



INTERNATIONAL LABOUR ORGANIZATION
Sectoral Activities Department

Green Jobs Creation Through Sustainable Refurbishment in the Developing Countries

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FOREWORD

Green Jobs have become an emblem of a more sustainable economy and society that preserves the environment for present and future generations and is more equitable and inclusive of all people and all countries. Green jobs reduce the environmental impact of enterprises and economic sectors, ultimately to levels that are sustainable. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high-efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution. Green jobs in emerging economies and developing countries include opportunities for managers, scientists and technicians, but the bulk can benefit a broad cross-section of the population which needs them most: youth, women, farmers, rural populations and slum dwellers.

However, many jobs which are green in principle are not green in practice because of the environmental damage caused by inappropriate practices. The notion of a green job is thus not absolute, but there are ‘shades’ of green and the notion will evolve over time. Moreover, the evidence shows that green jobs do not automatically constitute decent work. Many of these jobs are “dirty, dangerous and difficult”. Employment in industries such as recycling and waste management, biomass energy and construction tends to be precarious and incomes low. If green jobs are to be a bridge to a truly sustainable future, this needs to change. Green jobs therefore need to comprise decent work. Decent, green jobs effectively link Millennium Development Goal 1 (poverty reduction) and Millennium Development Goal 7 (protecting the environment) and make them mutually supportive rather than conflicting.

The Green Jobs Initiative is a joint initiative by the United Nations Environment Programme (UNEP), the International Labour Organization (ILO), the International Organization of Employers (IOE) and the International Trade Union Confederation (ITUC), which has been launched to assess, analyze and promote the creation of decent jobs as a consequence of the needed environmental policies. It supports a concerted effort by governments, employers and trade unions to promote environmentally sustainable jobs and development in a climate-challenged world.

Construction was the first specific sector of the economy to be addressed in the Green Jobs Initiative. This process started with the paper here published, which was produced by SECTOR. This paper has set the scene for a number of studies in specific countries (Bangladesh, Brazil, China, Malaysia, South Africa), with an aim at feeding policy-making.

This Working Paper is timely since construction has been recognised as a significant contributor to climate change through its emission of global warming gases (GWG). Construction of new buildings and refurbishment of existing buildings alike give the opportunity to reduce CO₂ emissions and energy consumption and to encourage the development of new professional skills leading to employment opportunities. The greening of the construction industry requires the development and implementation of new technologies aimed at reducing the negative impact of construction on the environment, and the delivery of enhanced performance by infrastructure. This green technology development requires new skill sets, new training methodologies and materials, and new entrepreneurs.

There is a need to better understand the technical and economic dynamic of the construction sector as well as the relationship between the technological changes and the issue of employment. How is a possible win-win situation forecasted and, especially, encouraged? It is

important to better understand how to use the shift to environment-friendly technologies to also improve employment and decent work opportunities. These are issues addressed in this Working Paper. The focus on refurbishment is relevant due to its impact on employment-generation. Finally, the paper includes policy recommendations which are in line with the Global Jobs Pact.

The paper was written by Ramin Keivani, Joseph H. M. Tah, Esra Kurul and Henry Abanda from the Oxford Institute for Sustainable Development, International Land Markets Research Group, Department of Real Estate and Construction, Oxford Brookes University. The work was technically supervised by Edmundo Werna, edited by Michael Richter and Colin Smith, and assisted by Angelique Flores-Girod in SECTOR.

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ABSTRACT

This paper 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 the built and natural environment within the context of sustainable development. In particular, it will show the impact of human activity, focusing on the role of buildings, on Carbon Dioxide (CO₂) emissions, and consequent greenhouse effects. The paper will consider the main elements of sustainable development and refurbishment in the context of developing countries, with special attention to conditions for attaining social sustainability and the role of employment therein. It will also examine the role of construction in development, with a particular focus on its contribution to pro-poor employment generation and social development objectives while meeting CO₂ mitigation targets.

The paper concentrates on case studies within 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, Brazil and South Africa illustrate the potential for sustainable refurbishment activities in developing countries, while the Netherlands serves as a model, particularly for institutional and policy development purposes. In line with this, we shall broadly examine 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. The analysis is complemented by a detailed examination of the four case studies which show the potential for sustainable refurbishment in meeting different aspects of sustainable development in practice at a project level.

The paper identifies that buildings are the second largest contributors to greenhouse gases (GHGs) in terms of CO₂ emissions. Similarly, 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 because many of the low-cost opportunities for CO₂ abatement have already been captured in the more developed economies due to progressive policy instruments in place or in the pipeline, whereas in developing countries this process is still in its infancy. It is also worth noting that developing countries have the largest CO₂ mitigation potential results from electricity savings, whereas in developed countries these savings are gained from heat-oriented measures. The former are considered less complicated in terms of switching to more efficient appliances and therefore more appropriate to developing nations with quick payback periods, while the latter involve shell retrofitting and fuel switching that are often more expensive and require longer payback periods, more suited to developed nations.

In terms of employment generation, the paper presents different skills requirements for these adaptations and examines the potential for employment creation. It shows that there are significant opportunities for creating 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 the added requirement for sustainable retrofitting and systems installations. In addition the paper shows that, in practice, sustainable refurbishment provides major opportunities for meeting other aspects of social sustainability. These include community development and participation, as well as contributing to the broader local and city/national economic development through local employment generation and the multiplier effects on other sectors of the economy. Nevertheless, the paper establishes that there is still a great deal of work that

must be done in developing the institutional framework to facilitate sustainable refurbishment activity.

The paper 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 accepted that the Earth's climate is rapidly changing due to the increased emissions 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 the future trends of these impacts. The projected trends are frightening and, as argued in Thornton et al (2006), are 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 about 25 per cent lower than the current levels by 2050 (Stern, 2006). The IPCC Fourth Assessment Report (IPCC, 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 per cent 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 is the way stakeholders have been involved in the execution of the refurbishment projects. The direct implications have been that astute contractors have reshaped their business models to incorporate sustainable refurbishment, that unskilled workers have undertaken new training for particular tasks, and that there have been increased sales of related building materials and components used in the refurbishment projects with, above all, an increase in the amount of employment created. Job creation 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 Organization (ILO), United Nations Environment Programme (UNEP) and the United Nations agencies and partners for fighting climate change, contributing to sustainable economic growth, and lifting people out of poverty. Developing country buildings are characterized by deplorable building states (labelled under the unenviable term “slum dwellings”) and the application of unsustainable construction practices. Sustainable refurbishment could therefore be a key solution in overcoming these challenging problems in 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 fully exploit the opportunities that exist in the sustainable refurbishment of existing buildings in developing countries.

This paper reviews some existing building refurbishment or retrofitting projects, identifies their successes, challenges, and lessons learnt, as well as the benefits derived from these projects. This includes community involvement, energy efficiency policy implications and, above all, the jobs created for the community as a result of executing sustainable energy efficiency refurbishment projects. Furthermore, the paper discusses the current state and 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 paper energy efficiency measures have been identified in selected projects in both developing and developed countries, with a focus on South Africa and Brazil, using the Netherlands as the best-practice reference model for considering the policy framework that can facilitate sustainable development. The paper identifies challenges facing developing countries and proposes relevant policy considerations. Though the paper focuses on South Africa and Brazil, the recommendations and conclusions that are drawn from it remain valid for other developing countries as well.

The main purpose of this study is to investigate the extent to which the energy efficiency refurbishment of existing building stock can lead to the creation of employment, paying particular attention to the situation in developing countries. The intention was to conduct a desk-study with a 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 is the potential for employment generation through sustainable refurbishment?
- d. What are the main challenges for developing countries to improve the energy-efficiency of the building stock? What obstacles or barriers prevent the implementation of measures which are cost-effective according to IPCC?
- e. 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 or units of the job. In the whole review only one project - i.e. Energy retrofit of Khayelitsha housing in South Africa (ILO, 2007c) - specified the content of the job package in person-years. Consequently lack of information

prevents us from providing exact definitions on measures such as person-hours, person-years or full time equivalence. In addition, it has been acknowledged that defining the term “green job” can be quite a complex methodological issue since even so called environment industries contribute to greenhouse gas emissions while some traditional high polluting industries reduce waste sent to landfill (Annandale and Morrison-Saunders, 2008). For the purposes of the international Standard Classification of Occupations this paper adopts the ILO (2008) definition of a job 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”. Considering this definition and those from Annandale and Morrison-Saunders (2008) and UNEP (2008a), 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”. However, it is important to take cognizance of the fact that a narrow definition of green jobs on solely green credentials can lead to creation of environmentally sound but socially unsustainable employment. As a result it is also important to bear in mind that green jobs also need to be decent jobs taking account of traditional labour concerns such as wages, career prospects, health and safety, etc. (UNEP, 2008b).

In the context of sustainable energy refurbishment, installing solar systems and insulating the building envelope are tasks undertaken by individuals performing green jobs. However, many standard jobs such as accountants, engineers, software developers, logistics, drivers, etc, that support the main green jobs activities will also become green jobs by association. (UNEP, 2008b) A summary of building refurbishment activities performed in response to climate change worldwide involving green jobs is 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 to the situation in developing countries.

The objectives of this study include:

- 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 implemented and those with the best technical and economic efficiency;
- iii. To assess the potential for employment generation through sustainable refurbishment;
- iv. To provide case studies of good practice in sustainable refurbishment in developing countries;
- v. To identify the main challenges for developing countries to improve the energy-efficiency of the existing building stock; and

-
- vi. To identify elements of policies and programmes which are essential to trigger a move towards efficient refurbishment.

1.3. METHODOLOGY AND SCOPE

This paper is based on a desk-based literature review of publications and reported case studies in selected developed and developing countries on residential refurbishment projects containing elements of energy efficiency among their objectives. 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. We selected the Netherlands as representative of best practices in developed countries from which policies adopted and lessons learnt could be applied to policy considerations in developing countries, adapted for context. We selected South Africa and Brazil as case studies in the developing countries. Our choice was guided by the fact that they had relatively more published information on their construction sectors in comparison to other developing countries.

The identification of good case study projects was based on the following criteria:

- *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 a 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 the greater availability of literature and their greater contribution to green house gas emissions and consequent potential for mitigation.
- *The clarity and objective of the project:* Only well-documented projects with clear initial objectives were considered.
- *The impact of the project on the community:* The project must have impacted positively upon the community through, for example, community participation and/or job creation.
- *Energy efficiency:* This was the predominant criteria in terms of satisfying environmental sustainability concerns.

Our information was analyzed and presented under the following headings: project title, country, targeted sector, reference, project summary, sustainability issues, barriers, lessons to be learnt, and general comments. We found no data on the individual employment effects of project cases in the Netherlands and Brazil. 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, case study analysis and developed countries' learning experiences allowed us to identify the energy improvement measures being implemented. In respect of the developing countries, these included the extent to which employment was being created; the barriers to the implementation of energy improvement measures; and the policies that were being adopted and potential policies that could be implemented.

We focused our research on the residential sector. Resources and time were limited and it was not possible to explicitly isolate the statistics on residential outputs or to develop a model to forecast the employment potential of refurbishment for energy efficiency in the developing countries as referred to in section 4.3.

1.4. STRUCTURE

In Section 2 we present an overview of climate change and its impact within the context of sustainable development. We briefly introduce global anthropogenic greenhouse gas (GHG) emissions in the economy as a whole. We discuss in detail sustainable development and the relationship between social development and employment. We examine the extent to which construction industry activities contribute to climate change and the significance of the construction sector and its role in responding to the mitigation of the impacts of climate change through sustainable construction and refurbishment. We consider CO₂ emissions from the various end-uses of energy in buildings and the potential for mitigation globally. We identify the energy-efficiency improvement measures currently being advocated globally to combat the impacts of climate change through sustainable refurbishment, and we present a comprehensive review of the associated literature. Finally, we present a review of reported activity involving sustainable refurbishment and the potential for job creation in developing countries.

In section 3 we present a detailed examination of energy efficiency policies and the implications of these for job creation. The Netherlands is used as a best practice model from which key policy measures and lessons learnt can be used to initiate policy considerations for developing countries. A detailed examination of the existing policies in the Netherlands is presented together with an example of a best practice project which demonstrates the outcomes of the application of these policies in practice. Armed with this best practice policy framework, we analyze the existing situation in Brazil and South Africa together with three best practice case study projects. 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 the overall implications for social, economic and environmental pillars of sustainable development. We also suggest elements of applicable policies that may trigger the move to energy efficiency. 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 utilize 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, which allows us to provide a number of inferences on potential levels of job creation. We do this through a detailed consideration of the different energy-efficiency improvement measures

identified. We present our 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). Finally, we summarize 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, and we consider the potential of sustainable refurbishment and challenges to be addressed in order to facilitate the greater adoption of sustainable refurbishment in developing countries.

In section 5 we consolidate the entire debate by summarizing the discussions and identifying specific policy considerations for facilitating energy-efficient sustainable refurbishment in developing countries. We also make general concluding remarks about the overall findings and implications of the study, shortcomings of existing literature, and areas for future study.

2. CLIMATE CHANGE AND THE CONSTRUCTION INDUSTRY

2.1. CLIMATE CHANGE AND CO₂ EMISSIONS

An overwhelming body of scientific evidence indicates that the Earth's climate is rapidly changing due to the increasing emission of greenhouse gases (GHG) into the atmosphere. The ultimate cry is for the international community to stabilize GHG emissions at acceptable concentration levels. These have been stipulated at a number of international conventions such as the Kyoto Protocol and the United Nations Framework Convention on Climate Change. Their success lies in the consistent use of policies to manage human processes, practices and exploitation of natural resources in a sustainable fashion. Yet, many constraints render the implementation of such policies and regulations difficult and complex. Partial resolutions rest in the close examination of various sectors' activities contributing to the emission of GHG, such as was performed by IPCC (2007) which found that global anthropogenic GHG emissions by sector are as follows: waste and wastewater: 2.8 per cent; energy supply: 25.9 per cent; transport: 13.1 per cent; agriculture: 13.5 per cent; forestry: 17.4 per cent; industry: 19.4 per cent; and residential and commercial buildings: 7.9 per cent.

As far as carbon dioxide is concerned, the least potent but by far the most plentiful and largest contributing compound in the greenhouse effect, the building sector, at 33 per cent¹, is the second largest global emitter of CO₂ gases after industry (Urge-Vorsatz and Novikova, 2008). Notwithstanding 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 construction.

The developed countries generate more than half the amount of GHG emitted into the environment. In parallel, there is increasing awareness of the impacts of buildings as much upon the physical, social and biological environments as on aesthetic appearance. While the "ideal state" in terms of sustainable building practice in developed economies has yet to be reached, there have been major institutional changes towards this goal since 2006, including the enforcement of the Energy Performance of Buildings European Directive (EPBD) by the European Union. Contrarily, in developing countries, lax environmental regimes, structural social and economic problems, particularly severe poverty, lack of resources and underdeveloped institutional structures, contribute to unsustainable building practices (Melchert, 2007). The outcome is unplanned urban growth often leading to over-crowded and under-serviced informal settlements, illegal occupation of land and a general neglect for environmental care, with the resulting consequences of

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 per cent. In this report figures reported by the original authors may vary slightly in different sections but this should not detract from the overall importance of the building sector to CO₂ emissions and consequent mitigation policies.

pollution, congestion, flooding, lack of proper sanitation, power cuts, lack of green areas and a plethora of environmental-related diseases.

The emission of GHG into the atmosphere is a result of human activity and the quest for a more comfortable life. This comfort is being threatened by GHGs which, in the long term, will have undesirable and persistent impacts on society as a whole (Stern, 2006; Commonwealth Foundation, 2007; Winkler, 2005; IPCC, 2007). Sustainability concerns are therefore no longer the pre-occupation of academics and pressure groups, but have gained international acceptance involving forceful debates on ways to devise and implement sustainable development policies that can eventually halt and hopefully reverse GHG emissions and their effect on global warming.

2.2. SUSTAINABLE DEVELOPMENT: WHAT DOES IT MEAN?

There are concerns about what sustainable development really entails. The use of the term sustainability has become so ubiquitous in both public and private policy discourse that its meaning in practical terms is susceptible to different interpretations and definitions and adoption as political jargon. Indeed, Parkin (2000) notes over 200 different definitions of the term. There is a serious concern that the meaning has become so vague, contested and indeterminate that its concept is open to widespread abuse by politicians and business people (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 and commitment to changing the course of events.

The phrase “sustainable development” first appeared in *World Conservation Strategy: Living Resource Conservation for Sustainable Development*, published in 1980 (Lee, 1994). It was propelled high onto 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, its ratification did not occur until five years later at the 1992 Rio Earth Summit, where the 170-plus signatory countries offered a more refined definition: “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.

Elkington (1998) proposed a more useful and holistic definition of sustainability, the “triple bottom line”, i.e., economic prosperity, environmental quality and social justice. While the triple bottom line was originally proposed as a form of institutionalizing reporting of wider impacts of corporate activity, it has proven useful for examining sustainable development policy and practice at the wider societal level.

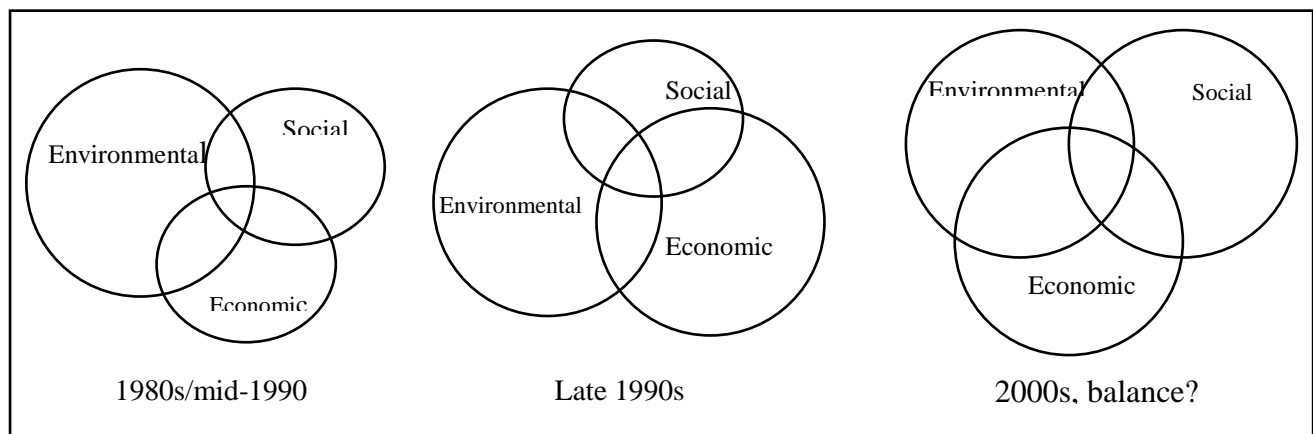
An important question to ask, however, is who benefits from sustainable development? The social sustainability pillar specifically points to social justice and urban equity as an important principle of sustainable development. In practice, however, social sustainability has received least attention both in the development of

the conceptual discourse and praxis. Colantonio (2007) brings evidence from the Organization for Economic Co-operation and Development (OECD) (2001) to show that up to early 2000 social sustainability was largely a peripheral adjunct to social implications of environmental politics rather than “an equally constitutive component of sustainable development” (Ibid, p4). In addition Littig and Griessler (2005) 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 therein. In the context of the UK, Hatter (2007) argues that at the regional level major strides have now been taken in mainstream sustainable development due to the specific mandates of regional agencies, but that this is far from true at the local level. He believes this is due to the lack of political priority sidelining, to subsuming, and to the centralized nature of state in the UK which reduces local governments to essentially a delivery arm of the central government.²

There is a widespread disparity of views on what actually constitutes social sustainability; it is even more difficult to specify objectives and indicators for it. We concur with Littig and Griessler (2005) 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 why the international community has not adopted a single universal definition nor subscribed to one conceptual framework (World Bank, 2004).

Despite this lack of clarity, studies increasingly show that in the first decade of the new century social sustainability may finally find its deserved place as an equal of the environmental and economic pillars. This is reflected in Figure 2.1 below.

Figure 2.1. Relative importance of main pillars of sustainable development through time



Source: Colantonio, 2007

² Further literature on scholars’ views on sustainability can be consulted by reading Stren and Polese (2000), Baines and Morgan (2004, cited in Colantonio), Bramley et al, 2006, cited in Colantonio, 2007), and Briart (2002, cited in Colantino, 2007)

A similar trend is apparent in the broader social dimension with the concept of “just sustainability”, developed in relation to buildings in the UK and the US and which emphasizes social justice in the implementation of environmental policies (Agyeman and Warner, 2002). The principal argument is that poor and minority communities should receive equal attention in all aspects of environmental policy and past injustices be redressed. 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). The issue can be warped in context where the question to be addressed is not only “sustainability” but also “sustainability for whom”?

For example, while global warming affects both the developing and developed countries, there is little similarity in the level of impacts and the perception of the phenomenon. Internationally agreed remediation measures must take account of this disparity and provide necessary support to developing countries both for their economic development and for implementation of these measures.³

At a more local level, environmental justice means supporting low-income and disenfranchised groups to gain better access to resources, employment and livelihood opportunities in order to alleviate their poverty. Littig and Griessler (2005) provide a convincing argument for inclusion of work as a central objective and an indicator of social sustainability:

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, and
- 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)

A schematic illustration of social sustainability and the relationship between society, work and nature appears in Littig and Griessler (2005).

In policy terms the importance of work in social sustainability is recognized by the international community in the commitments of the Copenhagen Summit 1995, known as the World Summit for Social Development. Of the Summit’s ten main commitments, employment ranks third and is promoted 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.

³ For further details on the differing impacts on poorer countries, please consult the IPCC (2007), ILO (2007a), (CDIAC, 2008).

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 two of the six key policy themes that require the attention of local authorities to ensure optimum employment generation, both in terms of attracting investment and ensuring that employment locations are not unduly segregated through ill-advised 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 priority concerns at city level. He notes that environmental protection is directly related to employment generation since poor people are primarily concerned with earning a living rather than protecting the environment. In other words, poor people will ensure their own survival before that of the environment. Therefore, it is impossible to address environmental concerns without addressing the issues of employment and poverty.

In this context the creation of increased employment opportunities through green refurbishment contributes directly to environmental protection through remediation measures for reducing GHG emissions and to 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 to enable companies to meet these baselines; implementing projects; and promoting and supporting the adoption of these tools and strategies by governments and other sectors that influence 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 its significance and current response to the challenge of sustainable development through sustainable construction and refurbishment of buildings.

2.3.1. The significance of the construction industry

The construction industry is a key factor in sustainable development for it makes a considerable contribution to our quality of life. The construction, use and demolition of buildings generate substantial social and economic benefits to society,

but may also have significant negative impacts, particularly on the environment, if the entire life cycle of buildings is not properly considered.

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 per capita construction value added and per capita gross domestic product (GDP). Construction accounts for about 45 to 60 per cent 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 because 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 per cent of GDP at the national level, approximately 10 per cent of global GDP, and approximately 7 per cent of the world's workplaces (ILO, 2007a). This accounts for 5 to 10 per cent of employment at the national level, amounting to over 111 million people directly employed worldwide, with 75 per cent in developing countries and 90 per cent 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 per cent of GDP and provide employment for about 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 per cent of output but 75 per cent of employment (Wells, 2001). Poorer and less developed countries rely more on the construction sector in terms of share of total output and employment. In India 16 per cent of the working population relies on construction for a livelihood; in sub-Saharan Africa evidence suggests a substantial reliance on the construction sector even in the absence of economic growth (Wells, 2001). The construction sector could make an even greater contribution to the economy and social development in developing countries when the employment potential of mitigation measures for climate change is considered.

The IPCC Fourth Assessment Report (IPCC, 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 per cent 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 for semi-skilled labour in the building sector. Though the report acknowledges the lack of empirical studies on climate change, mitigation measures and their impacts on employment and incomes, literature reveals that more than 100,000 workers are presently employed globally in solar photovoltaics. In solar

thermal more than 600,000 workers are employed in China, the USA and Europe. In 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 currently employed in renewables is 2.3 million (UNEP, 2008a). In the absence of detailed employment information, the above figures are likely to be very conservative.

Employment prospects for building refurbishment activities are likely to be higher than those above, especially in developing countries, for two main reasons: 1) the high input-output ratio between investment in construction and the total labour volume created by this investment 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 per cent reduction of housing depreciation would yield about a 14 per cent increase in GDP in a decade, and would cost only about 2.3 per cent of its GDP.

Construction also provides the delivery mechanism for many aspects of national government policies aimed at the provision and modernization of the built environment – for example, transport, housing, schools, hospitals, water, sanitary infrastructure, flood defenses, 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. 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 per cent of total energy use; 30 to 40 per cent of solid waste generation; and 30 to 40 per cent 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 being “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, an international construction research networking organization, 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;
- re-use resources;
- 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, they 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 views 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 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, these encapsulate 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 value of 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 per cent 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 recognized that the existing building stock offers the greatest potential for reducing carbon emissions. Existing buildings will comprise the vast majority of buildings far into the future and most 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 per cent 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 about 21.8 million homes in England across all tenures (CLG, 2005) contributing 27 per cent of all emissions. New building makes up less than 1 per cent of the total stock at 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 considered 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 modernization plus major refurbishment every 20-30 years, requiring about 1 per cent 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, offering 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 about 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, particularly in developing nations) emissions in 2030, representing an approximately 30 per cent share of total CO₂ emissions. In OECD countries, buildings account for about 35–40 per cent of national CO₂ emissions from the use of fossil fuels. In developing countries, coal and biomass are significant sources of energy for heating in buildings, invariably with adverse effects on the occupants. The fluctuations in extreme hot and cold temperatures, with increases in the intensity of tropical storms or 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 their contribution 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 lies in developing countries. This is because 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. The report estimates that by 2020 globally 29 per cent 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 per cent of the total reduction, transition economies with up to 37 per cent, and developed countries up to 25 per cent (ibid). It is also worth noting that in developing countries the largest CO₂ mitigation potential results from savings in use of electricity appliances, whereas in developed countries this saving is gained from space and water heating-oriented measures. The former are considered 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 with available information 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. Urge-Vorsatz et al. (2007) present 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, Ch. 6) presents a similar breakdown of energy end-use in the US, based on more recent sources of information. These combined figures are reflected in Figure 2.2, 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 2.2: Breakdown of residential and commercial use in the US, EU, and Canada

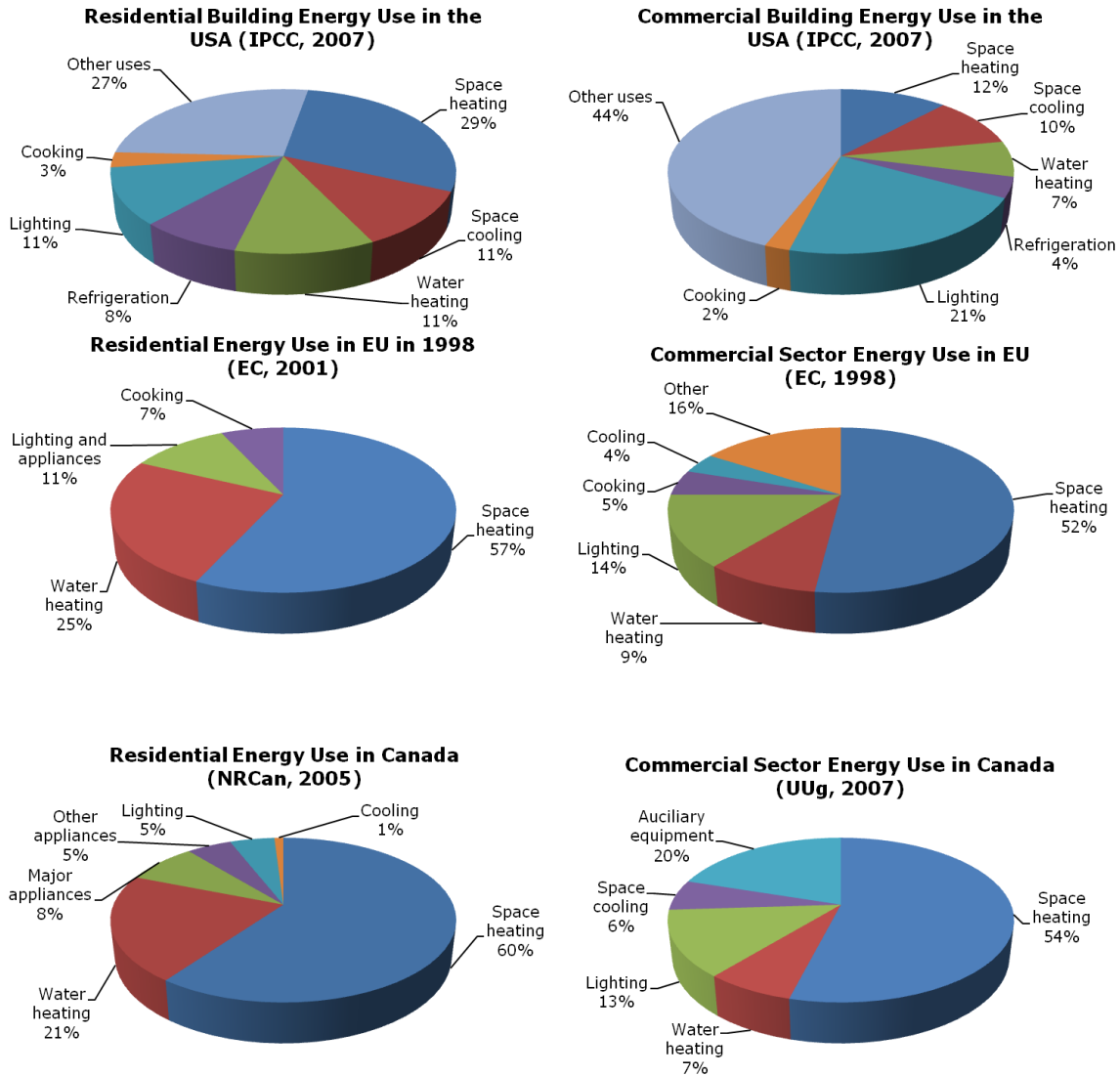
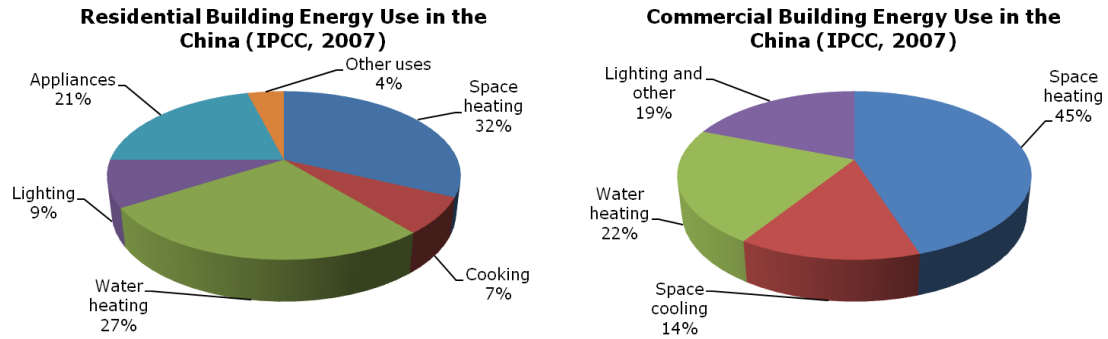


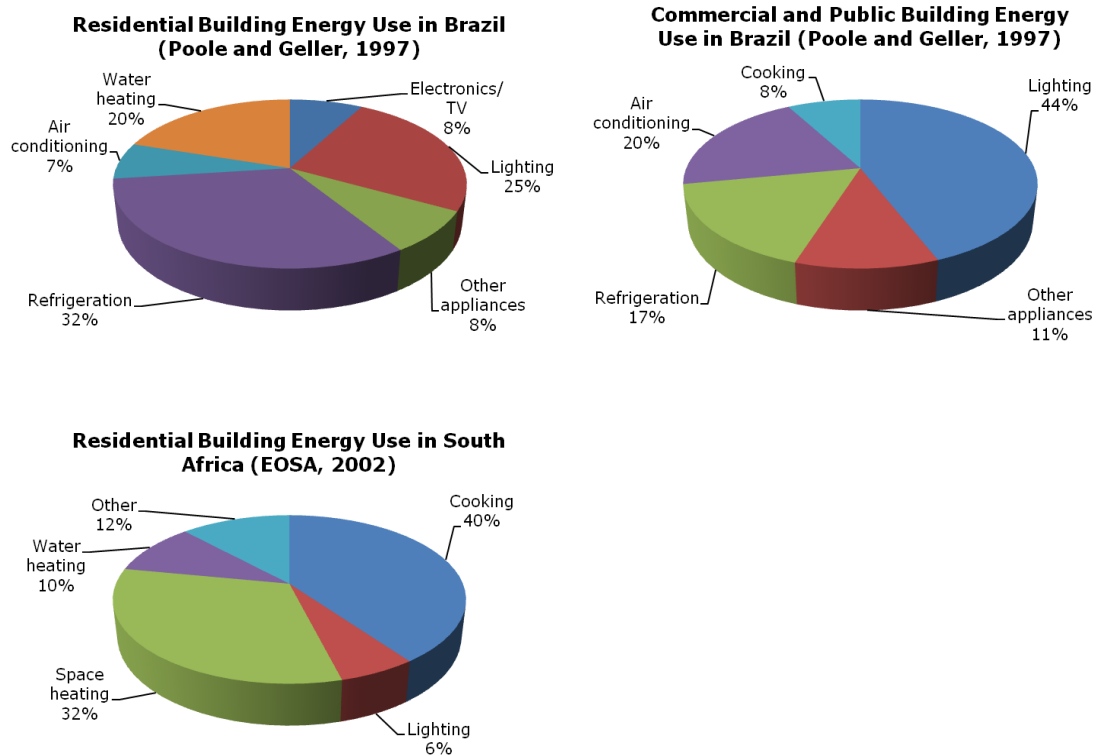
Figure 2.3 depicts the breakdown of energy end-use in the residential and commercial sectors in an economy in transition. The single largest end-use of energy in residential buildings in China is space heating, followed by water heating, and electric appliances. The largest energy end-use in commercial buildings in China is space heating, followed by water heating, lighting, and cooling.

Figure 2.3: Breakdown of residential and commercial energy use in China



It has not been possible to obtain recent figures for energy-end uses from developing countries. Figure 2.4 reflects data for Brazil from Poole and Geller (1997) and for South Africa (residential sector only) from Energy Outlook for South African report (EOSA, 2002). The largest end-use in the residential sector in Brazil is refrigeration, followed by lighting and water heating. Cooking is the 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 these two countries account for the disparity in end-uses.

Figure 2.4: Breakdown of residential and commercial use in Brazil and South Africa



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. The consumption patterns are remarkably different. Space heating and water heating predominate in the US, Canada and the EU. However, energy used in cooking predominates in South Africa and Mexico, whereas refrigeration energy consumption predominates in Brazil. Overall, no clear pattern emerges for 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

	Developing countries			¹ Developed countries		
	² Mexico	³ Brazil	⁴ South Africa	USA	Canada	EU
Cooking	1	///	1	8	///	4
Space heating	///	///	2	1	1	1
Water heating	2	3	3	2	2	2
Lighting	2	2	4	5	4	3
Electronics		4				
Refrigeration		1		3		
Air conditioner	3	5				
Space cooling				4	5	
TV				6		
Clothes dryers				7		
Furnace fans				9		
Appliances	3				3	
Washing machines						

Source: ¹Ürge-Vorsatz *et al* (2007), ²Olivia (2007), ³Poole and Geller (1997), ⁴Energy Outlook for South Africa (2002).

2.4.2. Mitigation through sustainable refurbishment measures

The choice between renovating existing and constructing new buildings depends largely on individual cases in different regions. However, supporting evidence points to a huge potential in energy savings by renovating or refurbishing existing buildings rather than constructing new ones. As already noted, in the near to medium future (at least up to 2020) new build will only comprise 15 per cent 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) demonstrate an energy saving potential of over 50 per cent, while Danish studies (Bach, 2006) demonstrate an energy saving potential of 40-60 per cent if energy efficiency measures are implemented. Most renovation projects have brought more than just energy savings to the community. Other benefits include technical, financial, well-being, environment and employment, so 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 are summarized in Table 2.2.

Table 2.2: Global improvement measures for sustainable building refurbishment

Category	Improvement measures
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 Use external recycled features Recycle complete structures
Sustainable Facility Management	Install building energy management system (BEMS) Implement efficient maintenance strategies Implement energy efficient policies and staff awareness and training

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

In Europe the “Energy Efficiency in the Refurbishment of High-Rise Residential Buildings” project, funded by the International Energy Agency and EuroACE, and 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 immensely beneficial to both communities. In addition to employment creation, we also note community or tenant involvement in decision-making and implementation of the refurbishment projects. By rendering the buildings energy-efficient, energy bills were reduced and affordable housing provided 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 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 minimize operational energy in buildings yet still maintain the indoor quality and energy performance standard of the building envelope. The outcome of these debates has often left professionals with the option of either 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.

Studies have shown that the economic costs of construction through energy-efficient refurbishment do not increase substantially (in the order of ~3-5 per cent) (UNEP, 2007). In both the developed and developing countries, the refurbishment of buildings is central to the debate on climate change. Policy makers advocate, among other things, refurbishment of existing buildings, construction of very highly energy-efficient buildings, and adaptation as ways of combating climate change. Not only is refurbishment a curative, technical, economic and environmental solution to improving the performance of existing buildings, it is also being viewed 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 will be a “job provider” rather than a “job killer”, as claimed by many skeptics in terms of the 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 this potential. Table 2.3 identifies nine refurbishment projects involving aspects of energy efficiency improvement and the extent to which jobs were created in each.

Table 2.3: Refurbishment projects and job creation in developing countries

Project	Description	Country	No of jobs
¹ Building Restoration for Social Housing Purposes, Celso Garcia, 787	Recycling of derelict building, installation of efficient lighting system and natural ventilation	Brazil	Created jobs but no figures
² Ekurhuleni, Municipal buildings retrofit project	Installation of efficient lighting systems	South Africa	Provided jobs
³ Johannesburg Housing Company(JHC)	Use of energy-efficient light bulbs and day-night sensors, solar energy system for heating water, and insulation of boilers.	South Africa	At least 1000
⁴ Watergy, Soweto	Rehabilitation of plumbing fixtures	South Africa	Over 1500 temporal jobs
⁵ Energy retrofit of Khayelitsha housing	Installation of solar water heaters, compact fluorescent light bulbs or energy efficient lamps and insulated ceilings.	South Africa	7 person-years during the construction phase. Could potentially create up to 508 person-years.
⁶ Botswana Renewable Energy Project	Installation of solar powered heating systems and lighting appliances in 88 off-grid villages, installation of domestic cooking gas system.	Botswana	Creating jobs but no figures
⁷ Solar Energy Support Programme	Install PV systems, and improved lighting thus reducing kerosene and pinewood use	Nepal	700 sales jobs, 700 people trained as technicians and 690 certified as qualified PV installers
⁸ Energy Efficiency-Housing Pilot Project	Upgrade, maintain and improvement of energy efficiency of crumbling apartment blocks inherited from the break-up of the Soviet Union	Lithuania	Created jobs but no figures
⁹ Azadjura Rural Housing Programme	Upgrade vernacular building systems using local materials	India	Created jobs but no figures

Source: ¹World Habitat (2004), ²Ekurhuleni (2005), ³World Habitat (2006), ⁴Watergy- Soweto (2003), ⁵Khayelitsha (2003) and ILO (2007c), ⁶UNEP (2006b), ⁷World Habitat (2005a), ⁸World Habitat (2005b), ⁹World Habitat (1999)

Due to insufficient 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, nor have energy savings which could be converted to jobs been mentioned. A more generalized view would help to understand and draw conclusions about developing countries with respect to green jobs creation. This generalization could be established through the analysis of the existing building stock in developing countries and the ways in which it 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 paper, South Africa and Brazil are studied in more detail.

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 or funding agent that aim at improving or maximizing 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 about two years ago (DME, 2005a). However, the development and application of energy efficiency policies is relatively well-advanced in developed countries. In this paper, the Netherlands has been selected as a best practice case. South Africa and Brazil have been selected as case studies representative of developing countries, 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 recognized these intertwined concepts and have perfectly balanced their sustainable building and energy policies. In a comparative study of five European countries Sunikka (2002) 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, p894), the Netherlands has achieved a worldwide benchmark sustainable-building approach. The Netherlands is a frontrunner regarding sustainable procurement in Europe (EEAP, 2007). In terms of energy efficiency the Netherlands is the only country besides Norway that almost satisfies 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 the Netherlands.

Most projects in the Netherlands and the developed world do not particularly target employment directly. In most situations the goal is to satisfy the needs of the residents relating to, for example, energy efficiency and water conservation. Hence in most projects published information on energy, economic, social and environmental benefits is quite common but much less so on job creation.

Several projects were reviewed for the identification of various refurbishment activities. Notable examples are the Green projects (The Green Funds Scheme, 2005), Tarvweveld/Gersteveld (Donekelaar, 2007) and the Tuindorp Kethel (Building and Social Housing Foundation, 2006). Though all fulfilled the established criteria, 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 fits 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	
Project title	Tuindorp Kethel refurbishment projects
Country	Netherlands
Reference	Building and Social Housing Foundation (2006)
Sector targeted	Residential
Project Summary	
<p>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 design to final construction. 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, and the replacement^W of doors. Before the project began an extensive resident consultation^P process was carried out, including 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.</p>	
Sustainability	
<p>Economic: Had the estate been demolished, residents may not have been able to afford the consequent significant increase in rents.</p> <p>Social: Residents' involvement led to a strong social cohesion, which would have been lost had the estate been demolished. Improved energy efficiency and the removal of damp and water penetration imply that residents are warmer and healthier than before.</p> <p>Environmental: Refurbishment as an alternative to demolition and new build avoided huge expenditure on energy and materials. Installation of more efficient boilers improved energy efficiency. External insulation was also undertaken. Energy is saved in the overall process of refurbishment.</p>	
Barriers	
<p>Few barriers were encountered, apart from some scheduling and delivery problems which led to time overruns.</p>	
Lessons learnt	
<p>Residents' involvement is vital - it attaches value to the improvements they have made to their homes.</p>	
Comments	
<p>^W This stands for the different types of energy-efficient refurbishment works used in an existing building and in the future development of a framework for such types.</p> <p>^P This highlights the different policies that were involved during the execution of the project. The policy instruments are:</p> <ol style="list-style-type: none"> 1) Information awareness: Information and general awareness are key components to achieve success in any project, especially refurbishment. Tenants need to be briefed on the duration of the project, the savings potential, health and safety issues and, above all, their willingness to participate in the design and execution of the project. Integration of their ideas into the refurbishing will ensure 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-quality insulation were installed. 	
<p>NB: The policies enumerated above are those that have been deduced. Limited sources of literature do not permit commentary on other policies that may exist.</p>	

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.

3.1.2.1. Legislative framework applied to buildings

As argued earlier in Melchert (2007), developing countries have relatively lax environmental regimes. Furthermore, the legislative framework applied to the construction industry lacks rich environmental content, norms and standards. If they do exist, they do not go beyond minimum requirements. 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 by refining the environmental content rather than necessarily changing the technologies that are already in place. Another aspect of the Dutch construction industry is the Housing Act, which covers all aspects of buildings and housing. It obliges municipalities to set up specific regulations for buildings and refurbishment and is a good piece of legislation for developing countries to use as an inspirational model for redefining their policy content to include refurbishment.

3.1.2.2. Financial framework

The developing countries have much to learn from the Dutch in the application of financial measures to the conservation of energy in the residential sector. Examples are energy investment deduction, grants for energy savings, and energy premium.

Energy Investment Deduction

This tax scheme 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 of financial institutions about the energy efficiency markets, they could be encouraged to participate more actively through the Energy Investment Deduction (EID) scheme.

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 operated from 1978-1987. These grants ended in 1982 for owner-occupied houses but continued for rental houses until 1987. This measure is especially appropriate 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 for energy saving measures in existing buildings. In this scheme, the energy performance of an existing building was evaluated and an Energy Index awarded (Donkelaar et al, 2006). This index depended on a number of energy saving measures, and if any 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 is 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 characterized by a limited number or lack of market players, a lack of experience by Energy Services Companies (ESCOs)⁴, a lack of knowledge of the market by financial institutions, and a lack of proper organization and definition of responsibilities. This may be attributed to the complex nature of sustainable energy efficiency and the various practitioners who have no clear boundaries of responsibilities. South Africa and Brazil both exhibit the above characteristics.

The Dutch sustainable building market had also been characterized in a similar manner, with many stakeholders or actors engaged in pushing the sustainable building agenda in different directions, generating confusion and superposing responsibilities. The Dutch government intervened by introducing a homogenized prescription framework through the National Sustainable Building Packages (VROM, 2007), which clearly defined the roles and attitudes of every market player within the Dutch construction industry. This Dutch example can serve as a guide for the developing countries.

3.1.2.4. Information awareness

In order to ensure dynamism amongst stakeholders, information and knowledge should be shared amongst key players, as exemplified in the Dutch National Sustainable Building Packages. Furthermore, in the Tuindorp Kethel project, information about the project was passed through consultative talks to the residents. In other cases, such as the JHC, workshops and training were used to raise community awareness. These are examples for other developing countries to emulate.

⁴ The purpose of ESCOs is to eliminate barriers for all stakeholders in order to facilitate the development and the implementation of measures that reduce 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, offer financial mechanisms, and procure and install equipment. ESCOs are also the principal overseer of other parties involved in energy efficiency businesses.

3.2. South Africa case study

In order to ascertain the extent to which energy-efficient refurbishment can lead to job 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 analyzed 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 comprises energy supply, conversion, efficiency and regulation. The Department of Mines and Energy (DME) and the National Energy Regulator (NER) play leading roles. The formation in 2005 of the Renewable Finance and Subsidy (REFSO) marked a turning point in the energy sector as a whole. Although not new in South Africa, the Energy Services Company (ESCO) is dominated by the monopoly position of ESKOM, the country's public utility company, which has 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. South Africa also lacks 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 per cent (EOSA, 2002) and there are indications that this trend will increase, as shown in Figure 3.1.

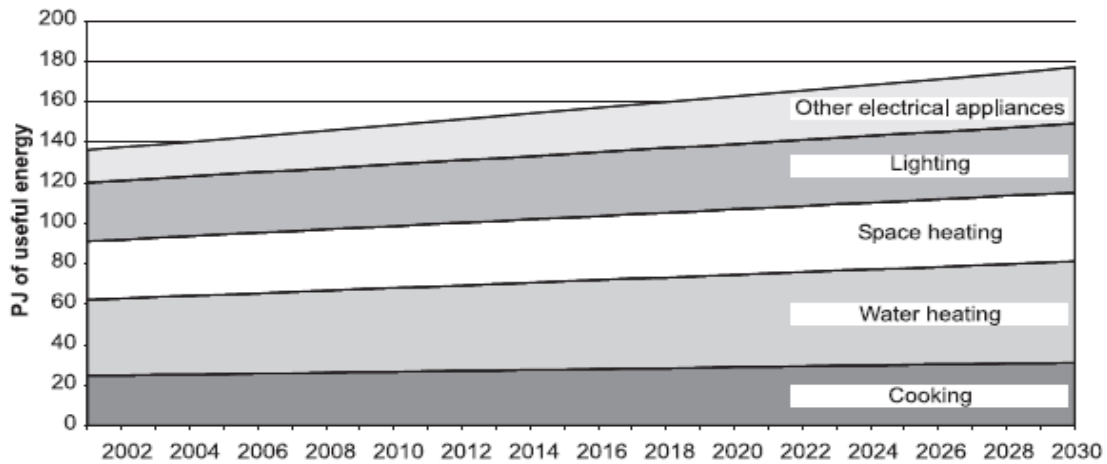
Table 3.1: South African Residential Energy Consumption

Residential Energy Consumption(PJ): Year 2000	
Cooking	113.4
Lighting	15.4
Space heating	90.8
Water heating	29.5
Other	35.1
Total	284.2

Source: Energy Outlook for South Africa (2002).

Space heating consumes more energy than cooking in South Africa. Research conducted by Holm (cited in Winkler, 2006a) reveals that most thermal energy in South African houses escapes through the roof. Spalding-Fecher et al (2002) argue that the single most effective intervention in the building shell is the installation of a ceiling. Furthermore, Holm 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



Source: Winkler (2006b)

3.2.3. Building refurbishment trends

In this paper it has been impossible to specifically state the exact components of home improvement. In the literature, refurbishment, renovation, or home improvement are used without directly specifying if such activities were geared towards energy efficiency. However, most attempts to undertake refurbishment indirectly involve energy efficiency measures. In Table 3.2, thermal insulation or energy efficiency refurbishment are not mentioned 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 home improvement activity. Furthermore, refurbishment activities, particularly in developing countries, would hardly involve structural alterations to the building fabric, except in the case of adaptive re-use; services such as electrical wiring, plumbing, painting, insulation and roof maintenance generally characterize refurbishment activities in developing countries.

Table 3.2: Estimated size of home-improvement market by Living Standards Measures Group (LSM): 2006

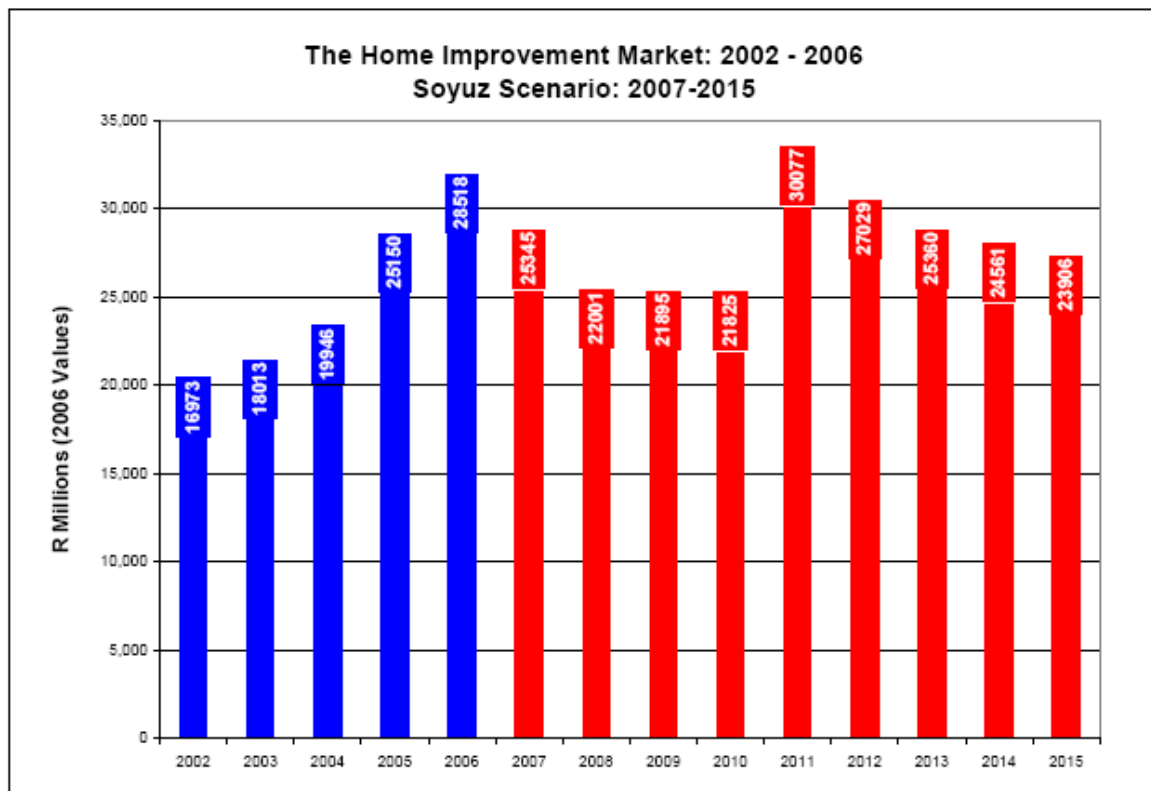
LSM Group	No. of households in RSA(x1000)	%	H.H. income Rand/month	% improving home	No. of households improvement (x1000)
Group 1-6	7 856	71.61	R2 401	5.63	442
Group 7	888	8.09	R6 971	18.00	160
Group 8	661	6.03	R9 234	20.60	136
Group 9	810	7.38	R12 901	24.90	202
Group 10	755	6.88	R20 362	37.00	279
Total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

Source: BMI Building Research Strategy Consulting Unit CC (2006).

As reflected in Table 3.2, 1.219 million households, representing 11.24 per cent, effected home improvements worth more than R1,000 in 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 per cent of LSM Group 10 (279, 000 households) effected home improvements worth more than R1,000 in 2006. LSM Group 10 comprises people with high living standards, earning high income, and who tend not to undertake home improvement work by themselves but prefer to delegate it to the poor.

The South African government intends to invest R400 billion on infrastructure, including new and existing buildings, over the next few years (BMI Building Research Strategy Consulting Unit CC, 2006). 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 1.7 million jobs 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



Source: BMI Building Research Strategy Consulting Unit CC (2006).

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, about 837,750 jobs would be created over the estimated seven 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 a more noticeable employment effect than in other sectors, considering earlier discussions on the employment function of the construction industry.

3.2.4. Exemplar case study projects – South Africa

Box 2	
Project title	Johannesburg Housing Company(JHC)
Country	South Africa
Reference	World Habitat (2006)
Sector targeted	Residential
Project Summary	
<p>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, which were the remnants of the old apartheid regime, had been abandoned to slum landlords and gangsters. The buildings’ deterioration led to extremely poor water, electricity 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)^w. In this project community workers were employed to help build capacity for community empowerment. Training programmes^p 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^w and maintenance^w of the residential buildings.</p> <p>Residents were involved in decision-making^p, design and the execution of the projects, thus establishing their awareness and knowledge of the project and its benefits.</p> <p>The project was financed from different sources:</p> <ul style="list-style-type: none"> • Housing subsidy^p worth R35 million(US\$4.67 million) by the South African government • Donation^p of R62.6 million(US\$8.3 million) over a five year period as start-up funds by the European Union • Donation^p of R13 million(US\$1.73 million) by the Flemish Regional Government • Commercial bank loans^p of R55(US\$7.33 million) 	
Sustainability	
<p>Economic: This project provides jobs for over 1,000 contractors in maintenance^w, cleaning^w and security services^w, and even more in the specialized plumbing and electrical services.^w</p> <p>Social: These buildings accommodate different ethnic groups as well as non-South Africans, thus</p>	

<p>encouraging multi-cultural integration. For example, over 400 youths are involved in previously uncommon inter-building soccer and netball leagues.</p> <p>Environmental: Initiatives have been included to efficiently manage energy consumption, such as: insulation^w of boilers, energy management systems to avoid use at peak-priced times, lowering of thermostats, insulated water tanks, solar energy systems, energy-efficient bulbs and day-night sensors.</p>
<p>Barriers</p> <p>JHC encountered the following:</p> <ul style="list-style-type: none"> • 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 the value of well-maintained properties). • Poor management practices by the use of 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. Successful results have encouraged other landlords to adopt these methods. • 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. <p>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.</p>
<p>Lessons learned</p> <p>The project was well-constructed and well-managed, and delivered good value for money to low-income tenants who were viewed as clients. This approach led to a culture of payment and participation.</p> <p>Substantial investment in training of staff, focus groups and some community leaders is vital to ensure good and efficient service</p>
<p>Comments</p> <p>^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> <p>^p This highlights the different policies that were implemented during the execution of the project. The policy instruments are:</p> <ol style="list-style-type: none"> 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: <ul style="list-style-type: none"> • Insulation of boilers and energy management systems to avoid use at peak-priced times, lowering of thermostats to achieve optimal electricity consumption. These all lead to reduced energy bills for residents. • A solar energy system has been installed at one of the multi-storey developments comprising 118 apartments. This provides all the energy required to heat the water, which is stored in insulated tanks. The use of a back-up system is necessary only on overcast days. • Use of energy-efficient light bulbs and day-night sensors. 3) Subsidies, loans and donations were received from various funding bodies to finance the project.

Box 3	
Project title	Watergy, Soweto
Country	South Africa
Reference	Watergy- Soweto (2003)
Sector targeted	Residential
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 conducted in the spirit of Watergy, i.e., helping cities to manage water and wastewater efficiently and to save energy, water and money. The Soweto community lacks a water supply, partly attributable to the lack of maintenance of private plumbing fixtures by property owners, as well as to the poor condition of the water network. One major objective of this project was the rehabilitation of the private plumbing fixtures. ^w The resulting economic, social and environmental benefits will be presented below.	
Sustainability	
<i>Economic:</i> Financial saving of US\$45 million/year	
<i>Social:</i> Creation of over 1500 temporary jobs in communities where the project is being implemented.	
<i>Environmental:</i> Water saving of 97 million kL/year and electricity saving of 175 million kWh/year	
Comments	
^w This stands for the different types of energy efficient refurbishment works in an existing building. This will be used later 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.

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 first blush, the labour implications 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

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; and to reduce household energy consumption and expenditure for water heating. The activities involved here are: design by engineers and HVAC technicians of boiler sizes according to households; selection of appropriate boiler sizes and purchase from the market (this involves transport agents such as a local cart pusher or logistics personnel with a service van, or commercial agents such as a store keeper simply selling the goods); and installation on site (which could involve bricklayers, carpenters, plumbers and unskilled workers⁵).

Space heating: although it is possible to eliminate the need for space heating through proper insulation and orientation of ceilings (Holm, 2000), currently at most 0.5 per cent 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 optimized roof overhang. In existing buildings these passive solar techniques could be achieved through the addition of components, installing windows in a north-facing direction and blocking windows that were previously in inappropriate positions. Roof and wall insulation are other techniques that can improve on the energy efficiency of the building envelope. Energy efficiency policies that will encourage passive solar techniques and roof and wall insulation will minimize space heating in South African households. The activities depend on which technical solution is adopted. The engineer will assist in the choice of the most appropriate solution. If efficient radiators are chosen, then transport, sale agents, technicians and unskilled workers are likely to participate. If underground heating or photovoltaic systems to generate thermal heating are chosen, then bricklayers, carpenters, electricians, transport and sale agents, and unskilled workers are likely to be involved.

The policy intervention for lighting examines the provision of more affordable lighting and reduction of 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. Electrical and painting jobs could be directly created here. The supply of light bulbs will involve electricians, carpenters, bricklayers and unskilled workers. An important issue to note here is that small businesses in developing countries can easily emerge as a result of high sales or demand in electrical appliances. Mobile sales agents selling electrical appliances in developing countries are quite common. This is simply because minimal capital is required to set up such a business.

⁵ Unskilled workers are normally engaged in activities such as for digging, carrying loads, clearing rubble, and generally helping out on site. They can also assist the skilled workers through for example preparing the ground, carrying their load, passing bricks,

Cooking: studies undertaken by Mehlwana (1999) reveal 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 wood is principally used in rural areas for cooking. As highlighted earlier, women in developing countries spend significant time fetching wood, which is a cumbersome burden on the maintenance of 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, transport, sales agents and unskilled workers 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 bricklayers, carpenters, sales and transport agents, technicians and unskilled workers.

3.2.5.2. Financial instruments

Subsidies, incentives and tax reduction

Home owners and their reluctance to incorporate new technologies impede the implementation of energy efficiency policies. They consider home improvement a financial burden and seldom consider any long-term saving potential. High financial incentives are required to persuade home owners to readily accept and implement energy efficient policies. Such incentives could be in the form of tax breaks, 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) but it still has not been affordable. An increase in electricity tariffs may prompt households to embrace new technologies or retrofitting projects for energy efficiency, therefore a balance should be struck between affordability and pricing.

3.2.5.3. Information awareness

One legacy of apartheid that has negatively impacted the construction industry is the low educational level of the majority black population. As such construction workers may be unable to receive simple instructions during project execution or in community training workshops . Furthermore, a report by the ILO (2002) concludes that employers are making insufficient contribution to raising the 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, will easily and quickly involve the tenants at the commencement of each project.

In order to establish a priority order for the above-mentioned energy saving measures, parameters or criteria need to be established based on detailed studies. Nevertheless, we can note that a survey conducted by ICLEI CCP(2001) of 11 municipalities on retrofitting projects in South Africa reveals that the top five 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 reflects 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

Measure	Project	Annual Energy Use Reduction (kWh)	Annual Energy Cost Savings (ZAR)	Payback period (years)	Annual Emissions Reduction (eCO ₂)
Lighting(efficient technology)					
Compact Fluorescent Light-CFL(15W) replacing Incandescent Light Bulb-ICB(60W)	Ekurhuleni Municipal buildings retrofit	131 kW/h/light	R50 light	0.3	122 Kg/light
Metal Halide Bay Fittings replacing Fluorescent Light Fittings	Tshwane Lighting retrofit in Hall C	728 kW/h/light	R276 light	2.6	680 Kg/light
Water Heating(efficient boilers and renewable Source)					
Zip hydroboils replacing urns and kettles	Ekurhuleni Municipal buildings retrofit	1861 kWh/hydroboils	R708.5/hydroboils	6.7	1740 Kg/hydroboils
Solar water heaters	Cape town Kuyusa low-cost housing thermal energy upgrade	1447kWh/household	R550/household		1 351 Kg/household
Space heating and cooling(air conditioning controls)					
Timers trim central plant timers and install new timers	eThekweni Air conditioning rationalization in City Engineers Building	R27kWh/m ²	R10/m ²	0.3	18Kg/m ²

Policy and Regulation(Green Building and Energy Awareness Campaign)					
Energy Awareness Campaign	eThekwini Raise awareness and optimize good housekeeping measures amongst general staff occupying City Engineers Building	121 800kWh	R46 300	1.6	114 Tonnes
Green Building	Potchefstroom Energy efficiency guidelines compliant with the South African Energy and Demand Efficiency Standard				

Source: <http://www.pepsonline.org/publications/SA%20EE%20Survey%20ICLEI%20CCP.pdf>

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 Brazil. In this case study, the energy market players, energy use trends, building refurbishment trends, and an exemplar project are analyzed 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 (ESCOs), financial institutions, the local community, the government and non-profit groups.

Two main parastatals, Electrobás and Petrobás, are in charge of promoting energy efficiency measures (Brazil Country Report, 2006). Examples of 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 energy efficiency market is the Brazilian Association of Energy Conservation Companies (ABESCO). Its energy supply services were widely 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 drawback to their obtaining

funding for energy efficiency projects (Júnior et al, 2003; Poole and Geller., 1997). Though an attempt to overcome this drawback 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).

There are some financial institutions currently 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 sums of investment. Furthermore, financial institutions have limited knowledge of the energy efficiency market and thus consider such projects a significant financial risk. (Júnior et al, 2003; Poole and Geller, 1997).

The local community lacks the enthusiasm and awareness for energy efficiency projects, especially for energy efficient building refurbishment, and places minimal importance on the benefits that can be gained from energy efficiency refurbishment projects.

The government and some non-profit organizations are involved in helping ESCOs to become established in Brazil. For example, the National Program to Combat the Waste of Electricity (PROCEL), the 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 a severe energy crisis (Rosa and Lomardo, 2003). This crisis has been further compounded by Brazil's huge energy demand. Brazil is ranked 10th largest energy consumer globally, behind France and the United Kingdom (Baker Institute Study, 2004). As in all other developing countries there is every indication of continuous demand in energy consumption in Brazil. This increase in energy demand in the residential sector is linear (Table 3.4) and if necessary measures are not taken Brazil may not be able to meet it. 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). These examinations provide an indication of the opportunities in the Brazilian local energy market.

Table 3.4: Utility sales by consumer class (% of Sales Volume)

Sector	1980	1990	1995
Industry	54.0	49.8	45.8
Residential	20.3	23.9	26.1
Commercial	12.0	11.9	13.2
Government	12.0	11.2	11.2
Other/Rural	1.7	3.2	3.7
Total (TWh)	114	201	243

Source: Poole and Geller(1997)

As seen in Table 3.4, the industry and the government share of electricity demand has fallen from 1980s levels. On the other hand there is a constant increase in the residential sector. In the commercial sector, there is a small drop in the 1990s and a rise in 1995.

Table 3.5: Energy consumption matrix in 2004

Sector	Thousand TOE ^a						
	Oil	Gas	Coal	Bio-mass ^b	Sugar cane	Electricity	Total
Non-Energy Use	11548	737	174	0	516	0	12976
Residential	5841	181	0	503	0	6758	13284
Commercial	528	216	0	137	0	4307	5188
Public	637	48	0	0	0	2588	3273
Agriculture	4858	2	0	6	0	1281	6146
Transport	43508	1390	0	0	6445	89	51432
Industry	11174	6663	11497	15273	12812	14797	72217
Total	66547	8500	11497	15920	19257	29820	151540

^a A ton oil equivalent is equivalent to 10.8Gcal, or 45.2 GJ

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

Source: Brazil Country Report (2006)

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

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

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

Source: Poole and Geller (1997)

As seen in Table 3.6 the amount of electrical energy used in 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 per cent) followed by the residential (26 per cent) and the commercial (16 per cent) sectors. Air conditioners use the least amount of electricity but this is perhaps misleading. Studies undertaken by Ghisi, Gosch and Lamberts (2007) revealed that ownership of air conditioners in Brazil is insignificant (0.03 to 0.11 air conditioning sets per dwelling on average) yet the low consumption level is very

significant. Thus a good strategy to minimize energy consumption in residential buildings would be the improvement of their thermal performance. 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 mentioned earlier, the Brazilian energy market has been characterized by a series of problems which in some instances prompted the government to ration electricity use. It may be argued that the government might have been the catalyst for 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; countervailing policies seeking tariff realism occasionally prevailed. This fluctuating pricing led to the implementation of reforms, the first of which occurred in April 1993 (Poole and Geller, 1997) which led to the rapid increase in the average electricity tariff, felt most seriously in the residential sector. Current Brazilian home energy prices are among the highest in the world (Júnior et al, 2003). Combined with the analysis on utility sales, energy consumption and electricity use in Tables 3.4, 3.5, and 3.6, they demonstrate clearly that the Brazilian energy market favours sustainability policies, and 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. Among 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

Housing demand is generally determined by population growth, household formation, income, and the requirements to replace dilapidated housing stock and 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; the corresponding housing stock increased from 10,501,000 to 38,678,933 units (Dowall, 2006). Brazil's population is on the increase, estimated to reach 235,505,000 by 2030 (Dowall, 2006). This increase will definitely pose housing problems, especially 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 measures. Preventive measures will entail constructing new buildings for the population, while curative will entail upgrading, improving or refurbishing existing buildings.

3.3.4. Case study project - Brazil

Box 4	
Project title	Building Restoration for Social Housing Purposes, Celso Garcia, 787
Country	Brazil
Reference	World Habitat (2004)
Sector targeted	Residential
Project Summary	
<p>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-making^p, discussion^p, design process, planning and management of the project.</p> <p>The project received financial support from the City government and the Federal savings Bank.</p>	
Sustainability	
<p>Economic: The central location of the project allows for savings on transportation costs and increased employment opportunities</p> <p>Social: The health of the residents is improved substantially due to the availability of natural ventilation and lighting</p> <p>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 saves the environment from the emission of GHG.</p>	
Lessons learned	
<p>Innovative social approach, involving discussions and participatory workshops with the residents, inspires them to know the reasons and benefits why they were investing in the project.</p> <p>^w This stands for the different types of energy-efficient refurbishment works in an existing building. This will be used later in the development of a framework of the types of energy-efficient refurbishment works.</p> <p>^p This highlights the different policies that were involved during the execution of the project. The policy instruments are:</p> <ol style="list-style-type: none"> 1) Information awareness: The involvement of the residents in the decision-making, discussion and workshops empowers them 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 repay loans at affordable monthly instalments, which do not exceed 0.7 per cent 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 only the following policy options for improving existing housing efficiency.

3.3.5.1. Research and technology

We have already noted in the case of South Africa the importance of research and technology for choosing alternatives for replacing existing technologies in buildings. The same arguments and alternatives apply to Brazil, but we address specific issues here.

Adoption of minimum efficiency standards for appliances and lighting

In response to the electricity crises of 2001, and as a result of PROCEL's efforts, many residential buildings conserved electricity, notwithstanding that there is still a substantial amount of energy wasted in residential buildings (Geller et al. 2004). Furthermore, as seen in Table 3.6 (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 per cent (Almeida et al, 2001). As mentioned earlier, studies by Ghisi, Gosch and Lamberts (2007) stressed the need to address air conditioning in 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 may be sensible 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/skills requirement under different alternatives

The types of jobs and skills requirements under different technological alternatives would be similar to those noted in the South African example, and the reader is directed to the previous discussion in section 3.2.5.

3.3.5.2. Financial instruments

Energy pricing

Current Brazilian home energy prices are among the highest in the world (Júnior et al, 2003) and there are indications of energy tariff increases, especially in the electricity sector (Júnior et al, 2003). Nevertheless, there are persistent distortions in the structure of regulated electricity prices, details of which have been elaborated in Júnior et al, 2003; Brazil Country Report, 2006; and Poole and Guimarães, 2003. One major impact of these price distortions is the fact that corporate investment in energy rationalization is distorted and energy efficiency improvements are a low priority (Poole and Guimarães, 2003). The remedy lies in conducting detailed studies before establishing electricity tariffs and implementing policies to regulate their application in sustainable building projects.

Subsidies, Incentives and tax reduction

As mentioned earlier, financial institutions are a key stakeholder in energy efficiency projects but are very reluctant to fund projects. Furthermore, the small size of ESCOs inhibits their capability to embark on energy efficiency projects. Government assistance in the form of subsidies will stimulate the energy efficiency market and 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 lacks the enthusiasm and has limited knowledge on energy efficiency refurbishment projects. The financial institutions have limited information on the energy efficiency market and consider venturing into it a huge risk (Júnior et al, 2003; Poole and Geller, 1997). Policies aimed at raising awareness, sensitizing energy consumers, and 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: As in most developing countries, subsidies for energy efficiency are not yet a top priority in South Africa and Brazil. 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 pressing national needs. Economic conditions in most developing countries, especially in Sub Saharan Africa, are more critical than those in South Africa, thus subsidies for projects may not even feature on their list of priorities.

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

Electricity pricing: Different drivers of tariff policy work in opposite directions, some favouring price increases, others keeping them low (Winkler, 2006a). The greatest challenge is 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 in 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 size of ESCOs inhibits their capability to offer effective energy efficiency services.

4. SUSTAINABLE REFURBISHMENT ACTIVITIES AND POTENTIAL GREEN JOBS

In this section we elaborate key issues that have been developed from findings in preceding sections and additional literature review. We identify the type of potential refurbishment activities that could be generated in developing countries, and 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 their primary objective:

- Tuindorp Kethel: executed in the Netherlands
- Johannesburg Housing Company (JHC): executed in South Africa
- Watery: 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 by 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. Most relevant are Hens and Verbeeck (2005), Winkler and Van Es (2007), Ghisi, Gosch and Lamberts(2007); Energy Research Center (2007) and Ordenes et al(2007).

Table 4.1, which is based on Hens and Verbeeck (2005), Winkler and Van Es (2007) and the review of the four case projects in section 3, 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 prioritization of refurbishment activities. Devising such a hierarchy requires additional primary research beyond the scope of this paper.

Table 4.1: Types of work in sustainable refurbishment and skills required in developing countries

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

4.2. Green jobs in developing countries

So far, the exemplar case study projects illustrated in boxes 2, 3 and 4 reveal the types of refurbishment activities, jobs and skills that have been either utilized or required in order to improve energy efficiency of refurbished building stock. Table 4.1 summarizes 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 determine the role of 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. Such an estimate is difficult to make because some countries do not publish results on their 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 decreasing due to changing lifestyles, the above estimate is conservative. Furthermore, since the ages of the buildings are not known, if we assume they were built today, they would require 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 the future. See, 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 implementation. As reflected in Table 3.6, most household energy (about 90 per cent) 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 environmental and human health consequences. As proposed in section 3.2, electrical hot plates or LPG stoves offer 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. Two factors affect stoves. First is their affordability to lower income groups; specific policies to enable such replacements may be required. Second is ensuring the regular availability of LPG largely supplied through portable capsules. In the case of hot plates, electricity must be accessible and affordable. 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 6,500MWp. The annual growth rate of PV cells and modules stands at 35 per cent. 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 installation and servicing. Though currently the greatest share of the PV market is in the developed countries, a global shift towards the developing countries will result in a significant market share of about 27 per cent by 2030 (EPIA/Greenpeace, 2007). These estimates do not clearly illustrate the portion of jobs that will be accrued from retrofitting buildings with PV systems. Using conservative figures, currently about 1.7 billion people in the developing countries live without electricity. Assuming a worst case scenario, where this figure remains constant up to 2030 and 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 provide electricity to those currently without it. This scenario only considers households with no access to mains electricity. Another contribution will come 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 being reduced to affordable levels.

4.2.3.2. Jobs from the use of PV systems for water pumping

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. Installation 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

Recent 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 reflecting 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 Xun, 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; alternatively, their air tightness could be improved through refurbishment in order to reduce these 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 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 2.1 illustrates that, in terms of residential energy consumption, water heating ranks second in Mexico and third in Brazil and South Africa. 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, mainly because they rely only on simple manufacturing technology derived from local materials. Their simplicity belies their potential to contribute substantially to global GHG reduction efforts. Nonetheless, the market opportunities are available to open 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 conclusions 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 per cent income tax rebate. Secondly, the rest of the countries receive subsidies from their governments for purchasing solar hot water systems. This is an added advantage for sustaining solar hot water systems over 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 ranks at the top of the residential energy consumption for Brazil in Table 3.6. Koizumi (2007) reveals that air conditioners, refrigerators and lighting fixtures are likely to be the three major electricity consumption appliances in residential homes in the developing countries.

Opportunities exist for the improvement of these appliances in the developing countries. Global demand for HVAC is tremendous, with the 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). Such a 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

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

Successful cases have 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 has 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 for estimating the employment capacity of the construction industry. The first is derived from macro-economic models' forecast of construction demand and largely based on assumed multiplier effects. Hence, larger variations of estimates result from this approach. The second approach, one of 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 third approach relies on "rule-of-thumb labour content estimates drawn up by construction industry specialists."

Ball and Wood 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 that 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 made in available statistics is between construction output in new build and in 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 increases in refurbishment output may not necessarily result in increases in employment. Of course, this may not apply to a great extent if there were government-led 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 have been 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 to 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 to be able to forecast the employment opportunities that would be created by this activity.

Such case studies would permit three different forecast approaches. The first could quantitatively forecast the different skills (in terms of person hours) that would be required for each construction output by type, e.g., skills required in refurbishment output as separate from repair and maintenance output. This method has some practical limitations in that such data is often not available at this level of detail in developing countries. To this end, the first method could be substituted by a second, which is less accurate but allows for easier data collection. It would require data pertaining to energy refurbishment activities obtained from housing agencies and government departments. In addition we can obtain the breakdown of refurbishment activities from family expenditure surveys from bureaus of statistics. These two methods can estimate the quantitative employment effect of energy efficiency refurbishment.

However, to enable effective policy intervention we need to consider the effects of different mechanisms behind the employment shift rather than solely general information on quantitative impact (Jeeninga et al, 1999). Hence the third method should consider the different mechanisms responsible for employment shifts, e.g., initial investment in energy efficiency projects, energy saving, and granting and repayment of loans, in addition to the quantity of employment generated. This would enable us to take account of the multiplier effects of these mechanisms and estimate not only the total quantity of direct jobs created but also the impact of changes in economic sectors on employment as a result of 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 to a given economy also could be direct and indirect. 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, especially in the developing countries, is generally needed to trigger refurbishment activities 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 is Leontief's "input-output economic model". 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 lacks sufficient data from the case studies to undertake detailed modelling for estimating employment benefits.

4.4. Sustainable refurbishment: a win-win scenario?

We commenced this paper 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 to social and economic sustainability through creation of jobs. As we conclude our review it is pertinent to ask: is sustainable refurbishment the win-win scenario that it seemed to be 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 cannot provide 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. South Africa, Brazil and the Netherlands show 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 programmes. This capability 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 specialized skills such as

installation of PV equipment (e.g., solar panels) as well as upstream and downstream occupations in supply, management and maintenance of specialized 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. Similarly, 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 realize its potential both in terms of its contribution to mitigating CO₂ emissions and employment generation. This is generally apparent in terms of technological, financial and institutional capacities in developing countries. Even in our main case study countries, 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 community awareness 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 homes. This is accentuated by subsidized energy pricing that in many cases reduces financial incentives for adoption of energy saving measures by households. This has, however, now been redressed in Brazil 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 toward 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, emphasizing 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
- 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, particularly in 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 our 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 per cent⁶, 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", i.e., 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 recognized as an equal pillar of sustainable development. In this respect access to employment opportunities that can address poverty alleviation and access to livelihoods are now recognized as important facets 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 care for the environment.

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

⁶ Depending on different sources we get slightly different estimates.

Significantly, the greatest economic potential (at net negative costs) for mitigating CO₂ emissions in buildings lies in developing countries. This is because 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 per cent 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 per cent of the total reduction, transition economies with up to 37 per cent, and developed countries up to 25 per cent. 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, a clear pattern in household energy consumption in developing countries is not established 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.

Various studies recommend a raft of improvement measures for sustainable refurbishment to reduce energy consumption in both domestic and non-domestic buildings. As shown in Table 2.2, over 40 improvement measures address 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.

Studies have shown that the economic costs of construction through energy-efficient refurbishment do not increase substantially and are in the order of ~3-5 per cent. Refurbishment, therefore, is not only a curative, technical, economic and environmental solution to improving the performance of existing buildings but also a key economic solution to the unemployment problem in the developing world. However, although no detailed primary studies exist to demonstrate this potential in developing countries, Table 2.3 reflects nine sustainable refurbishment projects where there is major scope for employment generation in these countries.

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 inspirational 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 and the general institutional context in the Netherlands shows that sustainable refurbishment provides great capacity for addressing much of the environmental, economic and, in particular, social sustainability goals through, for example, involvement of residents in project design and implementation. However, there is a great deal of work that must be done to develop the institutional framework for facilitating sustainable refurbishment activity. This includes 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. The Dutch case also illustrates the crucial 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.

Our analysis of South Africa and Brazil supports the findings from the Netherlands in terms of positive input of sustainable refurbishment to social sustainability, particularly community development, environmental protection and major employment creation. In addition, on a more general level, population growth levels, household formation patterns and energy use trends in both countries indicate wide scope for future expansion of sustainable refurbishment activity. In South Africa, for example, estimates indicate significant employment generation as a result of a 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 South Africa and Brazil and, by implication, in developing countries in general. Many relate to institutional weaknesses, particularly the lack of supportive legislation and adequate financial mechanisms, but also technological limitations, importation of necessary equipment and materials, and a lack of experienced key players in the energy supply markets and public authorities able to identify and support energy efficiency measures that often underpin sustainable refurbishment.

Despite these impediments, we have been able to identify the range of skills and job opportunities generated through sustainable refurbishment and related activities largely through qualitative analysis of existing literature and information from case study projects. Therefore, in addition to building stock refurbishment, 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, there are at least 0.39 billion dwellings worldwide that could potentially require PV installations if PV systems were used to provide electricity to those people currently without access. Installation of PV systems also offers opportunities 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 implementing insulation technologies.

The main limitations in writing this paper were the unavailability and inaccuracy of data and exaggerated assumption. These hindered the accurate forecast of employment opportunities in sustainable refurbishment on a general level for developing countries. As a result the paper has relied primarily 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 paper, however, has proposed models that could be used in forecasting the employment impacts of sustainable refurbishment measures in the developing countries. Such a task can be undertaken as a follow-up to this paper and requires more detailed case studies.

Overall, therefore, this paper can conclude that sustainable refurbishment does indeed provide a win-win scenario in terms of supporting different pillars of sustainable development. It demonstrates the great scope for reduction of CO₂ emissions through sustainable refurbishment in developing countries. In addition, refurbishment policies can generate employment and provide training opportunities for the labour force in skilled and semi-skilled activities related to green refurbishment of existing dwelling stock. These would have a multiplier effect on other economic sectors while at the same time enhancing opportunities for social cohesion and community participation.

In terms of most cost-effective technologies with the highest potential for more immediate application, we emphasize that these are context-dependent, i.e., the area of highest current energy consumption and local financial, human and technological resource capacity must be identified. This 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 the energy consumption requirements of households vary in different countries. For example, the highest energy consumption in South Africa is in cooking and space heating, while in Brazil it 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.

But developing countries must still generate the right institutional and support framework for the wider adoption of sustainable refurbishment at household, community and city levels. To attain this, we have identified the following seven policy considerations:

Consideration 1: Targeted research in sustainable refurbishment and employment

Little is known or has been done about climate change and its implications for sustainable construction and refurbishment. Dedicated research is required. For instance:

- Gather specific data on the scope for sustainable refurbishment, given the generally higher rate of new build due to rapid urbanization and higher rate of obsolete buildings when compared to developed countries.
- Research specific aspects of energy efficiency refurbishment and employment. For example, we are able to determine the quantity of kerosene per household in developing countries but 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 utilize existing capacities and maximize 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 must clearly identify 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 in Sub-Saharan Africa, warrants serious attention for any sustainable energy efficiency policy implementation. It is particularly important to accurately identify the range of stakeholders and how they can be better involved in the 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: Providing information and raising awareness

As noted in the South African and Brazilian case studies, lack of sufficient information among stakeholders often leads them to incorrectly assume that green activities are an additional cost burden offering no financial return to owners or tenants of dwellings. Supplying comprehensive information can correct this misconception by highlighting both the greater societal/plant benefits of adopting/retrofitting energy saving and green technologies and the 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 focus on building costs and the buildings' life cycle rather than short-term utility/financial concerns. This task requires not only effective public information campaigns but also the involvement of building and housing professional bodies, educational institutions and non-governmental organizations for facilitating green initiatives. The success of the Brazilian Association of Energy Conservation Companies (ABESCO) serves as a good example.

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 overhauling to take into consideration energy efficiency. This is the surest way to initiate or raise energy consciousness in the minds of the general population, particularly future generations. In the construction industry, even though the jobs created are of relatively low qualification level, it 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 intervention 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 in the context of South Africa and Brazil that one of the main impediments to adoption of energy saving refurbishment in existing dwellings is the unrealistic and often highly-subsidized 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 reform of energy pricing in most countries would 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 an holistic approach

The case studies from the Netherlands, South Africa and Brazil demonstrated the importance of community participation, higher design standards and good estate management to the overall success and long-term sustainability of green refurbishment initiatives. To ensure this sustainability it is imperative to consider the bigger social and economic picture in designing and implementing green refurbishment initiatives rather than focusing solely on the technological aspects.

Importantly, though, we must emphasize that while some of our policy considerations for developing institutional capacities in developing countries were inspired by the Netherlands study, we must also be aware of the institutional limitations and path-dependent conditions present in developing countries. Many Southern Hemisphere countries already have plans, laws and regulations copied from developed countries that are either inappropriate to specific conditions or not implemented due to weaknesses in human, physical, financial or institutional capacities. A prime example is urban planning and housing standards that are often irrelevant to social, economic or environmental conditions or cannot be implemented because of insufficient enforcement powers or ineffective enforcement organizations and personnel. We do not, therefore, advocate the Netherlands' approach of blindly copying existing laws. 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, in order to achieve the objectives of “Decent Work” and “Green Job Initiatives” in the developing countries, enhanced cohesion between climate change policies (including energy efficiency policies) and employment policies is essential.

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