it is
important to identify the different kinds of energy end-uses in the residential and commercial
sectors in different climates where such information is available. Urge-Vorsatz et al. (2007)
presents a breakdown of energy end-use in residential and commercial buildings in the United
States (US), Canada and European Union (EU) whilst the IPCC Report (2007, chp. 6) presents a
similar breakdown of energy end-use in the US, based on more recent sources of information.
Thus, the figures presented in Urge-Vorsatz et al. for Canada and the EU and those presented in
the IPCC Report for the US have been used to present the energy end-use breakdowns in Figure
2.4, representing typical end-uses in developed countries.

Space heating represents the single largest use of energy in residential buildings in these regions,
followed by water heating. Space heating also represents the single largest use of energy in
commercial buildings in both Canada and the EU, accounting for up to two-thirds of total energy
use. Lighting is the largest single use of electricity in commercial buildings in the US. Water
heating is not significant in commercial buildings in the developed countries.
Figure 2.4: Breakdown of residential and commercial use in the US, EU, and Canada

The IPCC Report (2007, chp. 6) presents a breakdown of energy end-use in China as indicated in Figure 2.5. It presents a breakdown of energy end-use in the residential and commercial sector for China, an economy in transition. The single largest end-use of energy in residential buildings in China is space heating, followed by water heating, and electric appliances. The largest energy end-use in commercial buildings in China is space heating, followed by water heating, lighting, and cooling.
It has not been possible to obtain recent figures for energy-end uses from developing countries. The work of Poole and Geller (1997) provided data for Brazil and the Energy Outlook for South African report (EOSA, 2002) provided relatively recent data on the residential sector only for South Africa as indicated in Figure 2.6. The pattern of energy use in these developing countries is different for each country. The largest end-use in the residential sector in Brazil is refrigeration, followed by lighting and water heating. Cooking is largest end-use in the residential sector in South Africa followed by space heating. Lighting is by far the single largest use in the commercial sector in Brazil, followed by air conditioning and refrigeration. The differences in hot and cold climates in this two countries account for the disparity in end-uses.
The differences in the energy consumption patterns between representative developed and developing countries can best be compared by ranking the end-uses as shown in Table 2.1. Notice that there is a remarkable difference between the consumption pattern in the developed countries and the developing countries. Space heating and water heating top the lists in the US, Canada and the EU. However, energy used in cooking tops the list for South Africa and Mexico whereas refrigeration energy consumption tops the list for Brazil. Overall, it is not straightforward to establish a clear pattern in household energy consumption in developing countries. This is largely due to the disparity in climatic and weather factors which necessitate the partitioning of a country into smaller units in order to obtain a clearer picture.

### Table 2.1: Rank of residential energy consumption pattern in selected countries

<table>
<thead>
<tr>
<th>End-Use</th>
<th>Developing countries</th>
<th>Developed countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>²Mexico</td>
<td>³Brazil</td>
</tr>
<tr>
<td>Cooking</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Space heating</td>
<td>///</td>
<td>///</td>
</tr>
<tr>
<td>Water heating</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Lighting</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Electronics</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Refrigeration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air conditioner</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Space cooling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clothes dryers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furnace fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appliances</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Washing machines</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


### 2.4.2 Mitigation through sustainable refurbishment measures

The choice for renovating existing buildings or constructing new buildings depends largely on individual cases in different regions. However, there is enough evidence that there is a huge potential in energy savings in the renovation or refurbishment of existing buildings than constructing new buildings. As already noted in the near to medium future (at least up to 2020) new build will only comprise 15% of total housing stock inevitably focusing attention on refurbishment of existing stock as the main route for addressing targets on CO₂ abatement. In addition studies carried out by the European Alliance of Companies for Energy Efficiency in Buildings (EuroACE) shows energy saving potential of over 50%, while Danish studies show energy saving potential of 40-60% (Bach, 2006) if energy efficiency measures are implemented. Most renovation projects have brought wider benefits to the community than just energy savings. Technical, financial, well-being, environment and employment are some major benefits that can be reaped from refurbishment projects. From some notable refurbishment projects in both the
developed and the developing world there is no doubt that refurbishment can be used as an engine to drive development.

A review of literature reveals that a raft of improvement measures for sustainable refurbishment is being recommended for both domestic and non-domestic buildings (EBN, 2007; RICS, 2007b, 2007c; and Smith, 2004) in hot and cold climates worldwide. Typical measures identified from the literature are summarized in Table 2.2.

**Table 2.2: Global improvement measures for sustainable building refurbishment**

<table>
<thead>
<tr>
<th>Category</th>
<th>Improvement measures</th>
</tr>
</thead>
</table>
| Energy - Building Fabric and Envelope | Air-seal foundations  
Moisture-proof basement/insulate walls  
Draught proofing/air-seal building  
Building fabric - external wall insulation enhancement  
Upgrade windows/enhanced glazing insulation  
Modify windows/shading devices to reduce heat gain and solar controls  
Insulate floors  
Insulate roofs  
Make roof reflective |
| Energy – Mechanical and Electrical Systems | Install energy efficient lighting and appliances  
Install energy efficient heating  
Install energy efficient ventilation  
Optimize pipe sizes  
Optimize ducts  
Upgrade pumps  
Upgrade chillers  
Install energy efficient appliances |
| Energy - Renewable Energy Sources     | Install solar water heating  
Install combined heat and power (CHP).  
Install ground source heating and cooling pumps (GSHP).  
Install micro wind turbines  
Install photovoltaic |
| Water Efficiency Measures            | Install water consumption meters  
Install water management plan  
Install rainwater recycling  
Install dual flush toilets  
Install reed bed water treatment  
Install water efficient devices/fittings  
Drainage irrigation |
| Waste Reduction Measures             | Select carpets with high level of recycled content  
Select vinyl flooring with high level of recycled content  
Selection of carpet underlay with up to 100% recycled content  
Use plasterboard containing high levels of recycled material  
Use recycled building materials  
Use recycled internal features |
<table>
<thead>
<tr>
<th>Sustainable Facility Management</th>
<th>Install building energy management system (BEMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Implement efficient maintenance strategies</td>
</tr>
<tr>
<td></td>
<td>Implement energy efficient policies and staff awareness and training</td>
</tr>
</tbody>
</table>

2.5 OVERVIEW OF SUSTAINABLE REFURBISHMENT AND POTENTIAL FOR JOB CREATION IN DEVELOPING COUNTRIES

This report examines the opportunities for jobs creation within the building sector in the developing countries arising from the measures taken by these countries in fighting and adapting to climate change and its impacts. In Europe the “Energy Efficiency in the Refurbishment of High-Rise Residential Buildings” project funded by the International Energy Agency and EuroACE, carried out by the Association for the Conservation of Energy created additional jobs for the community (EuroAce, 2007). This project was executed in Bulgaria, Hungary, Latvia, Portugal, Russia and the United Kingdom. In a similar fashion the “Johannesburg Housing Company” project in South Africa (World Habitat, 2006) and “Building Restoration for Social Housing Purposes-Celso Garcia, 787” project in Brazil (World Habitat, 2004) have been of immense benefit to both communities. In addition to employment creation, we can also note community or tenant involvement in decision making and implementation of the refurbishment projects. Other benefits were, rendering the buildings energy efficient, hence, a reduction in energy bills and provision of affordable housing to the community.

In the developed countries, studies show that a greater portion of energy used in the life cycle of a building constitutes operational energy (Sartori and Hestnes, 2007; Jones, (cited in UNEP, 2007)). In developing countries operational energy is used for cooking and lighting by means of burning wood or other biomass (UNEP, 2007). One may argue that using biomass in this way does not contribute to climate change. However, large scale exploitation of biomass may be questionable due to unsustainable harvesting and respiratory effects on households as a result of greater internal pollution and poor ventilation. There is no doubt that operational energy has received substantial attention from the research community. There have been debates and studies on how to reduce or minimise operational energy in buildings yet maintaining the indoor quality and energy performance standard of the building envelope. The outcome of these debates has often left professionals with the options of total building demolition for a new built or refurbishment of the existing building envelope. Current studies demonstrate that the latter is the better technical alternative (Roger et al., 2002; Yohanis and Norton, 2002) as it has a lower environmental impact.

Economically, studies have shown that the costs of construction through energy efficient refurbishment do not increase substantially (it is in the order of ~3-5%) (UNEP, 2007). In both
the developed countries and the developing countries, the refurbishment of buildings is central to the debate on climate change. Policy makers on climate change are advocating refurbishment of existing buildings, construction of very highly energy efficient buildings and adaptation as preventive measures among others as ways of fighting climate change. Not only is refurbishment a curative, technical, economic and environmental solution to improving the performance of existing buildings, it is being seen as a key solution to one of the societal problems in the developing world i.e. unemployment. It can be argued from the labour point of view that refurbishment is going to be a “job provider” rather than a “job killer” as claimed by many sceptics in terms of impact of environmental mitigation measures on the economy. Although, there are indications that energy efficient refurbishment of existing building stock presents a good opportunity for job creation, there is a lack of detailed studies on developing countries demonstrating these potential. Through a review of existing literature on developing countries, 9 refurbishment projects involving aspects of energy efficiency improvement have been identified and are presented in Table 2.3 with an indication of the extent to which jobs were created in each.

### Table 2.3: Refurbishment projects and job creation in developing countries

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Country</th>
<th>No of jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Building Restoration for Social Housing Purposes, Celso Garcia, 787</td>
<td>Brazil</td>
<td>Created jobs but no figures</td>
</tr>
<tr>
<td>Recycling of derelict building, installation of efficient lighting system and natural ventilation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2Ekurhuleni, Municipal buildings retrofit project</td>
<td>South Africa</td>
<td>Provided jobs</td>
</tr>
<tr>
<td>Installation of efficient lighting systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3Johannesburg Housing Company(JHC)</td>
<td>South Africa</td>
<td>At least 1000</td>
</tr>
<tr>
<td>Use of energy-efficient light bulbs and day-night sensors, solar energy system for heating water, and insulation of boilers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4Watergy, Soweto</td>
<td>South Africa</td>
<td>Over 1500 temporal jobs</td>
</tr>
<tr>
<td>Rehabilitation of plumbing fixtures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5Energy retrofit of Khayelitsha housing</td>
<td>South Africa</td>
<td>7 person-years during the construction phase. Could potentially create up to 508 person years.</td>
</tr>
<tr>
<td>Installation of solar water heaters, compact fluorescent light bulbs or energy efficient lamps and insulated ceilings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6Botswana Renewable Energy Project</td>
<td>Botswana</td>
<td>Creating jobs but no figures</td>
</tr>
<tr>
<td>Installation of solar powered heating systems and lighting appliances in 88 off-grid villages, installation of domestic cooking gas system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7Solar Energy Support Programme</td>
<td>Nepal</td>
<td>700 sales jobs, 700 people trained as technicians and</td>
</tr>
</tbody>
</table>
Unfortunately, due to a lack of sufficient information it has not been possible to identify the quantity and types of employment created in all cases. However, Table 2.3 gives an indication of the nature of green jobs created through refurbishment projects. The multiplier effects have not been considered, and energy savings which could be converted to jobs is not mentioned. A more generalised view is needed to understand and draw conclusions about developing countries with respect to green jobs creation. This generalisation could be established through the analysis of the existing building stock in the developing countries and the ways in which the building stocks could be refurbished or rendered more energy efficient. An examination of the roles of stakeholders (general contractors, specialist contractors and qualified personnel) is also important. In this report, a more detail study is undertaken on two countries in the developing world. These are South Africa and Brazil.
3 ENERGY EFFICIENCY POLICIES AND EMPLOYMENT IMPLICATIONS

Within the framework of this project, energy efficiency policies refer to the set of activities directed by the government, competent authority, funding agent that aim at improving or maximising energy efficiency in existing buildings through enabling instruments and interventions. Most developing countries are yet to develop concrete energy efficiency policies. South Africa for example, developed its first energy efficiency strategy just about two years ago (DME, 2005a). However, the development and application of energy efficiency policies is relatively well advanced in developed countries. In this report, the Netherlands has been selected as a best practice case study from which the developing countries could learn. South African and Brazil have been selected as case studies representative of developing countries. The energy efficiency policies of these two countries are analysed drawing largely on information from the Department of Minerals and Energy (2005a) for South Africa and Geller et al. (2004) for Brazil.

3.1 THE NETHERLANDS BEST PRACTICE CASE STUDY

From an environmental and economic point of view, sustainable building is strongly related to energy. The Dutch have long recognised these intertwined concepts and have been maintaining a perfect balance in their sustainable building and energy policies. In a comparative study of five European countries by Sunikka (2002), it was established that the Netherlands was an international reference with respect to its well established policy for sustainable building. In the National Dubo Centrum (cited in Melchert, 2007, pp894), the Netherlands has achieved a worldwide benchmark sustainable building approach. From all the above there is no doubt as to why the Netherlands is a frontrunner when it comes to sustainable procurement in Europe (EEAP, 2007). In terms of energy efficiency the Netherlands is the only country beside Norway almost satisfying Article 6 on Minimum Energy Requirements of Existing Buildings of Energy Performance Directives (EPD) (EPD, 2003). A recent Royal Institution of Chartered Surveyors (RICS) status report on the implementation of Directive 2002/91 on the Energy Performance of Buildings (EPBD) in the EU Member States indicates that there had only been five full implementations at the time of publication (RICS, 2007a). One of these is Netherlands. We shall draw on the Netherlands experience in institutionalising and facilitating sustainable refurbishment in more detail to inform possible policy considerations for developing countries.

Most projects in the Netherlands and the developed world at large do not particularly target employment directly. In most situations the goal is to satisfy the needs of the residents such as energy efficiency and water conservation among others. Hence in most projects published information gives little or no indication on job creation but information on energy, economic, social and environmental benefits are quite common.

Several refurbishment projects were reviewed for the identification of various refurbishment activities. Some notable ones are the Green projects (The Green Funds Scheme, 2005), Tarweweveld/Gersteveld (Donekelaar, 2007) and the Tuindorp Kethel (Building and Social Housing Foundation, 2006). Though all the above projects fulfilled the criteria set earlier, Tuindorp Kethel was chosen as the exemplar case study because of its comprehensive report and
availability of some important statistics. The Tuindorp Kethel project also falls perfectly into one of the categories (Sustainable Construction with emphasis on energy efficiency) of the Green projects.

3.1.1 Exemplar case study project – the Netherlands

Box 1: Tuindorp Kethel

<table>
<thead>
<tr>
<th>Project title</th>
<th>Tuindorp Kethel refurbishment projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Reference</td>
<td>Building and Social Housing Foundation (2006)</td>
</tr>
<tr>
<td>Sector targeted</td>
<td>Residential</td>
</tr>
</tbody>
</table>

**Project Summary**
This project involves the renovation of Tuindorp Kethel, a post-war garden village of 241 low-cost single-family houses built using pre-fabricated construction systems. Rather than demolishing the deteriorated estate, a sensitive refurbishment process was carried out, improving energy efficiency and addressing the needs of individual properties. Residents were involved throughout the renovation process, from the design stage through to the final construction stage. The following activities were undertaken in the project: the use of a pre-fabricated fibre-cement cladding system\(^p\), the decoration\(^p\) of the occupants’ front doors, the replacement\(^w\) of doors. Before the project began an extensive resident consultation\(^p\) process was carried out from the outset of the project and continued throughout its development. This included the production and distribution of a regular newsletter. A small school building on the estate was used as a project information centre where residents’ meetings were held.

**Sustainability**

**Economic:** Had the demolition route been taken, there would have been a significant increase in the rents that residents may not have afforded.

**Social:** In executing this project the residents were involved which led to a strong social cohesion, and this would have been lost had the demolition option been taken. Improved energy efficiency and the removal of damp and water penetration imply that residents are warmer and healthier than before.

**Environmental.** Refurbishment as an alternative to demolition and new build avoided huge expenditure on energy and materials that would have been transported to the site. Replacement of boilers with more efficient ones improve upon energy efficiency. External insulation was also undertaken. Energy is saved in the overall process of refurbishment.

**Barriers**
There were few barriers encountered in the project which on balance ran very smoothly, apart from some scheduling and delivery problems which led to some time overruns.

**Lessons learnt**
Involving residents is vital, as is attaching value to the improvements they have made to their homes.

**Comments**
\(^w\) This stands for the different types of energy efficient refurbishment works in an existing building. This will be used later on in the development of a framework of the types of energy efficient refurbishment works.

\(^p\) This highlights the different policies that were involved during the execution of
the project. The policy instruments are:
1) Information awareness: Information and general awareness are key components to achieve success in any project especially refurbishment projects. Tenants needs to brief on the duration of the project, the importance of the projects (the saving potentials) , health and safety issues and above all their willingness to participate in the design and execution of the project. It is only by integrating the ideas from a tenant who must have lived in the building before refurbishing the building can one be sure of the optimal functionality of the building and its services.
2) Technology: technological options represent a significant potential for energy efficiency improvements. In this project efficient boilers and high insulation were introduced.

NB: The policies enumerated above are those that have been deduced, there are definitely others but within the limitation of this literature source nothing more can be said about other policies.

3.1.2 Energy efficiency policies – learning from the Netherlands

This section reviews policy options regulating residential buildings in the Netherlands and how the various policies could be applied to the developing countries. Inspiration was also gained from the projects reviewed and the policies noted.

3.1.2.1 Legislative framework applied to buildings

As earlier argued in Melchert(2007), developing countries have relatively lax environmental regimes. Furthermore the legislative framework applied to the construction industry lack rich environmental content, norms and standards. If they do exist, they do not go beyond minimum requirement. The Dutch Sustainable building policy (Huovila, 1999; VROM, 2007) offers certain advantages for the developing countries to emulate. It demonstrates the possibility of integrating financial, environmental and legal objectives within the built environment without necessarily changing the technologies that are already in place, but rather by refining the environmental content. Another aspect of the Dutch construction industry is the Housing Act, which covers all aspects of buildings and housing. This act obliges municipalities to set up specific regulations for buildings and refurbishment. This is a good Act for developing countries to use as an inspirational model and redefine their policy content to include refurbishment.

3.1.2.2 Financial framework

The developing countries have a lot to learn from the Dutch in terms of the application of financial measures in the conservation of energy in the residential sector. Some of the financial measures used by the Dutch are: energy investment deduction; grants for energy savings; and energy premium.

Energy investment Deduction
This is a tax scheme that aims to save energy by stimulating investment in energy efficient assets and renewable technologies (SenterNovem / Ministry of Finance, 2007; Donkelaar et al, 2006). This policy is similar to the Tax Reduction for Investments in Energy Saving Equipment and Sustainable Energy. Considering the limited number of stakeholders in the developing countries
in the energy efficiency markets and also the scepticism held by financial institutions about the energy efficiency markets, they could be encouraged to participate more actively through the Energy Investment Deductions (EID) schemes.

**Grants for Energy Savings**

These are subsidies for grants of energy saving measures such as insulation of existing dwellings (Donkelaar et al, 2006). An example is the National Insulation Program which was operated from 1978-1987. These grants ended in 1982 for owner occupied houses while for rental houses it continued till 1987. This is an appropriate example that can be applied to developing countries especially in Sub-Saharan Africa where most houses are owned by individuals or rented from private landlords.

**Energy premium**

From 2000 to 2004, the Dutch Energy Agency ran the Energy Premium Scheme. This scheme was for energy saving measures in existing buildings. In this scheme, the energy performance of an existing building is evaluated and an Energy Index awarded (Donkelaar et al, 2006). This energy index depended on a number of energy saving measures, and if any of these measures were implemented in an existing building, it was eligible for a grant. This again could be applied to developing countries. In situations where energy performance of buildings are lower than expected, house owners will be obliged to embark on energy efficiency refurbishment.

### 3.1.2.3 Stakeholders or market players

The developing countries energy efficiency markets are characterised by a limited number or lack of market players, lack of experience by Energy Services Companies (ESCOs), lack of knowledge of the market by financial institutions, lack of proper organisation and definition of responsibilities. This may be attributed to the complex nature of sustainable energy efficiency with various practitioners involved with no clear boundaries of responsibilities. The above characteristics are clearly exhibited by the South African and Brazilian energy efficiency market.

The Dutch sustainable building market had also been characterised in a similar manner. Though not necessarily with few market players and lack of experience, but many stakeholders or actors engaged into pushing the sustainable building agenda in different directions generating confusion and superposing responsibilities. This generated a lot of confusion within the Dutch building industry. The Dutch government intervened by introducing a homogenized prescription framework through the National Sustainable Building Packages (VROM, 2007). These packages clearly defined the roles and attitudes of every market player within the Dutch construction industry.

The Dutch example can serve as a guide for the developing countries. Developing sustainable energy refurbishment packages with clear definition of roles and responsibilities of actors can help overcome some of the problems arising from lack of experience of actors facing the energy efficiency markets of the developing world.

---

2 The purpose of ESCOs is to eliminate barriers for all stakeholders in order to facilitate the development and the implementation of measures that reduce the energy consumption costs. Their responsibilities in most countries are: to sell energy services, manage energy saving activities, meet clients needs to reduce costs, improve energy efficiency, manage risk, undertake energy audits, offers financial mechanism, equipment procurement, installation and is the principal overseer of other parties involve in energy efficiency businesses.
3.1.2.4 Information awareness
In order to ensure dynamism amongst stakeholders, there should be information flow; knowledge should be shared amongst key players. As explained above the Dutch National Sustainable Building Packages contain information for all stakeholders involved in the Dutch sustainable building market. Furthermore in the Tuindorp Kethel project, information about the project was passed through consultative talks to the residents. In some other cases such as the JHC, workshops and training were used to raise community awareness. These are examples for other developing countries to emulate.

3.2 SOUTH AFRICA CASE STUDY

In order to ascertain the extent to which energy efficient refurbishment can lead to jobs creation it is important to review energy demands in buildings, the existing building stock level, and the role of the potential stakeholders. In this case study, the energy market players, energy use trends, building refurbishment trends, and an exemplar project are analysed to determine the energy efficiency market potential and the types of employment opportunities.

3.2.1 Energy market structure and players

The South African energy market in general is characterised by a number of players involved in the following activities: energy supply, conversion, efficiency and regulation. The Department of Mines and Energy (DME) is playing a leading role in the domain of South African energy market. With matters pertaining to energy regulations, the National Energy Regulator (NER) formed in 2005 is in charge. In the same year, the Renewable Finance and Subsidy (REFSO) was formed marking a turning point in the energy sector as a whole. The Energy Services Company (ESCO) although not new in South Africa, is dominated by the monopoly position of ESKOM- the South African public utility company with limited experience to carry out the broad range of ESCO activities in spite of its huge scale of operation at the Southern African regional level. There is also lack of a special agency for energy efficiency.

3.2.2 Energy demand trends

There are five main uses of residential energy in South Africa: cooking, lighting, space heating, water heating and others (TV, radio, fridges, etc). The various consumption levels are shown in Table 3.1. The residential energy demand stands at 17% (EOSA, 2002) and like the world energy demand, there are indications of an increasing trend as shown in Figure 3.1.

Table 3.1: South African Residential Energy Consumption

<table>
<thead>
<tr>
<th>Residential Energy Consumption(PJ): Year 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooking</td>
</tr>
<tr>
<td>Lighting</td>
</tr>
<tr>
<td>Space heating</td>
</tr>
<tr>
<td>Water heating</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
Notice from Table 3.1 that after cooking, space heating consumes more energy. Research carried out by Holm (cited in Winkler, 2006a) reveals that most thermal energy in South African houses escapes through the roof. Spalding-Fecher et al (2002) argues that the single most effective intervention in the building shell is the installation of a ceiling. Furthermore Holm (cited in Winkler 2006a) states that space heating could be eliminated through proper insulation, orientation and ceilings. This is an indication that work related to roof insulation is an important element in green refurbishment and therefore could be a significant potential job provider.

![Figure 3.1: Projected energy demand by end use in South Africa](image)

**3.2.3 Building refurbishment trends**

In this report it has been impossible to specifically state the exact components of home improvement. In the literature, refurbishment, renovation, or home improvement is used without directly specifying if such an activity was geared towards, energy efficiency. However in most attempts to undertake refurbishment one indirectly undertakes energy efficiency measures. In Table 3.2, there is nothing mentioned on thermal insulation or energy efficiency refurbishment but we can infer from the building materials bought in these projects (BMI Building Research Strategy Consulting Unit CC, 2006), that sustainable energy efficiency made up a greater component of the home improvement activity. Furthermore, refurbishment activities in general and in particular in developing countries would hardly involve the structural alterations of the building fabric except in case of adaptive re-use; services such as electrical wiring, plumbing, painting, insulation, roof maintenance generally characterise refurbishment activities in developing countries.
Table 3.2: Estimated size of home-improvement market by Living Standards Measures Group (LSM): 2006

<table>
<thead>
<tr>
<th>LSM*Group</th>
<th>No. of households in RSA (x1000)</th>
<th>%</th>
<th>H.H. income Rand/month</th>
<th>% improving home</th>
<th>No. of households improvement (x1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1-6</td>
<td>7,856</td>
<td>71.61</td>
<td>R2 401</td>
<td>5.63</td>
<td>442</td>
</tr>
<tr>
<td>Group 7</td>
<td>888</td>
<td>8.09</td>
<td>R6 971</td>
<td>18.00</td>
<td>160</td>
</tr>
<tr>
<td>Group 8</td>
<td>661</td>
<td>6.03</td>
<td>R9 234</td>
<td>20.60</td>
<td>136</td>
</tr>
<tr>
<td>Group 9</td>
<td>810</td>
<td>7.38</td>
<td>R12 901</td>
<td>24.90</td>
<td>202</td>
</tr>
<tr>
<td>Group 10</td>
<td>755</td>
<td>6.88</td>
<td>R20 362</td>
<td>37.00</td>
<td>279</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10,970</td>
<td>100</td>
<td>R5 314</td>
<td>11.24</td>
<td>1,219</td>
</tr>
</tbody>
</table>


From Table 3.2, 1.219 million household representing 11.24% undertook home improvement of more than R1000 in the year 2006. It should be noted that there is a large component of unrecorded building activity in home improvement, additions and alterations in the residential sector (BMI Building Research Strategy Consulting Unit CC, 2006). Furthermore 37% of LSM Group 10 (279 000 households) undertook home improvement of more than R1000 in the year 2006. LSM Group 10 is a group of people with high living standards, earning high income and has the tendency of not doing these jobs by themselves, thereby giving it out for the poor to execute.

The South African government is intending to invest the sum of R400 billion on infrastructures over the next few years (BMI Building Research Strategy Consulting Unit CC, 2006). This includes both in new and existing buildings. The same study also estimates that for every R1 Million invested in building, 4.26 jobs are created directly in the building industry. We can, therefore, infer that there are 1.7 million jobs that can potentially be created in the South African Construction Industry from the building sector over the period of the investment. Though it has not been possible to explicitly disaggregate the percentage of the home improvement market associated with sustainable energy efficiency refurbishment from this figure, the estimates for the sector look promising from 2008-2015 (see Figure 3.2).
Figure 3.2: South African home improvement market

Taking the cumulative investment from 2008-2015, the total projected investment in home improvement is R196.65 billion. If we again use the above noted ratio of investment to job creation in the South African building industry we would have around 837,750 jobs created over the estimated 7 year period.

We must acknowledge that these estimates of potential job creation seem rather over optimistic. However they are based on findings of an official report for the Construction Industry Development Board in South Africa. In spite of this we may want to be cautious in accepting them at face value. Particularly, as other reports indicate much lower employment expectations for major investments in other related sectors in South Africa. In particular we can note the R124 billion investment in the electricity and transport networks that is expected to produce only 55,000 jobs over a five year period (Business Report, January 23, 2006). Nevertheless, even if we are unsure about exact employment figures we can be certain that the planned investment in construction and refurbishment will have an important employment effect that will be much higher than other sectors considering earlier discussions on the employment function of construction industry.
### 3.2.4 Exemplar case study projects – South Africa

**Box 2: Johannesburg Housing Company (JHC)**

<table>
<thead>
<tr>
<th>Project title</th>
<th>Johannesburg Housing Company (JHC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>South Africa</td>
</tr>
<tr>
<td>Reference</td>
<td>World Habitat (2006)</td>
</tr>
<tr>
<td>Sector targeted</td>
<td>Residential</td>
</tr>
</tbody>
</table>

**Project Summary**

This project involved the development and adaptive re-use of city-centre buildings to deliver mixed-tenure, energy efficient affordable rental housing whilst acting as a trigger for the regeneration of the surrounding area. To date JHC has provided 2,700 homes in 21 buildings, adding a further eight per cent to the residential stock of Johannesburg’s inner city. The buildings involved in this project were the remnants of the old apartheid regime which had been abandoned to slum landlords and gangsters. Little or no maintenance was done to the buildings and thus it deteriorated leading to extreme poor water, electric and sanitation facilities among other problems. Refurbishment of derelict buildings and the conversion of offices and hotels into residential space were carried out (water systems, electrical refits including new efficient boilers, lighting installations and in some cases solar systems, installation of sanitation facilities, breaking and rebuilding of partition walls, etc). In this project community workers were employed to help build capacity for community empowerment. Training programmes and social support (e.g. crèches for working mothers) were also provided. At the end of the project contracts are being awarded for the management and maintenance of the residential buildings.

One important aspect of this project was the involvement of the residents in decision making, design and the execution of the projects. Thus the awareness of what was going on, the knowledge of the project and its benefits was established from a financial point of view, the project was financed from different sources:

- Housing subsidy worth R35 million (US$4.67 million) by the South African government
- Donation of R62.6 million (US$8.3 million) over a five year period as start-up funds by the European Union
- Donation of R13 million (US$1.73 million) by the Flemish Regional Government
- Commercial Bank loans of R55 (US$7.33 million)

**Sustainability**

**Economic:** This project provides jobs for over 1000 contractors in maintenance, cleaning and security services and even more in specialised functions such as plumbing and electrical services.

**Social:** This building houses different ethnic groups as well as non-South Africans thus encouraging multi-cultural integration. It is evidenced by the fact that today; over 400 youths are involved in inter-building soccer and netball leagues which was not common before.

**Environmental** Initiatives had been included to efficiently manage energy consumption such as: insulation of boilers, energy management systems to avoid use at peak priced times, lowering of thermostat, insulated water tanks, solar energy system, energy efficient bulbs and day-night sensors.
Barriers encountered by JHC have included the following:

- An investment strike by major financial institutions and investors who didn’t want to run the risks associated with inner city residential letting. This was overcome with a good track record over time (high repayment levels, low void rates, increasing value of the well-maintained properties).

- Poor management practices where buildings were managed by strong-arm tactics. A different management style was introduced by JHC – based on an acknowledgement of values, mutual rights and responsibilities, recognition of customer service and a rapid response time to maintenance problems. Given the successful results these methods are being increasingly adopted by other landlords.

- The professional mindset of designers and architects that said low-income housing meant low cost construction and inferior standards. Over time and with the introduction of project management processes, which place value at the centre of the contractual relationship, JHC has established a best practice regime, which places comfort and best value over a 20-year life span at the centre of the design and construction process.

- Slow and cumbersome regulatory systems. These were not easily overcome, but sufficient time and resources have to be budgeted to deal with them correctly.

By-law enforcement is arbitrary and inefficient. This has led to unhealthy and illegal uses of the streets, pavements, and alleyways. JHC buildings stood out as quality accommodation in severely degraded areas. Engagement with local officials and councillors has helped to combat this.

Lessons learnt

The project was well constructed, well managed which delivers good value for money to low income tenants who are viewed as clients leads to a culture of payment and participation.

There was great investment in training of staff, focus groups and some community leaders which are vital to ensure good and efficient service

Comments

* This stands for the different types of energy efficient refurbishment works in an existing building. This will be used later on in the development of a framework of the types of energy efficient refurbishment works.

* This highlights the different policies that were involved during the execution of the project. The policy instruments are:

1) Information awareness: Tenant focus groups were brought together before the refurbishment project to identify requirements. These groups were involved in most stages of the execution of the project.

2) Technology: The following technological options were integrated:

- Insulation of boilers and energy management systems to avoid use at peak priced times, lowering of thermostats to achieve optimal electricity consumption. This all leads to reduced energy bills for residents.

- A solar energy system has been installed at one of the multi-storey development which has 118 apartments. This provides all the energy that is required to heat the water, which is stored in insulated tanks. It is only
necessary to use a back-up system on overcast days.

- Use of energy-efficient light bulbs and day-night sensors.

3) Subsidy, loans and donations were received from various funding bodies for the running of the project.

Box 3: Watergy - Soweto, South Africa

<table>
<thead>
<tr>
<th>Project title</th>
<th>Watergy, Soweto</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>South Africa</td>
</tr>
<tr>
<td>Sector targeted</td>
<td>Residential</td>
</tr>
</tbody>
</table>

**Project Summary**

The aim of this project is to create an efficient water supply system and achieve significant savings in total water supplied to the Soweto region by reducing excessive consumption and wastage. This project is being done in the spirit of Watergy i.e. helping cities manage water and wastewater efficiently, saving energy, water and money. One of the problems in the Soweto community is the lack of water supply which has partly been attributed to lack of maintenance of private plumbing fixtures by property owners, as well as the poor condition of water network. One major objective of this project was the rehabilitation of the private plumbing fixtures. This objective among many others has led to so many economic, social and environmental benefits that will be presented below.

**Sustainability**

**Economic:** Financial saving of US$45 million/year

**Social:** Creation of over 1500 temporary jobs in communities where the project is being implemented.

**Environmental:** Water saving of 97 million kL/year and electricity saving of 175 million kWh/year

**Comments**

This stands for the different types of energy efficient refurbishment works in an existing building. This will be used later on in the development of a framework of the types of energy efficient refurbishment works.

### 3.2.5 Energy efficiency strategy and labour implications

The policy areas reviewed here are those that can potentially enhance or trigger a move towards sustainable energy efficient refurbishment. They are:

#### 3.2.5.1 Research and technology (R&T).

R&T play a key role in refurbishment projects. Comparative analysis must be made between alternatives before replacing an existing technology with a more efficient one. Energy saving measures could be implemented in five areas:

- water heating;
- space heating and cooling;
- lighting;
- cooking; and
- insulation in general or roof insulation in particular.

It is important to note that, at a first sight the labour implication may not be appealing or sizeable but if residential buildings are to contribute effectively against climate change then refurbishment would need to be undertaken at the city level which will have significant employment effects.

Types of labour/skill requirement under different alternatives
In the case of water heating, an energy efficiency policy regulates the replacement or addition of efficient water boilers and appliances that depend on renewable sources (e.g. solar water heaters) for energy consumption. The objectives of such a policy are: to provide water heating at more affordable prices due to minimal electricity input especially if it uses solar energy, cut-down on household energy consumption and expenditure for water heating. The activities involved here are: design of boiler sizes according to households involving engineers and HVAC technicians; choosing of appropriate boilers’ sizes and purchase from the market- this involves transport agents who could be a local cart pusher or a logistic personnel with a service van, a commercial agent who could be a store keeper simply selling the goods; installation on site- which could involve bricklayers, carpenters, plumbers and labourers.

Space heating: Although it is possible to eliminate the need for space heating through proper insulation, orientation of ceilings (Holm, 2000), currently at most 0.5% of South African households are efficient in their thermal design (Winkler, 2006b). Possible technical solutions to redress existing energy inefficient buildings are passive solar techniques such as: correct orientation, north-facing windows and optimised roof overhang. In existing buildings these passive solar techniques could be achieved through addition of components, installing windows in the north-facing directions and blocking previous windows that were in the inappropriate positions. Furthermore roof and wall insulation are other techniques to improve on energy efficiency of the building envelope. Energy efficiency policies that will encourage passive solar techniques, roof and wall insulation will minimise space heating in South African households. The activities depend on which technical solution to adopt. The engineer will assist in the choice of the most appropriate solution. If efficient radiators are chosen, then transport, sale agents, technicians and labourers are likely to participate. If underground heating is chosen, then bricklayers, carpenters, electricians, transport and sale agents, labourers are going to be involved. If photovoltaic systems are chosen to generate thermal heating, then, similar personnel as in the previous case may be involved.

The policy intervention for lighting examines the provision of more affordable lighting, reduction on energy bills. This could be achieved by retrofitting buildings with highly efficient bulbs such as compact fluorescent. Furthermore repainting of the building based on the theory of light luminosity could be undertaken. The direct jobs that could be created here are electrical and painting jobs. The supply of light bulbs will involve electricians, labourers, carpenters and bricklayers. An important issue to note here is that petit businesses in developing countries can easily crop up as a result of high sales or demand of electrical appliances. It is quite common to see mobile sales agent in developing countries selling electrical appliances. This is simply because; little capital is required to set up such a business.

Cooking: Studies undertaken by Mehlwana (1999) reveals that electricity contributes a larger share of household energy in urban areas than in rural areas while the inverse is true for fuel
wood. This fuel wood in rural areas is principally used for cooking. As highlighted earlier women in developing countries spend a large amount of their time for fetching wood. As such this is actually a cumbersome option for domestic homes. Policies encouraging the replacement of traditional wood burning fire places with high energy efficient technologies such as electrical hot plates, ovens and microwaves running off solar generated electricity could be of great importance. In this case technicians, labourers, transport and sales agents are involved.

Roof insulation: Most thermal energy in a house escapes through the roof (Holm, 2000) and the most effective technical intervention in the building envelope is the installation of the ceiling (Spalding-Fecher et al, 2002). Therefore policies should aim at reinforcing the integration of ceilings in existing buildings, especially buildings constructed under the Reconstruction and Development Programme (RDP). Most insulation will involve bricklayer, carpenters, sales and transport agent, technicians and labourers.

3.2.5.2 Financial instruments

Subsidies, incentives and tax reduction
One of the major barriers to the implementation of energy efficiency policies are home owners themselves. They consider any home improvement as a financial burden and seldom consider any long-term saving potential. The reluctance to incorporate new technologies is also a major barrier. High financial incentives are needed to overcome these barriers so that home owners can readily accept and implement energy efficient policies. This financial assistance could be through tax incentives, loans and subsidies and training in energy efficient processes.

Electricity pricing
For decades, the South African electricity tariff has been the cheapest in the world (DME, 2005b). A consideration of increasing electricity tariffs may prompt households to embrace new technologies or retrofitting projects for energy efficiency. Though the electricity tariffs in South Africa is the cheapest in the world, it has not been affordable, and so increasing the tariffs a balance should be stroke between affordability and pricing.

3.2.5.3 Information awareness
One of the legacies of apartheid that has had an impact on the construction industry is the low educational level of the majority black population. This is having negative consequences as labourers or construction workers may be unable to receive simple instructions during project execution or even the workshop training that are being used in most refurbishment projects to engage the tenants or the community. Furthermore a report by ILO (2002) concludes that employers are making insufficient contribution to raising awareness and education of their employees. Though energy efficiency is a competence requirement under the National Qualifications Framework training programmes for skilled workers in relevant construction and building services trades (DME 2005a), policies regulating communication between tenants, contractors and all the stakeholders involved in a particular project should be established. This will ensure a clear understanding among players and above all the ease to quickly involve the tenants right at the start of each project.

In order to establish a priority order for the above noted energy saving measures parameters or criteria need to be established based on detailed studies. Nevertheless we can note that a survey undertaken by ICLEI CCP(2001) on 11 municipalities on retrofitting projects in South Africa,
reveals that the 5 top energy efficiency measures implemented in ICLEI CCP projects are lighting technology, water heating, space heating and cooling, energy awareness campaign and green building. Table 3.3 below gives the detail of the projects. These may provide an initial understanding of possible priority areas for public policy development. However, more detailed studies are needed to provide definitive answers on selected priority actions.

Table 3.3: Top 5 Energy efficiency measures implemented in ICLEI’s CCP Network in South Africa

<table>
<thead>
<tr>
<th>Measure</th>
<th>Project</th>
<th>Annual Energy Use Reduction (kWh)</th>
<th>Annual Energy Cost Savings (ZAR)</th>
<th>Payback period (years)</th>
<th>Annual Emissions Reduction (eCO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lighting (efficient technology)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compact Fluorescent Light-CFL (15W) replacing Incandescent Light Bulb-ICB (60W)</td>
<td>Ekurhuleni Municipal buildings retrofit</td>
<td>131 kW/h/light</td>
<td>R50 light</td>
<td>0.3</td>
<td>122 Kg/light</td>
</tr>
<tr>
<td>Metal Halide Bay Fittings replacing Fluorescent Light Fittings</td>
<td>Tshwane Lighting retrofit in Hall C</td>
<td>728 kW/h/light</td>
<td>R276 light</td>
<td>2.6</td>
<td>680 Kg/light</td>
</tr>
<tr>
<td><strong>Water Heating (efficient boilers and renewable Source)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zip hydroboils replacing urns and kettles</td>
<td>Ekurhuleni Municipal buildings retrofit</td>
<td>1861 kWh/hydroboils</td>
<td>R708.5/hydroboils</td>
<td>6.7</td>
<td>1740 Kg/hydroboils</td>
</tr>
<tr>
<td>Solar water heaters</td>
<td>Cape town Kuyusa low cost housing thermal energy upgrade</td>
<td>1447kWh/household</td>
<td>R550/houseld</td>
<td></td>
<td>1351 Kg/household</td>
</tr>
<tr>
<td><strong>Space heating and cooling (air conditioning controls)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timers.trim central plant timers and install new timers</td>
<td>eThekwini Air conditioning rationalisation in City Engineers Building</td>
<td>R27kWh/m²</td>
<td>R10/m²</td>
<td>0.3</td>
<td>18Kg/m²</td>
</tr>
</tbody>
</table>

**Policy and Regulation (Green Building and Energy Awareness Campaign)**
### Table 1: Energy Efficiency Campaigns

<table>
<thead>
<tr>
<th>Energy Awareness Campaign</th>
<th>eThekwini</th>
<th>Green Building</th>
<th>Potchesfroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raise awareness and optimise good housekeeping measures amongst general staff occupying City Engineers Building</td>
<td>121 800kWh</td>
<td>Energy efficiency guidelines compliant to the South African Energy and Demand Efficiency Standard</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R46 300</td>
<td>1.6</td>
<td>114 Tonnes</td>
</tr>
</tbody>
</table>


### 3.3 BRAZIL CASE STUDY

As with the South African case, a review of the energy demands in buildings, the existing building stock level, and the role of the potential stakeholders is necessary to determine the extent to which energy efficient refurbishment can lead to jobs creation. In this case study, the energy market players, energy use trends, building refurbishment trends, and an exemplar project are analysed to determine the energy efficiency market potential and the types of employment opportunities.

#### 3.3.1 Market structure and players

In Brazil the key players in energy efficiency measures are the parastatals, contractors and/or Energy Services Companies (ESCO), financial institutions, the local community, the government and non-profit groups.

So far two main parastatals operate in Brazil. These are Electrobás and Petrobás. These parastatals are in charged of promoting energy efficiency measures (Brazil Country Report, 2006). Some of the government programmes undertaken by these parastatals are PROCEL (the government electricity conservation program) piloted by Electrobás and COPET (conservation program for oil and gas) piloted by Petrobás.

Another key player in the Brazilian energy efficiency market is the Brazilian Association of Energy Conservation Companies (ABESCO). ABESCO supply energy services, its activities were highly noticed during the electricity rationing period. The main suppliers of such services in Brazil are small and medium size companies; however few utilities have established ESCO operations (Júnior et al, 2003; World Bank and ABESCO, 2005) and very few have been interested in building retrofits (Poole and Geller, 1997). The smallness of Brazilian ESCOs has been a draw back to them obtaining funding for energy efficiency projects (Júnior et al, 2003; Poole and Geller, 1997). Though an attempt to overcome this draw back was undertaken
through the establishment of Guarantee Mechanisms (Guarantee Fund for Competitivity Promotion and Guarantee Fund to Micro and Small Size Enterprises), little success was achieved (Júnior. et al, 2003).

Currently there are some financial institutions funding ESCO operations in Brazil; these are the National Bank of Development (BNDES), National Financial Agencies for Studies and Projects (FINEP), Banco do Brasil, International and National Banks (Júnior et al, 2003). ESCOs often struggle to meet the financial demands of these financial institutions that require huge initial sum of investment. Furthermore financial institutions have limited knowledge of the energy efficiency market and thus consider financing such projects a significant risk. (Júnior et al, 2003; Poole and Geller, 1997).

The local community themselves lack the enthusiasm and awareness for energy efficiency projects especially for energy efficient building refurbishment. They pay little importance to the benefits that can be gained from energy efficiency refurbishment projects.

The government and some non-profit organisations are involved in helping ESCOs industry to get established in Brazil. Some of them are the: National Program to combat the waste of Electricity(PROCEL), Agency for the Application of Energy of the State of São Paulo(AAE-SP), the National Institute for Energy Efficiency(INEE) and the International Energy Initiative(IEI) (Poole and Geller, 1997).

### 3.3.2 Energy demand trends

The Brazilian energy sector has been plagued by severe energy crisis (Rosa and Lomardo, 2003). This energy crisis has been further compounded by its huge energy demand. Brazil is ranked 10th largest energy consumer globally, just behind France and the United Kingdom (Baker Institute Study, 2004). Like all other developing countries there is every indication of continuous demand in energy consumption in Brazil. The residential sector represents one of the sectors where this increase in energy demand is linear (Table 3.4). If necessary measures are not taken Brazil may not be able to meet this rising energy demand. It is therefore imperative to examine the energy consumption pattern by sector (Table 3.5) and the energy end use by services within a building (Table 3.6).The examination of the energy consumption pattern and energy end-use by services within the construction industry gives us an indication of the opportunities in the Brazilian local energy market.

<table>
<thead>
<tr>
<th>Sector</th>
<th>1980</th>
<th>1990</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>54.0</td>
<td>49.8</td>
<td>45.8</td>
</tr>
<tr>
<td>Residential</td>
<td>20.3</td>
<td>23.9</td>
<td>26.1</td>
</tr>
<tr>
<td>Commercial</td>
<td>12.0</td>
<td>11.9</td>
<td>13.2</td>
</tr>
<tr>
<td>Government</td>
<td>12.0</td>
<td>11.2</td>
<td>11.2</td>
</tr>
<tr>
<td>Other/Rural</td>
<td>1.7</td>
<td>3.2</td>
<td>3.7</td>
</tr>
<tr>
<td>Total(TWh)</td>
<td>114</td>
<td>201</td>
<td>243</td>
</tr>
</tbody>
</table>

Source : Poole and Geller(1997)
From Table 3.4, the industry and the government share of electricity demand have fallen from their 1980’s levels. On the other hand there is a constant increase in the residential sector. In the commercial sector, there is a little drop in the 1990’s and a rise in 1995.

Table 3.5: Energy consumption matrix in 2004

<table>
<thead>
<tr>
<th>Sector</th>
<th>Thousand TOE&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Oil</th>
<th>Gas</th>
<th>Coal</th>
<th>Biomass&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Sugarcane</th>
<th>Electricity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Energy Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>11548</td>
<td>737</td>
<td>174</td>
<td>0</td>
<td>516</td>
<td>0</td>
<td>12976</td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>5841</td>
<td>181</td>
<td>0</td>
<td>503</td>
<td>0</td>
<td>6758</td>
<td>13284</td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>528</td>
<td>216</td>
<td>0</td>
<td>137</td>
<td>0</td>
<td>4307</td>
<td>5188</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>637</td>
<td>48</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2588</td>
<td>3273</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>4858</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>1281</td>
<td>6146</td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>11174</td>
<td>6663</td>
<td>11497</td>
<td>15273</td>
<td>12812</td>
<td>14797</td>
<td>72217</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>66547</td>
<td>8500</td>
<td>11497</td>
<td>15920</td>
<td>19257</td>
<td>29820</td>
<td>151540</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> A ton oil equivalent is equivalent to 10.8Gcal, or 45.2 GJ

<sup>b</sup> values exclude estimated “non-commercial fuel wood” use in the agricultural sector (2130 TOE) and residential sector (8074 TOE).


There is little or no use of space heating in the residential sector; this might be attributed to the general mild weather of Brazil. There is little use of fuel for water heating and most is undertaken with shower heads. Furthermore fuel is used in cooling in residential homes.

Table 3.6: Electricity use by end use service (%)

<table>
<thead>
<tr>
<th>End-Use</th>
<th>Residential</th>
<th>Commercial &amp; Public</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics/TV</td>
<td>8</td>
<td>//</td>
<td>//</td>
</tr>
<tr>
<td>Lighting</td>
<td>25</td>
<td>44</td>
<td>2</td>
</tr>
<tr>
<td>Other appliances</td>
<td>8</td>
<td>11</td>
<td>//</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>32</td>
<td>17</td>
<td>//</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>7</td>
<td>20</td>
<td>//</td>
</tr>
<tr>
<td>Water heating/boiling</td>
<td>20</td>
<td>//</td>
<td>10</td>
</tr>
<tr>
<td>Furnaces</td>
<td>//</td>
<td>//</td>
<td>32</td>
</tr>
<tr>
<td>Cooking</td>
<td>//</td>
<td>8</td>
<td>//</td>
</tr>
<tr>
<td>Electrochemistry</td>
<td>//</td>
<td>//</td>
<td>7</td>
</tr>
<tr>
<td>Motive power</td>
<td>//</td>
<td>//</td>
<td>49</td>
</tr>
<tr>
<td>Total (TWh)</td>
<td>63.5</td>
<td>54.9</td>
<td>127.7</td>
</tr>
</tbody>
</table>

Source: Poole and Geller (1997)

From Table 3.4 the amount of electrical energy consumed by residential buildings in Brazil is second to that of the industry. Similar results have been obtained by Jannuzzi(2005) where the industrial sector is the major consumer of electricity (54%) followed by the residential (26%) and the commercial (16%) sectors. Electricity consumed by air conditioners is the lowest and perhaps
misleading. Studies undertaken by Ghisi, Gosch and Lamberts (2007) revealed that the ownership of air conditioners in Brazil is still very low (0.03 to 0.11 air conditioning sets per dwellings on average) yet the low consumption level is very significant. Thus some good strategies to minimise energy consumption in residential buildings would be the improvement of the thermal performance of such buildings. This could be achieved through retrofitting or refurbishing existing buildings. With respect to energy consumed by refrigeration, water heating/cooking and lighting, similar results have been obtained by studies carried out by Ghisi, Gosch and Lamberts (2007) on 17,643 houses in over 12 states in Brazil. Considering the fact that there is abundant sunshine in most parts of Brazil, a good strategy to reduce energy consumption in lighting, refrigeration, and water heating/boiling is to implement policies that encourage building retrofits with energy efficient appliances and solar energy systems.

As earlier mentioned, the Brazilian energy market has been characterised by a series of problems and in some occasions prompted the government to rationing electricity use. It may be argued that the government might have been at the fore-front of the cause of some of the problems in the sense that the adoption of energy conservation measures had been inhibited by low electricity pricing. Successive governments lowered electricity tariffs as part of short term policies to slow down inflation (Poole and Geller, 1997). However, this low electricity pricing was not continuous as in some occasions countervailing policies seeking tariff realism prevailed. This oscillating electricity pricing led to reforms being implemented. The first of such reforms were implemented in April 1993 (Poole and Geller, 1997) which led to the rapid increase in the average electricity tariff. This increase was seriously felt in the residential sector. Today the Brazilian current home energy prices are one of the highest in the world (Júnior et al, 2003). This high home energy prices coupled with the analysis on utility sales, energy consumption and electricity use in Tables 3.4, 3.5, and 3.6, demonstrate clearly that the Brazilian energy market is a favourable one for sustainability policies and energy consumers should welcome energy efficient measures that could lead to potential reduction in energy prices. The Brazilian Association of Energy Service Companies (ABESCO) has estimated that the market size of energy efficiency projects could reach R$ 1 billion (~US$350 million) per year within the next few years. Amongst these projects building retrofits have been pinpointed to constitute the largest or first big market (Júnior et al, 2003). Furthermore, during the electricity rationing crisis priority was given to the retrofitting of incandescent lamps in the residential sector (Jannuzzi, 2005).

3.3.3 Building refurbishment trends

Generally housing demand is determined by population growth, household formation, income and the requirements to replace dilapidated housing stock and replace housing units removed from the stock. The population of Brazil in the 15 largest metropolitan regions increased from 52,084,984 in 1970 to 137,697,439 in 2000 and correspondingly the housing stock increased from 10,501,000 to 38,678,933 units (Dowall, 2006). Brazil’s population is on the rise, it is estimated to reach 235,505,000 by 2030 (Dowall, 2006). This rising population will definitely pose housing problems. It is even going to be very critical as the current demographic trend is towards fewer persons per household. In 1970, 1980, 1991 and 2000 the number of persons per household was 5.0, 4.4, 3.9 and 3.6 respectively (Dowall, 2006). Strategies to provide housing to this population include both preventive and curative methods. Preventive measures will entail constructing new buildings for the population while curative entails upgrading, improving or refurbishing existing buildings.
### 3.3.4 Case study project - Brazil

**Box 4: Building Restoration for Social Housing Purposes, Celso Garcia, 787**

<table>
<thead>
<tr>
<th><strong>Project title</strong></th>
<th>Building Restoration for Social Housing Purposes, Celso Garcia, 787</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong></td>
<td>Brazil</td>
</tr>
<tr>
<td><strong>Sector targeted</strong></td>
<td>Residential</td>
</tr>
</tbody>
</table>

**Project Summary**

The main aim of this project was to recycle and convert derelict buildings in São Paulo’s city centre into housing for low-income groups, reversing a ten-year tendency of exodus from the area and making use of its urban infrastructure. This is the very first project in the Brazilian national housing programme to involve a change of use from commercial to residential. In this project adequate natural ventilation$^w$ and lighting$^w$ were provided to replace the former air-conditioned and electrically lit systems. The residents participated in the decision taking$^p$, discussion$^p$, design process, planning and management of the project. The project received financial support from the City government and the Federal Savings Bank.

**Sustainability**

- **Economic**: The central location of the project allows for savings on transportation costs and increased employment opportunities.

- **Social**: The health of the residents is improved substantially due to the availability of natural ventilation and lighting.

- **Environmental**: The project takes advantage of the existing urban infrastructure, and residents’ proximity to the workplace results in energy saving in terms of transportation. The replacement of the ventilation and electrical systems by natural ventilation and light save the environment from the emission of GHG.

**Lessons learnt**

Innovative social approach, involving discussions, participatory workshops with the residents inspire them and made them to know the reasons and benefits why they were investing in the project.

$^w$ This stands for the different types of energy efficient refurbishment works in an existing building. This will be used later on in the development of a framework of the types of energy efficient refurbishment works.

$^p$ This highlights the different policies that were involved during the execution of the project. The policy instruments are:

1) Information awareness: The involvement of the residents in the decision making, discussion and workshops empower the residents to participate fully in the project.

2) Technology: natural ventilation was provided to replace the formerly air-conditioned and electrically lit buildings.

3) Financial support from the City government and the Federal Savings Bank. The residents were to repay to the Federal savings Banks at an affordable monthly instalments which do not exceed 0.7% of the total cost, over a period of 15 years after which they can claim ownership.
3.3.5 Energy efficiency strategy & labour implications

This section does not examine energy efficiency policies as a whole but just policy options for improving existing housing efficiency. After reviewing literature the following policies worth considering for the Brazilian home improvement market are examined and presented below.

3.3.5.1 Research and technology

We have already noted the importance of research and technology for choosing different alternatives for replacing existing technologies in buildings in the case of South Africa. The same arguments and technological alternatives also apply to Brazil and will not be repeated again. However, specific issues to Brazil are:

Adoption of minimum efficiency standards for appliances and lighting
In response to the electricity crises of 2001, and as a result of efforts of PROCEL many residential buildings conserved electricity. That notwithstanding there is still a substantial amount of energy wasted in residential buildings (Geller et al. 2004). Furthermore from Table 8 (Electricity Use by End Use Service), the amount of electrical energy consumed by lighting is quite significant. Retrofitting electrical appliances and lighting could cut electricity use by 30% (Almeida et al, 2001). As earlier mentioned studies by Ghisi, Gosch and Lamberts (2007) stressed the need to address air conditioning in the Brazilian housing. The adoption of minimum efficiency standards for new major household appliances (refrigerators, freezers, dish washers, clothes washers and air conditioners) and lighting products (lamps and fluorescent lighting ballasts) could lead to tremendous energy savings. Energy efficiency policies encouraging the use of efficient appliances in existing buildings will eliminate the present inefficient appliances in the Brazilian market.

Stimulation of renewable energy use in off-grid applications
Given that there is abundant sunlight in some parts of Brazil, it could make sense to retrofit buildings with photovoltaic (PV) systems. A program known as PRODEEM installed 5700 solar PV systems in off-grid areas, though some operational problems were noticed afterwards. It has been argued that these problems might have been due to the fact that they were provided at no cost (Lima, 2002). Subsidies to solar PV entrepreneurs could help in the efficient installation and provision of PV systems at affordable prices. Policies towards the encouragement of retrofitting buildings with PV systems will be of great importance.

Types of labour/skill requirement under different alternatives
The types of jobs and skill requirements under different technological alternatives would be similar to that noted for the South African example. As such the reader is referred back to the previous discussion in section 3.2.5.

3.3.5.2 Financial instruments

Energy pricing
Today the Brazilian current home energy prices are one of the highest in the world (Júnior et al, 2003). Currently there are indications of increase in energy tariffs in Brazil especially in
electricity sector (Júnior et al, 2003). Nevertheless, there are persistent distortions in the structure of regulated electricity prices and details of these distortions have been elaborated in (Júnior et al, 2003; Brazil Country Report, 2006; Poole and Guimarães, 2003). One of the major impacts of these price distortions is the fact that investment in energy rationalisation by firms are distorted and energy efficiency improvements are put at the end of the line or lowly prioritised (Poole and Guimarães, 2003). In order to remedy this situation detailed studies are required before establishing electricity tariffs and policies are put in place to regulate its application in sustainable building projects.

**Subsides, Incentives and tax reduction**

As mentioned earlier financial institutions as one of the key stakeholders in energy efficiency projects are very reluctant funding projects and further more the small sizes of ESCOs inhibits their capability on embarking on energy efficiency projects. A major financial input from the government in the form of subsidies will stimulate the energy efficiency market. Policies towards this direction will be of great importance to ESCOs.

3.3.5.3 Information awareness

Key stakeholders have limited knowledge of the Brazilian energy market. The local community lack the enthusiasm and limited knowledge on energy efficiency refurbishment projects. The financial institutions have limited information on the energy efficiency market and consider it a huge risk venturing into it (Júnior et al, 2003; Poole and Geller, 1997). Policies that will aim at raising awareness, sensitising the energy consumers, revealing to the financial institutions the benefits and opportunities in energy efficiency projects will trigger the move towards the practice of energy efficient refurbishment.

3.4 THE BARRIERS TO THE UPTAKE OF SUSTAINABLE REFURBISHMENT IN DEVELOPING COUNTRIES

Subsidies for energy efficiency projects: Like in most developing countries, subsidies for energy efficiency are yet to become a reality in South Africa and Brazil as there are other priorities. It has been argued in DME (2005a) that the South African government, for example, may not be able to justify subsidies for energy efficiency due to the existence of other national pressing needs. Economic conditions in most developing countries, especially Sub Saharan Africa are more critical than those of South Africa, thus subsidies for projects may not even feature on their list of priorities.

Limitation of technology: Technological options are a significant potential for energy efficiency improvements, nonetheless most of the technologies are not manufactured in developing countries as is the case with South Africa (DME, 2005a). This is a big challenge to most developing countries, since they have to import technology from overseas. Furthermore the implications of importing from overseas may cast doubts on the global fight against climate change. Environmental (embodied energy) and economic (financial cost) issues needs to be fully assessed.

Electricity pricing: Different drivers of tariff policy work in opposite directions, some favouring price increases and others keeping them low (Winkler, 2006a). The greatest challenge is how to provide affordable electricity at reasonable prices so as to discourage wastage and promote the incorporation of sustainable energy efficiency measures.
Nature of key players: In the developing countries, much still needs to be done to facilitate and motivate stakeholders to engage into the energy market. As noted by DME (2005a) in the case of South Africa very few players operate in this market and lack sufficient experience and expertise. On the other hand in Brazil while the situation is better the small sizes of ESCOs inhibits their capability on offering effective energy efficiency services.
4 SUSTAINABLE REFURBISHMENT ACTIVITIES AND POTENTIAL GREEN JOBS

In this section we elaborate three key issues that have been developed from findings of preceding sections and additional literature review. Firstly, we identify the type of potential refurbishment activities that could be generated in developing countries. Secondly, we discuss the scope for the types of jobs created as a result of these activities being undertaken.

4.1 TYPES OF WORK AND SKILLS INVOLVED IN SUSTAINABLE REFURBISHMENT

This section examines the types of works involved in the execution of energy efficiency refurbishment activities and hence the types of jobs (green jobs) that are linked to these activities. In section 3 we reviewed a number of refurbishment projects that included energy efficiency as a primary aspect of their objectives. These projects are:

- Tuindorp Kethel: executed in the Netherlands
- Johannesburg Housing Company (JHC): executed in South Africa
- Watergy: executed in Soweto, South Africa
- Building Restoration for Social Housing Purposes, Celso Garcia, 787: executed in Brazil

In the discussion of these projects, the types of sustainable energy efficiency activities were identified as with a "w" suffix in their respective boxes.

The literature indicates the existence of a wide range of improvement measures for sustainable building refurbishment in developed countries as shown in Table 2.2. However, the literature on sustainable refurbishment in developing countries is relatively limited. Within this limited context, Hens and Verbeeck (2005), Winkler and Es D van (2007), Ghisi, Gosch and Lamberts(2007); Energy Research Center (2007), Ordenes et al(2007) were identified as to be relevant to the scope of this report.

Table 4.1 is based on Hens and Verbeeck (2005), Winkler and Es D van (2007) and the review of the four case projects in section 3. It illustrates the types of activities that are associated with sustainable refurbishment and skills required in developing countries. It is important to note that this list does not suggest a hierarchy or prioritisation of refurbishment activities. Devising such a hierarchy requires additional primary research that is out of the scope of this report.
Table 4.1: Types of works in sustainable refurbishment and skills required in developing countries

<table>
<thead>
<tr>
<th>Component activity</th>
<th>Skills required</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activities before the execution of projects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Consultative meetings with residents</td>
<td>• Engineer</td>
<td>This stage is very crucial as tenants views are taken into consideration before the actual refurbishment begins.</td>
</tr>
<tr>
<td>• Design or establishment of project requirements with residents</td>
<td>• Surveyor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Commercial agent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Security</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Labourer</td>
<td></td>
</tr>
<tr>
<td><strong>Activities during the execution of the projects</strong></td>
<td></td>
<td>It is still possible for the skilled labour involved in this stage to be called during maintenance activities.</td>
</tr>
<tr>
<td>• Insulation(roof, wall, floor, artic)</td>
<td>• Engineer</td>
<td></td>
</tr>
<tr>
<td>• Air sealing</td>
<td>• Labourer</td>
<td></td>
</tr>
<tr>
<td>• Space heating(under floor heaters, ground source heat pumps, photovoltaic tubes)</td>
<td>• Plumber</td>
<td></td>
</tr>
<tr>
<td>• Water heating(boilers)</td>
<td>• Electrician</td>
<td></td>
</tr>
<tr>
<td>• Ventilation(passive stack, change of windows, installation of ventilators)</td>
<td>• Builder</td>
<td></td>
</tr>
<tr>
<td>• Efficient appliances</td>
<td>• Carpenter</td>
<td></td>
</tr>
<tr>
<td>• Photovoltaic systems</td>
<td>• Painter</td>
<td></td>
</tr>
<tr>
<td>• Electrical wiring</td>
<td>• Liaison officer</td>
<td></td>
</tr>
<tr>
<td>• Grey water system</td>
<td>• General supervisor</td>
<td></td>
</tr>
<tr>
<td>• Rain water harvesting</td>
<td>• Plasterer</td>
<td></td>
</tr>
<tr>
<td>• Water conservation(replacement of toilet with a low-flush or dual-flush toilet)</td>
<td>• Pipe fitter</td>
<td></td>
</tr>
<tr>
<td>• Efficient appliances</td>
<td>• Bricklayer</td>
<td></td>
</tr>
<tr>
<td>• Plumbing</td>
<td>• Foreman</td>
<td></td>
</tr>
<tr>
<td>• Concrete works</td>
<td>• manufacturers</td>
<td></td>
</tr>
<tr>
<td>• Carpentry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Paintings and paper hanging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Masonry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tiling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Floor works</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Activities after complete execution of project</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Constant inspection and maintenance</td>
<td>• Maintenance officer</td>
<td>These activities are highly prominent in social housing</td>
</tr>
<tr>
<td>• Rents collection</td>
<td>• Security</td>
<td></td>
</tr>
<tr>
<td>• Security checks</td>
<td>• Property manager</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Property manager</td>
<td></td>
</tr>
</tbody>
</table>
4.2 GREEN JOBS IN DEVELOPING COUNTRIES

So far, the exemplar case study projects 2, 3 and 4 (illustrated in the associated boxes) have revealed the types of refurbishment activities, refurbishment jobs and skills that have either been utilised or required in order to improve energy efficiency of refurbished building stock. Table 4.1 summarises these activities. For completeness the actual sizes of these jobs need to be established. However, due to the unavailability of data some have received qualitative appraisal rather than quantitative forecasts. The jobs sizes will eminently determined the role of the energy refurbishment activities with respect to the economy in general and employment creation.

4.2.1 Jobs from residential building stock refurbishment

This section attempts to estimate the size of the building stock in the developing countries and the period over which they would need refurbishment. There is a great difficulty estimating the number of existing building stock in the world simply because some countries do not publish their results on housing census. However using the population census it is possible to estimate the existing building stock and make predictions (Rosenfeld and Warszawski, 1993). As of 2005, the population of the developing world was at least 5,299,115,000 (UN Population Division, 2007). Taking the latest estimates on average size of households in developing countries at 4.4 persons per household (UNFPA, 2004) - we can estimate that there are at least 1,204,344,318 residential buildings in the developing world. Considering that the number of persons per household is on the decrease due to changing lifestyles, the above estimate is a conservative figure. Furthermore since the ages of the buildings are not known, if we assume all the buildings were built today, it means it should be requiring refurbishment in at least the next 29 years (Aikivuori, 1996). It is difficult to provide a precise estimate on the number of potential jobs that can be created as a result of such refurbishment activities. However, the scale of the task involved implies major employment opportunities in building refurbishment across the globe in to the future. For example section 3.2.3 for estimates in the case of South Africa.

4.2.2 Jobs from the use of liquefied petroleum gas (LPG) stoves and hot plates for cooking

Though this is an indirect activity linked to clean energy in residential housing, in the absence of PV systems, it can be used as an alternative in places with no electricity at all. It has been considered due to its employment potential upon its implementation. From Table 3, most household energy (about 90%) in developing countries is used for cooking. However, approximately 2.5 billion people in developing countries rely on charcoal, wood, agricultural waste and animal dung for cooking fuel (World Energy Outlook, 2006). In the absence of appropriate policies, this number will increase to 2.6 billion and 2.7 billion by 2015 and 2030 respectively. Biomass in itself is not harmful but its dominant use in developing countries is in the form of burning in open fires. Overall, therefore, unsustainable harvesting and inefficient conversion in closed spaces, often with inadequate ventilation, pose serious consequences on the environment and human health. As proposed in section 3.2, the use of electrical hot plates or LPG stove could be a possible technical solution. If we assume one stove/hot plate per household then by 2030, based on the previous estimate of 4.4 persons per household, 0.61 billion households will require these technologies in their homes. On this basis we can estimate that there is a global potential demand for 0.61 billion LPG stoves or electrical hot plates by 2030 if appropriate policies are implemented to replace open fire biomass fuel for cooking. In the case of
former this would be dependent on two factors. The first issue that must be addressed is the affordability of LPG stoves and capsules to lower income groups and may require specific policies to enable such a replacement. Secondly, ensuring the regular availability of LPG that is largely supplied through portable capsules to lower income groups in most developing countries. In the case of the latter there must be access to electricity at affordable prices. The job opportunities here will involve sales, transport, and maintenance of the stoves, capsules and hot plates.

4.2.3 Jobs from the implementation of photovoltaic technologies

4.2.3.1 Jobs from the use of PV systems for direct lighting
The global electricity market from solar technology has been on the rise. The cumulative installed capacity of PV systems around the world was at least 6500MWp. The annual growth rate of PV cells and modules stands at 35%. Estimates by the EPIA/Greenpeace (2007) show a projection of global PV electricity jobs at approximately 6.33 million by 2030. More of these jobs will be in the installation and servicing. Though currently the greatest share of the PV market is the developed countries, a global shift towards the developing countries will result in a significant market share of about 27% by 2030 (EPIA/Greenpeace, 2007). These estimates do not bring out clearly the portion of the jobs that will be accrued from retrofitting buildings with PV systems. Working on conservative figures, currently about 1.7 billion people in the developing countries live without electricity. Assuming the worst scenario where this figure is constant up to 2030 and that the number of persons per household stays at 4.4, then at least 0.39 billion dwellings could potentially require PV installations if PV systems were to be used to provide electricity to those people who do not currently have access to it. This scenario only considers households with no access to mains electricity. Another contribution will be from refurbishing buildings with inefficient mains electricity systems.

However, the cost of PV systems is still prohibitive even in the developed countries. Hence, the job creation capacity of PV systems for direct lighting will ultimately depend on the cost of these systems coming down to affordable levels.

4.2.3.2 Jobs from the use of PV systems for water pumping
Some areas in the developing countries lack access to electricity and water supply. PV systems could be used for pumping water to local residents in the developing countries. Studies undertaken by Kordab (2007) demonstrate the strengths of using PV systems over other available alternative technologies such as the extension of the national electric grid and the use of diesel electricity generation sets in the Economic and Social Commission for Western Asia (ESCWA) countries. The studies project that applications of PV systems for water pumping in ESCWA member countries could increase till the year 2010 to be within 10.4 to 15.0 MWp. The installations of such PV systems for water pumping will create more jobs in the developing countries.

4.2.4 Jobs from meeting or reducing space heating requirements
Recently research on household energy demand has received considerable attention. Even so, only a limited number of studies have been undertaken on space heating (Nesbakken, 2001;
Chang Tsai-Feng and Liao Huei-Chu, 2002). There are no figures for the demand for space heating in dwellings in developing countries, despite the potential benefits associated with the provision of space heating. This has been attributed to the reluctance of policy makers. Wu Xu, Lampietti and Meyer (2004) state some factors favouring the necessity of space heating such as cold weather, the crumbling legacy of central heating and the falling household incomes in Eastern Europe and Central Asia. Residential buildings could be retrofitted with various appropriate sustainable technologies such as efficient heat pump systems in order to meet their space heating requirements or their air tightness could be improved through refurbishment in order to reduce such requirements. Such activities could potentially create jobs for the local community.

Weather conditions, and hence heating requirements, vary widely in different parts of the world and different regions of the countries. Therefore, it is not possible to forecast the number of jobs that could be created through meeting or reducing space heating requirements in the developing world on a global scale.

4.2.5 Jobs from the implementation of water heating technologies

Table 3 illustrates that water heating occupies the 2nd position in Mexico and 3rd positions in Brazil and South Africa in terms of residential energy consumption. This is quite significant and measures to improve upon the efficiency of water heating technologies are highly recommended. Solar water heating has proven to be the most successful water heating technology in the developing countries. This is mainly because they rely only on simple manufacturing technology and could be made out of local materials. Their simplicity belies their potential to contribute substantially to global GHG reduction efforts. Nonetheless the market opportunities are there and open the doors for many jobs in the developing countries. A South African study undertaken by Austin et al (2003) found that if the government implements more ambitious policies for domestic solar penetration, over 355,000 new jobs could be created. Furthermore, research undertaken by Milton and Kaufman (2005) reveals the existence of the market potential for solar water heating in six developing countries, i.e. Barbados, Brazil, China, India, Mexico and South Africa. Two main points can be drawn about these markets. Firstly, the National Income in Purchasing Power parity in Barbados is high and many Barbadians can pay for their solar water heating systems up-front. Furthermore, many households can take advantage of 100% income tax rebate. Secondly the rest of the countries receive some subsidies from their governments in the buying of solar hot water systems. This is an added advantage for sustaining solar hot water systems against electric water heating systems in the various markets thus contributing to the availability of jobs through green refurbishment.

4.2.6 Jobs from the implementation of efficient appliances

Energy consumption through refrigeration is at the top of the residential energy consumption ranking for Brazil in Table 3. Koizumi (2007) reveal that air conditioners, refrigerators and lighting fixtures are likely to be the three major electricity consuming appliances in residential homes in the developing countries.

There exist opportunities for the improvement of these appliances in general in the developing countries. In fact the global demand of HVAC is tremendous with Asia/Pacific region likely to outpace the world average (Koizumi, 2007). Improvement of air conditioning and lighting systems in the existing building stock of Asia has been identified as one of the main abatement strategies for GHG (Ürge-Vorsatz, and Novikova, undated; ALGAS Report, 1998). Embarking
on this strategy in the Asia/Pacific region will create an unprecedented number of jobs in these countries especially in India and China.

4.2.7 Jobs from the implementation of insulation technologies

Insulation has been identified in Holm (cited in Winkler 2006a) as an effective way of eliminating thermal loss. The demand for insulation in the existing building stock of Asia is great and has been identified as another main abatement strategy for GHG (Ürge-Vorsatz, and Novikova, undated). Embarking on the implementation of insulation technologies in the present residential building sector in the developing countries will create many job opportunities.

So far, a review of successful cases has been mentioned in the previous section. In some refurbishment activities potential job sizes have been stated though not on a global basis, while in others the availability of jobs have been identified without any numerical or quantitative precision. The following section presents some thoughts on the possibility of developing models to forecast employment potential subject to the availability of necessary data.

4.3 MODELLING EMPLOYMENT EFFECTS OF SUSTAINABLE REFURBISHMENT

Ball and Wood (1995) refer to three main approaches to estimating the employment capacity of the construction industry. Employment estimates in the first approach are derived from macro-economic models’ forecast of construction demand and are largely based on assumed multiplier effects. Hence, larger variations of estimates result from this approach. The second approach, one of the two ‘alternative methodologies’ proposed by the authors, yields a ‘rough Leontieff-style’ labour to output coefficient calculated by averaging the published output and employment data for a certain time period. The final approach relies on ‘rule-of-thumb labour content estimates drawn up by construction industry specialists’.

Ball and Wood (1995) continue to argue that construction employment is a function of output, lagged output, type of output, construction and manufacturing wages and the user cost of capital and materials prices. They also argue that different types of construction work use different combinations of material and labour, resulting in different levels of employment capacity. It is therefore necessary to establish these combinations in the context of refurbishment work for energy efficiency in order to accurately forecast employment opportunities such work would generate. This cannot be done through a literature review as even the very basic disaggregate data on refurbishment for energy efficiency is not available. The most common output distinction that is made in available statistics is construction output in new build and repair and maintenance. In addition, “repair and maintenance work [of which refurbishment is part] is price inelastic in that it involves rapid responses to breakdowns in or damage to buildings” (Ball and Wood, 1995). Therefore, trained workers need to exist before work becomes available so that they can rapidly respond to increased labour demand through overtime. As a result, it may be possible that increase in refurbishment output may not necessarily result in increase in employment. Of course, this may not apply to a great extent if there were government-lead policies in place to train a workforce in energy efficient refurbishment in anticipation of an increased labour demand.

As illustrated above, availability and accuracy of data and assumptions are the main barriers to an accurate forecast of employment opportunities that would be generated through refurbishment.
for energy efficiency. However, some studies have been undertaken to forecast the direct and indirect employment effects of energy conservation schemes, e.g. Jeeninga et al. (1999). At this juncture it should be noted that all these studies are undertaken in a specific geographic context, e.g. France, Spain, EU, and that they rely heavily on data collected through case studies. This enabled the authors of these studies overcome the barriers discussed above. Therefore, similar case studies in the context of refurbishment for improving energy efficiency in the developing countries should be undertaken in order to be able to forecast the employment opportunities that would be created by this activity.

If such case studies are undertaken then three different forecast approaches could be undertaken. The first method could quantitatively forecast the different skills (in terms of labour man-hours) that would be required for each construction output by type, e.g. total residential area refurbished. This method inherits some practical limitations in that it requires information on the range of skills that would be required for each output type and segregate construction output data by detailed type, e.g. refurbishment output as separate from repair and maintenance output. Such data is often not available at this level of detail. To this end, the first method could be substituted by a second method, which is less accurate but the data required can be collected more easily than that required for the first method. This latter method would require us to obtain data pertaining to energy refurbishment activities from housing agencies and government departments. It would also require the breakdown of refurbishment activities taken from family expenditure surveys from developing countries’ bureau of statistics. These two methods estimate the quantitative employment effect; however in analysis, focus should be on the effects of different mechanisms behind the employment shift rather than solely on quantitative impact (Jeeninga et al, 1999).

Hence, other parameters such as initial investment in energy efficiency projects, energy saving, granting of loans and repayment of loans should be investigated in addition to the quantity of employment generated. This would enable us to estimate how much refurbishment work is likely to be available. The last model we could have used does not only estimate the total quantity of jobs created but it also estimates the impacts of changes in some economic factors on employment in energy efficiency refurbishment activities.

As already highlighted, implementing energy efficiency refurbishment could lead to direct and indirect employment in both the developing and developed countries. The impacts as well could be direct and indirect to a given economy. Though the reasons for undertaking refurbishment have widely been established in the literature (Aikivuori, 1996; Young-Doo Wang, Tannian & Solano, 1985; Hillebrant, 2000), financial investment is generally needed to trigger refurbishment activities especially in the developing countries, and hence to recoup the employment benefits of refurbishment. Therefore, our model should establish the impacts of investment in construction.

Many models set out to explore this influence. One of the most popular models used in most economies is the “input-output economic model”, which is attributed to the work of Leontief. It facilitates the consideration of the relative output levels in different sectors in a given economy together with the labour requirement to produce one unit of output and the demand on this output from other sectors. However, as indicated earlier this review is unable to undertake detailed modelling for estimating employment benefits from the reviewed cases due to lack of data. Such a work can be undertaken with more detailed primary case studies as a follow up to this review.
4.4 SUSTAINABLE REFURBISHMENT: A WIN-WIN SCENARIO?

We started this report by arguing that sustainable refurbishment provided a virtuous circle that addressed all the main pillars of sustainable development in that it contributes to environmental protection through reduction of CO₂ emissions, and contributing to social and economic sustainability through creation of jobs. As we are coming to the end of our review and case studies it is pertinent to ask if we stand by the earlier assertion. Put another way is sustainable refurbishment the win-win scenario that it seemed at the beginning of our review?

The answer is definitely positive but with some limitations. Undoubtedly in terms of potential opportunities the construction sector as a whole still provides one of the best potentials for pro-poor economic growth through its high labour absorption capacity in developing countries. In addition, given the political urgency for GHG abatement across the globe, building/housing refurbishment offers the largest scope for highest gain at lowest cost in terms of reducing demand on energy supplies and direct and indirect emissions of CO₂.

Moreover, while lack of data prevents us from offering precise global figures on the employment function of sustainable refurbishment our case studies indicate major potential for employment generation. In South Africa both of the case projects show significant employment generation at project level and overall it is shown that there is a significant potential for job creation as a result of new investment between 2008 and 2015. In Brazil while we can not give figures on actual employment generation it is clear that there is major scope for sustainable refurbishment as the rising population and smaller household formation increase demand for all types of housing and building activity and at the same time high energy costs increase demand for energy saving refurbishment and retrofitting of buildings.

The potential for sustainable refurbishment is reinforced through specific case study projects in both South Africa and Brazil as well as Netherlands showing that not only is there scope for substantial employment generation at project level but also much higher scope for addressing social sustainability and community development objectives through direct participation of residents in all aspects of refurbishment programme. This is a capability that would not be available at this level through demolition and construction of new housing due to disruption to, and/or unavailability, of existing communities.

Our review also shows that in addition to traditional construction activities such as bricklaying and unskilled labour requirements sustainable refurbishment offers the opportunity for training the labour force in more specialised skills such as installation of PV equipments (e.g., solar panels) as well as upstream and downstream occupations in supply, management and maintenance of specialised equipment. For example replacing biomass fuels for cooking with liquefied petroleum gas (LPG) stoves in developing countries could potentially require 0.61 billion LPG stoves. Similarly, installing PV systems for direct lighting can cover 0.39 billion dwellings. These levels of demand would inevitably entail a large scale of employment activities in different areas from supply of the equipment to their installation and future maintenance. On a similar note we can identify major demand for installation of PV systems for water pumping, space heating, and fitting insulation.

In spite of such potential, however, there are major challenges that must be addressed before sustainable refurbishment can realise its potential both in terms of its contribution to mitigating
CO$_2$ emissions and employment generation. This is apparent in all aspects in terms of technological, financial and institutional capacities in developing countries. The fact of the matter is that even in our main case study countries, i.e., South Africa and Brazil, sustainable refurbishment is low in public spending priorities given the severe resource shortages and competing demands. At the same time lack of awareness of communities and the small scale and lack of experience of energy supply companies limit the scope for bottom up initiatives for adoption of energy saving measures in the homes. This is accentuated by subsidised energy pricing that in many cases reduce financial incentives for adoption of energy saving measures by households. Although in Brazil this has now been redressed with more realistic energy prices that should in principle provide incentives to households for adopting energy saving measures and sustainable refurbishment approaches that would reduce their energy bills in the long term.

Having said this however the experience of the Netherlands shows that governments in developing countries can take major steps for developing a supportive institutional and financial framework for facilitating sustainable refurbishment. Such measures include:

- developing an appropriate legislative framework that clearly sets out the benefits of sustainable refurbishment emphasising the refinement of environmental considerations rather than requiring major technological shifts,
- devising an appropriate financial framework with tax and if possible grant schemes that encourage adoption of sustainable refurbishment by both consumers and suppliers as well as building rating systems,
- clearly setting out the role of different stakeholders and facilitating their participation in the refurbishment process,
- and information awareness and information sharing activities targeted at all stakeholders through formal national sustainable building information packages, regulations, media campaigns and project consultation meetings.
5 SUMMARY AND CONCLUDING REMARKS

The main aim of this study was to investigate the extent to which the possible renovation of the existing building stock for the purposes of energy efficiency will impact on employment creation, with particular attention on the situation of developing countries. To do this, however, we needed to adopt a more holistic and multidisciplinary approach drawing on studies in different aspects of sustainable development and construction.

Following the introductory comments, in section 2 we presented an overview of climate change and its impact within the context of sustainable development. In so doing we argued that there is an overwhelming body of scientific evidence that indicates the Earth’s climate is rapidly changing due to the increasing emission of greenhouse gases (GHG) into the atmosphere. We showed that in terms of CO₂ emissions globally at 30-33%³, the building sector is the second largest emitter of CO₂ gases after industry. Consequently the desire for developing effective policies for instituting a sustainable path to development is not only an academic concern but also has gained political and practical urgency at an international level.

Perhaps one of the more useful and holistic definitions of sustainability is that of “triple bottom line” and can be defined conceptually as economic prosperity, environmental quality and social justice. In practice, however, social (justice) sustainability has received least attention both in the development of the conceptual discourse and praxis. This situation is now changing with social sustainability becoming increasingly recognised as an equal pillar of sustainable development. In this respect it is becoming recognised that access to employment opportunities that can address poverty alleviation and access to livelihoods is an important facet of social sustainability. This is even more significant in developing countries where environmental protection is directly related to employment generation since the primary concern of poor people is to earn a living rather than look after the environment.

In this respect the construction industry can play a crucial role towards sustainable development particularly due to its high employment capacities particularly for absorbing unskilled labour. The sector accounts for 5 to 10% of employment at the national level, amounting to over 111 million people directly employed worldwide, with 75% in developing countries and 90% in micro firms (less than 10 employees). However, the activities of the sector have major impact on the built and natural environment as such many policies have been implemented to increase environmental sustainability of construction practice in general. These have been mainly focused on new construction and include environmental rating and measurement systems such LEED and BREEAM. However, attention is now moving to sustainable refurbishment given the realisation that carbon emissions from existing homes by far have the greater significance than those from all the new homes that will be built in the next 2-3 decades considering that some 85 percent of the global housing stock until 2020 will consist of existing rather than new buildings.

Significantly the greatest economic potential (at net negative costs) for mitigating CO₂ emissions in buildings lies in developing countries. This is due to the fact that many of the low cost opportunities for CO₂ abatement have already been captured in the more developed economies due to progressive policies in place or in the pipeline. Overall, studies show that by 2020 globally 29% of the projected baseline emissions can be avoided cost effectively through mitigation measures in buildings. However, developing countries have the largest cost effective

³ Depending on different sources we get slightly different estimates.
potential abatement with up to 52% of the total reduction, transition economies with up to 37% and developed countries up to 25%. Consequently, urgent mitigation measures are required to reduce energy consumption in buildings, particularly in developing countries if we are to achieve the international targets in CO₂ and GHG emissions.

In terms of energy end-use in buildings there is a remarkable difference between the consumption pattern in the developed countries and the developing countries. Space heating and water heating top the lists in the US, Canada and the EU. However, energy used in cooking tops the list for South Africa and Mexico whereas refrigeration energy consumption tops the list for Brazil. Overall, it is not straightforward to establish a clear pattern in household energy consumption in developing countries. This is largely due to the disparity in climatic and weather factors which necessitate the partitioning of a country into smaller units in order to obtain a clearer picture.

To reduce energy consumption in buildings a raft of improvement measures for sustainable refurbishment have been recommended for both domestic and non-domestic buildings through various studies. As shown in Table 2.2 these include over 40 improvement measures addressing different aspects of building functions covering the building fabric, mechanical and water systems, renewable energy sources, water efficiency measures, waste reduction measures, and sustainable facility management.

Economically, studies have shown that the costs of construction through energy efficient refurbishment do not increase substantially and is in the order of ~3-5%. Overall, therefore not only is refurbishment a curative, technical, economic and environmental solution to improving the performance of existing buildings, it is being seen as a key economic solution to one of the societal problems in the developing world i.e. unemployment. However, there is a lack of detailed primary studies on developing countries demonstrating these potential. However, as shown in Table 2.3 a review of nine sustainable refurbishment projects in developing countries show that in all of these there are major scope for employment generation.

In section 3 we presented a detailed examination of energy efficiency policies and the implications for job creation. We selected the Netherlands to provide an aspirational template for policy development for developing countries. Various studies have shown that the Netherlands is at a much higher stage of developing and implementing policies on sustainable building and energy use in comparison with not only developing but also more developed EU countries. Analysis of both a case study project in the Netherlands and their general institutional context shows that sustainable refurbishment provides great capacity for addressing much of the environmental economic and particularly social sustainability goals, for example through involvement of residents in project design and implementation. However, there is a great deal of work that must be done for developing the institutional framework to facilitate sustainable refurbishment activity. These include developing the legislative framework for integrating financial, environmental and legal objectives within the built environment, developing the necessary financial framework with supporting financial incentives including tax deductions and grants schemes for undertaking sustainable refurbishment work and/or energy efficiency measures, and information awareness. Crucially the Dutch case also illustrates the importance of instituting and supporting the work of Energy Services Companies (ESCOs) that can facilitate the development and the implementation of measures that reduce the energy consumption costs for all stakeholders particularly households.
In respect of our two main case study countries, i.e., South Africa and Brazil, our analysis of specific case studies in both countries supports the findings from Netherlands in terms of positive input of sustainable refurbishment to social sustainability particularly community development, environmental protection and also major employment creation. In addition on a more general level population growth levels, household formation patterns and energy use trends in both countries indicate a major scope for future expansion of sustainable refurbishment activity. This has the potential of major employment generation. In South Africa for example estimates indicate significant employment generation as a result of projected investment of R196.65 billion in housing improvements between 2008 and 2015.

There are, however, major impediments to the expansion of sustainable refurbishment in both of the case study countries and by implication developing countries in general. Many of these relate to institutional weaknesses particularly lack of supportive legislation and adequate financial mechanisms but we can also add technological limitations and having to import necessary equipment and materials as well as lack and inexperience of key players in the energy supply markets and public authorities for identifying and supporting energy efficiency measures that often underpins sustainable refurbishment.

In spite of these limitations in section 4 largely through qualitative analysis of existing literature and information from case study projects we have been able to identify the range of skills and job opportunities generated through sustainable refurbishment and related activities. Therefore in addition to building stock refurbishment we can also note major possibilities from replacement of biomass fuels with LPG stoves where there is a global potential demand for at least 0.61 billion LPG stoves by 2030 if appropriate policies are implemented to replace biomass fuel for cooking.

Similarly we can note that there are at least 0.39 billion dwellings worldwide that could potentially require PV installations if PV systems were to be used to provide electricity to those people who do not currently have access to it. There are also major opportunities that could be available through installation of PV systems for water pumping, reducing space heating requirements (for example through retrofitting with various appropriate sustainable technologies such as efficient heat pump systems), installing more efficient and sustainable water heating systems (for example solar panels), and implementation of insulation technologies.

The main limitation in writing this report was the unavailability and inaccuracy of data and exaggerated assumption. This hindered the accurate forecast of employment opportunities in sustainable refurbishment on a general level for developing countries. As a result the report primarily has relied on qualitative appraisal of the existence of green jobs in specific case study projects and overviews of sectoral activity in the case study countries. The report, however, has proposed models that could be used in forecasting the employment impacts of implementing sustainable refurbishment measures in the developing countries. Such a task can be undertaken as a follow up to this report and requires more detailed case studies.

Overall, therefore, this report can conclude that sustainable refurbishment does indeed provide a win-win scenario in terms of supporting different pillars of sustainable development. We have shown there is great scope for reduction of CO₂ emissions through sustainable refurbishment in developing countries. In addition such policies can have major employment generation effects and provide training opportunities for the labour force in skilled and semi-skilled activities related to green refurbishment of existing dwelling stock, major multiplier effects in supporting
other economic sectors while at the same time enhancing opportunities for social cohesion and community participation.

In terms of most cost effective technologies with highest potential for more immediate application we must note that these are context dependent and require identifying the area of highest current energy consumption and local financial, human and technological resource capacity. As such a definitive answer to this question would require more detailed study on costs and benefits of intervention. Clearly, the simplest and least costly intervention in the highest areas of energy demand would be most cost effective in reducing GHG emissions and possibly more employment friendly due to simpler required technology. However, in reality we have seen that the energy consumption requirements of households differ in different countries. For example the highest energy consumption in South Africa has been in cooking and space heating while in Brazil the highest requirement is in refrigeration. As such it would be difficult to provide generic conclusions based on the current review. Nevertheless, this study has shown that the simplest and most urgent interventions can be for improving space and water heating through measures such as better adoption of passive solar designs, roof insulation, as well as installation of timers and replacement of cooking and lighting facilities with low cost but more efficient appliances.

In spite of the potential there are also limitations in developing countries that must be overcome particularly in terms of developing the right institutional and support framework for the wider adoption of sustainable refurbishment at household, community and city levels. For this we have identified seven policy considerations needed for the enhancement of sustainable energy efficiency refurbishment in the developing countries with a view of optimising employment generation opportunities. These are noted below:

**Consideration 1: Targeted research in sustainable refurbishment and employment**

Firstly, more research needs to be rapidly undertaken as little is known and has been done with respect to climate change, its implications for sustainable construction and refurbishment. In undertaking this research clear focus should be directed towards each line of inquiry. For instance:

- We need more specific data on the scope for sustainable refurbishment given the generally higher rate of new build due to rapid urbanization and higher rate of obsolescence of buildings in comparison to the developed countries.
- Specific aspects of energy efficiency refurbishment and employment should be thoroughly researched and not solely focused on broader energy efficiency as a major topic. For example in developing countries we are able to determine the quantity of kerosene per household but are unable to determine if the kerosene is used for water heating, food cooking or lighting.
- Energy efficient sustainable refurbishment comprises different activities and levels of sophistication from simple changing of lighting appliances to installing sophisticated photovoltaic panels and power generating equipment. These entail different capital, skills, technological and management requirements and have different employment effects. As such path dependent programmes need to be devised that can best utilise existing capacities and maximise employment generation in each country and at the same time build up institutional and technological capacities for future development and expansion of such programmes. For this we require more detailed studies for identifying more clearly the characteristics, resource requirements, cost and employment implications of different approaches based on original field studies in different developing regions to provide a yard stick for developing more general and practical policy recommendations.
Consideration 2: Complexity of the construction and housing industry
The complex nature of the construction industry in the developing countries especially the Sub–Saharan Africa warrants serious attention for any sustainable energy efficiency policy implementation. The failure to recognise this complexity is like laying a building foundation on sand. The construction industry in the developing countries should be well examined before advocating any sustainable energy efficiency policies. This is particularly important to accurately identify range of stakeholders and how they can be better involved in adoption of more comprehensive and effective green refurbishment policies. Given the heterogeneity of context in developing countries we propose that specific/regional policy measures should be developed and targeted at individual countries/regions rather than using broad policy measures based on a few cases that may have limited regional applications.

Consideration 3: Information and awareness raising
As noted in the South African and Brazilian case studies, lack of sufficient information among stakeholders often leads to the onerous assumption of seeing green activities as an additional cost burden without financial return to owners or tenants of dwellings. Greater public information efforts can go a long way to correct this misconception highlighting both the greater societal/plant benefits of adopting/retrofitting energy saving and green technologies as well as greater financial benefits over the life cycle of the building. Indeed there is a need for a paradigm shift among professionals (designers, builders), investors (developers, financiers) and consumers (tenants, owners, occupiers) to view building costs and the buildings life cycle rather than short term utility/financial concerns. This task requires not only greater involvement of related public officials for public information campaigns but also involvement of building and housing professional bodies, educational institutions and non-governmental organisations for facilitating green initiatives. Here we would note the experience of the Brazilian Association of Energy Conservation Companies (ABESCO) in facilitating green initiatives in Brazil.

It is important to note also the critical role of general educational policies that are in many cases outdated versions of systems from western, often colonial powers. These policies need a major overhaul to take into consideration energy efficiency. This is the surest way to initiate or raise energy consciousness in the minds of general population, particularly future generations. In the construction industry, even though the jobs created are of relatively low qualification level, the industry has to take up the challenge of training its workers in sustainable energy efficiency refurbishment.

Consideration 4: Institutional reform
As noted in the context of the Netherlands greater adoption of green building and refurbishment practices may require legislative development to ensure application of green practices and standards in both new build and refurbishment of buildings and housing developments.

Consideration 5: Appropriate energy pricing
It has been noted both in the context of South Africa and Brazil that one of the main impediments to adoption of energy saving refurbishment in existing dwellings is in fact the unrealistic and often highly subsidised energy tariffs. These are often applied for political reasons. However, in reality and in the context of severe financial and technical resource constraints it limits expansion of supply and is a financial disincentive to adoption of
energy saving initiatives. The energy pricing in most countries would need to be reformed to ensure more appropriate and realistic prices.

Consideration 6: More appropriate financial framework
The Dutch experience again highlights the importance of having an appropriate financial framework for encouraging adoption of green refurbishment policies through both positive and punitive financial and fiscal measures including grants and taxation. In particular we must note that in some countries such as Brazil the small size of energy service companies may in fact prevent them from being able to muster their own resources or raise sufficient funding to effectively participate in energy efficiency projects. As such a publicly funded financial framework can compensate for such failures.

Consideration 7: Adopting holistic approach
In all case studies from the Netherlands, South Africa and Brazil it has been shown the importance of including community participation, higher design standards and good estate management as crucial elements of the overall success and long term sustainability of the green refurbishment initiatives. For ensuring long term sustainability it is imperative to consider the bigger social and economic picture in designing and implementing green refurbishment initiatives rather than solely focusing on the technological aspects.

Importantly, though we must emphasise that while some of our policy considerations have utilised the experience of the Netherlands as an inspirational model for developing institutional capacities in developing countries we must also be aware of the institutional limitations and path dependent conditions already existing in developing countries. In many countries of the South, there already exist many plans, laws and regulations that have been copied from western developed countries that are either inappropriate to the specific conditions or are not implemented due to weaknesses in human, physical, financial or institutional capacities. The prime example of this have been many laws and regulation on urban planning and housing standards that are often not relevant to social, economic or environmental conditions or cannot be implemented due to institutional weaknesses including insufficient enforcement powers or effective enforcement organisations and personnel. We do not, therefore, advocate blind copying of existing laws of the Netherlands’ experience. However, they can act as inspirational models of best practice which can be used for developing institutional capacities based on specific local cultural, political, economic and environmental conditions.

Finally for the objectives of “Decent Work” and “Green Job Initiatives” to be attained in the developing countries, enhanced coherence between climate change policies (including energy efficiency policies) and employment policies need to be ensured.
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