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ISSN :2333-2581

Modern Environmental Science And Engineering

Volume 4, Number 3, March 2018

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Academic Star

Subscription Information:

Price: US$500/year (print)

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Modern Environmental Science and Engineering (ISSN 2333-2581) is a refereed journal. All research articles in this journal undergo rigorous peer review, based on initial editor screening and anonymous refereeing by at least two anonymous referees. The review process usually takes 2-4 weeks. Papers are accepted for publication subject to no substantive, stylistic editing. The editor reserves the right to make any necessary changes in the papers, or request the author to do so, or reject the paper submitted.

Database Index:

Modern Environmental Science and Engineering (ISSN 2333-2581) is indexed by SSRN, CrossRef and Ulrich now.

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Academic Star

Modern Environmental Science and Engineering

Volume 4, Number 3, March 2018

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Academic Star Publishing Company, 2018
www.academicstar.us

Sustainable Retrofitting — Global Strategies & Implementation Issues

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Abstract: This paper examines the issues related to the implementation of Sustainable Retrofitting in the construction industry and the various initiatives and approaches that are being used in various countries around the world to promote the retrofitting of existing buildings. Whilst existing buildings generally represent approximately 98% of the total building stock sustainable design and construction initiatives have typically tended to focus on new buildings. However, the past decade has seen greater focus placed on existing buildings. The research methodology is based on a literature review of the key global issues in relation to retrofitting and then a detailed investigation of implementation strategies and "best practices" that have been developed in a range of countries and cities around the world. The research reveals that there are considerable implementation issues. The key problems relate to the lack of incentives for existing building owners to retrofit their buildings and the difficulties in adequately communicating the retrofitting "business case" to these owners. Nevertheless, an increasing number of countries are developing successful retrofitting implementation strategies. A key finding was the importance of coordinated government support, leadership and incentives as a critical driver for sustainable retrofitting of the existing building stock.

Key words: existing buildings, retrofitting business case, sustainable retrofitting

1. Introduction

Existing buildings and the construction sector have an enormous impact on the environment. Globally, buildings account for approximately 40% of energy consumption, 30% of all energy-related greenhouse gas (GHG) emissions, 30% of global resource consumption, 12% of global fresh water use and produces 40% of waste [1]. Accordingly, the built environment has been widely recognized as having the greatest potential for addressing global environmental problems and particularly through existing buildings which account for approximately 98% of the total building stock [2]. This can be achieved by effective long term sustainable retrofitting of the existing global building stock.

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The importance of the retrofit market will continue to grow as the world's population grows in combination with increased urbanization. The World Economic Foroum (2011) [3] contend that "together, government and industry stakeholders stand at the apex of a historic opportunity to spark the retrofit market; there is no time to waste. As the world's urban population continues to swell towards 70% by 2050, existing buildings and infrastructure will be increasingly strained; more urban fabric will be built than ever before; and more of the world's resources will be used to fuel such growth. When we reach 2050, over 50% of today's existing building stock will still be in use. Forward-thinking policy will not only ensure that today's building stock is retrofitted to avoid a country or region's exposure to the increasing risks of resource scarcity but that the systematic framework is in place to ensure that tomorrow's

generation of buildings will continue to be as efficient as possible, even as they age".

This paper will examine the global issues related to sustainable building retrofitting and strategies that are being used around the world to try and achieve this.

2. Retrofitting — Global Potential

The IEA (2013) [4] articulate the global potential for retrofitting the existing building stock through utilizing existing technologies and further innovation.

"The buildings sector, including the residential and services sub-sectors, uses a wide array of technologies. They are used in the building envelope and its insulation, in space heating and cooling systems, in water heating, in lighting, in appliances and consumer products, and in business equipment. The long lifetime of buildings and related equipment presents both challenges and opportunities for the sector. Some of the technologies needed to transform the buildings sector are already commercially available and cost effective, with payback periods of less than five years. Others are more costly and will require government intervention if they are to achieve wide market uptake. Unlike many of the technologies needed in the transport and industry sectors, only a small proportion requires major research and development (R&D) breakthroughs. Many could, however, benefit from a combination of additional R&D and economies of scale to reduce costs, enhance performance and improve their affordability" [4].

The IEA (2013) [4] contend that the global barriers to seizing these opportunities and implementing effective building retrofits are complex and require government leadership to achieve high levels of market diffusion. Integrated and comprehensive policies are needed to overcome the common barriers such as high initial costs. A transformation of the buildings sector could have long term profound effects particularly with respect to the power sector. This is significant as the IEA (2013) [4] note that in a "business-as-usual" scenario energy demand in buildings will increase by 50% globally by 2050.

3. Research Methodology

The research methodology adopted for this study was a comprehensive literature review and case study analysis of retrofitting trends, policies, best practices and strategies being implemented around the world and the main global implementation issues and challenges.

4. Global Comparisons

4.1 Generally

Solidiance (2016) [5] undertook an extensive study of 10 major cities around the world to analyze and rank each on their green building performance. The cities were London, New York, Beijing, Dubai, Hong Kong, Paris, Shanghai, Singapore, Sydney and Tokyo. The cities were assessed on 4 criteria:

i) Green Building Landscape

Based on the number of green buildings, % of green buildings out of total buildings, green building ratings and number of green building certified professionals.

ii) Green Building Efficiency and Performance

Based on CO_2 emissions and energy use.

iii) Green Building Policies and Targets.

Based on green government policies, building codes and targets.

iv) Green City Culture and Environment

Based on the sustainability culture of the city.

Whilst the study covered both new and existing buildings, the results provide an excellent indication of the relative green "maturity" of these cities which naturally provides a good indicator of the way that they "green" the existing building stock. They also provide a good indicator of green policies and implementation in the countries that they represent.

The overall assessment ranked Paris first followed by Singapore and London. These three cities were found to be the most advanced in the adoption of new and existing green buildings with a high level of green building activity. They were followed by Sydney, Tokyo and Hong Kong and then New York, Dubai,

Beijing and Shanghai respectively.

Singapore were observed as a pioneer in the construction industry with a long history of comprehensive and bold policies and targets. The city's target of greening 80% of its building stock by 2030 is considerable more ambitious than the other cities studied. The study also noted that, whilst Beijing, Dubai and Shanghai ranked at the bottom, these cities joined the green building movement much later than their counterparts but are catching up at a remarkable rate [5].

The most relevant section of this study for this paper was Criteria 3 — Green Building Policies and Targets. Green building policies, codes, incentives and targets form the backbone for sustainable building and retrofitting and are primarily government driven. Government leadership is crucial for effective long term implementation of green building initiatives. Also crucial is certainty that these policies will be implemented over the long term and not be viewed as short-term stop-gap measures. The study found that Tokyo led the way with its Green Building Program in 2002 followed by Singapore with the first of its Green Building Masterplans in 2006.

The following section is drawn from Solidiance (2016) [5].

4.2 Tokyo

The Tokyo government introduced a "Green Building Environment Plan" in 2002 to provide a clear framework for the design, implementation and evaluation of sustainable buildings — both new and existing. Building Environment Plans are required for new buildings or retrofitting projects where the total floor area exceeds 5000 m^2. The government then introduced the Tokyo "Cap-and-Trade Program" in 2010 for industrial/commercial buildings that mandates a reduction of CO^2 emissions from these sectors. Targets have been set to establish caps (emission limits) and a mandatory reduction rate has been set for buildings/facilities based on the relevant cap.

Financial incentives adopted by the government include tax incentives through an "Energy Saving Promotion" scheme targeting small to medium enterprises. These incentives enable building owners to offset enterprise taxes when they incorporate energy efficient equipment and/or renewable energy into their buildings.

4.3 Singapore

The Singapore government, through their Building and Construction Authority (BCA), has been a long term leader in promoting sustainable development in the country. They introduced the Green Mark green building rating system in 2005 and this provided the benchmark for evaluating the environmental performance of their buildings. This was followed in 2006 by the introduction of a 'Green Master Plan' that has been subsequently revised twice with the 3rd "Green Master Plan" launched in 2010. The key objectives of the Master Plans were to establish green building as the norm in Singapore, to green both new and existing buildings, develop green technologies and design innovation and to ultimately establish Singapore as a global leader in sustainable development. In 2010 they developed a "Sustainability Blueprint" that set a very ambitious target of greening 80% of its existing building stock by 2030. This was embraced by the industry and indications ae that this goal will be achieved — by 2014 more than 25% of the existing building stock had been "greened".

In 2012 the Singapore government introduced further requirements specifically targeted at existing building owners. Existing building owners are required to submit annual reports via a Building Energy Submission System (BESS) that detail information about their building and its energy consumption. Existing building retrofits are required to incorporate stringent energy usage standards and comply with the minimum environmental standards set by the Green Mark scheme. This includes regular energy efficiency audits.

A number of financial incentives are provided to encourage existing building owners to retrofit their buildings to become more sustainable. This includes a Green Mark Incentive Scheme that provides cash incentives for sustainable retrofits. To help address the issue of the typically high initial costs with sustainable retrofits, the Building Retrofit Energy Efficiency Financing (BREEF) Scheme financing program was established.

4.4 Paris

In Paris, a lot of work has been done to encourage large businesses in the city to sign up to the "Paris Climate Action Charter" to help meet their "Climate-Energy Plan" objectives. Under this charter, the Paris District Heating Company, which supplies approximately one-third of heating launched a programme to reduce pollution and promote renewable energies. Over 30 large businesses have now signed up to the Charter.

In terms of encouraging the retrofitting of the existing building stock, Paris has initiated a plan for 1000 buildings to undergo energy-targeted renovations by 2020. This is also supported by the annual investment of approximately US$44 million to help encourage/finance the retrofitting of residential buildings. In 2015 legislation was introduced requiring the rooftops on all new or refurbished buildings in commercial zones to be partially covered in plants or solar panels to improve energy performance. Authorities also conduct GHG inventory and energy consumption assessments of public/community buildings every 5 years.

4.5 New York

New York was an early global leader in policies focusing on improving the energy performance of the existing building stock. In 2009 they developed a "Greener Greater Buildings Plan" (GGBP) that incorporated benchmarking, energy audits and retro-commissioning and a new energy code. This was supported in 2010 by the establishment of the New York City Energy Conservation Code (NYCEEC) — an independent, non-profit financial corporation to help implement the GGBP. The GGBP requires large commercial buildings to benchmark their energy and water consumption with the Energy Star rating scheme with the data published online. Buildings over 50,000 sq feet must have periodic energy audits and undergo energy retrofits if required.

They have adopted the slogan of "One City-Built to Last" and have an all-inclusive 10 year plan to target all public/private buildings that need major energy upgrades. Energy performance targets have been developed for existing buildings to be achieved through both voluntary reductions and new regulations. The target is to reduce the city's building emissions by 30% by 2025.

The city also provides considerable financial incentives through funding of approximately US$ 250 million per annum to support a wide range of program that include direct financial incentives for energy reduction. Tax credits are also provided through the 'New York State Green Building Tax Credit' scheme that provides $US 25 million in tax credits for owners and tenants of existing buildings that meet established energy benchmarks. Lower interest loans are also provided to owners and tenants for energy reduction retrofits.

4.6 Hong Kong

Hong Kong established its Building Energy Codes in 1998 to articulate building compliance standards and this subsequently required mandatory compliance with the Buildings Energy Efficiency Ordinance (BEEO). The BEEO now has a statutory requirement for commercial buildings to have energy audits carried out every 10 years. In 2011, the Hong Kong government introduced a new plan titled the 'Building Design to Foster a Quality and Sustainable Built Environment' (BDF QSBE) for all new commercial buildings and retrofit projects to promote energy efficiency and green

design. The BDF QSBE requires that all new buildings and retrofits be assessed via the Hong Kong Green Building Council BEAM Plus rating system in order to receive concessions for additional gross floor area. In 2013 they launched the HK3030 campaign that included targets of reducing total building electricity use by 30% by 2030.

However, Hong Kong has arguably made its greatest mark by establishing one of the world's largest government funded financial incentive schemes to encourage private sector building owners to invest in environmental retrofits — the Buildings Energy Efficiency Funding Scheme (BEEFS). It has provided US$ 450 million for this scheme and new matching schemes secured for 2014-18 from two major electricity companies has added approximately US$100 million to this funding.

4.7 London

London has established a Green Organizations Program to encourage building owners to upgrade their buildings to be more energy efficient and to train their staff in the operational aspects. They also introduced an innovative RE:FIT retrofit program for commercial buildings to encourage retrofits and achieve cost savings in operation. The UK government has also set new ambitious national targets requiring all new homes built from 2016 and all new non domestic buildings from 2019 to be zero carbon. They have also established new energy benchmarking and disclosure requirements for both new and refurbished existing buildings. This comprises a sustainability statement (BREEAM or a Code for Sustainable Homes pre-assessment) and an Energy Strategy incorporating a detailed assessment of the energy demand of the building.

Financial incentives include the London Energy Efficiency Fund (LEEF) providing US$ 50 million in funding for energy efficient building retrofits.

4.8 Sydney

Sydney has developed a "Greening Your Business" sustainability program to help meets its ambitious target of reducing carbon emissions in the city by 70% by 2030. It comprises 4 main pillars: Smart Green Business — assisting program participants, City Switch Green Office — guidance and assistance for office building owners/tenants, Better Buildings Partnership — group of leading commercial property owners and Environmental Upgrade Finance. Sydney has also developed an Energy Efficient Master Plan.

Financial incentives are provided through Environmental Upgrade Finance and Environmental Grants Programs. The Environmental Upgrade Finance involves finance for sustainable retrofits/upgrades that are repaid through the city's council rate collections as an Environmental Upgrade Charge. The Grants Program provides grants with priority given to projects aligned with the city's "Sustainable Sydney 2030" strategic targets.

4.9 Dubai

Dubai introduced their "Green Building Regulations and Specifications Code" in 2012 for public buildings and in 2014 extended this to cover private commercial buildings. It incorporates the Estimada Pearl Rating System that is adopted widely in the United Arab Emirates. In 2015 their Green Building Council introduced their "Technical Guidelines for Retrofitting Existing Buildings". In a relative short space of time Dubai has been able to green nearly 9% of its existing building stock in line with the Estimada and other international rating tools. The Emirates Authority for Standardization & Metrology (ESMA) has set mandatory energy efficiency requirements and labelling systems for certain water and electrical fixtures. Dubai also has a Smart City Plan that includes a target of installing 250,000 smart meters and smart-grid power to all buildings by 2018.

The Dubai government has provided extensive financial incentives through collaboration with the private sector to provide US$ 545 million to retrofit 100,000 buildings to meet specified green building

standards. They have also allocated nearly US$ 14 billion for renewable energy projects. The overall aim is to reduce energy consumption by 30% by 2030.

4.10 Beijing

Beijing released their "Green Building Action Plan" in 2013 that requires all new buildings to achieve at least a 1 star rating (out of 3) under the Chinese Green Building Label-3 rating system. For developments over 20,000 m^2 a rating of at least 2 stars is encouraged. The plan also encourages the development of green eco-demonstration zones such as the Future Science and Technology City. These zones must have buildings that all meet a minimum 1 star rating and have at least 40% of the buildings achieving a 2 star rating or higher. Financial incentives are being developed with one Beijing District providing financial rewards based on areas of LEED certified building spaces.

4.11 Shanghai

Shanghai was the first city in China to introduce a green standard in construction. This was introduced in 2011 and was followed by the Shanghai Municiplaity 3 year Green Building Action Plan for the period 2014-2016. This requires all new civil buildings to meet the 1 star rating under the Chinese rating system and government office buildings over 20,000 m^2 are required to meet a minimum 2 star rating. Other policies, plans and regulations have been developed through the Special Planning Shanghai Green Building and Eco-City plans. This includes the monitoring of these standards and energy auditing. Financial incentives include subsidies awarded by the Shanghai government for buildings with exceptional green features.

5. Implementation Issues

5.1 Generally

McGraw Hill (2013) [6] has undertaken a series of global surveys on the main "green building and retrofit" implementation barriers and issues since 2008 and found that these barriers/issues were relatively consistent around the world. Their surveys covered construction consultancy and contracting organizations in 9 countries — the United States, Australia, Germany, Norway, United Kingdom, Singapore, South Africa, the United Arab Emirates and Brazil.

They found that the main challenge/issue was clearly cost. "Essentially, it comes down to cost. Whether real or perceived, higher first costs for green building efforts is viewed as the most significant obstacle between current levels of green building and future growth. In fact nearly all other challenges became significantly less important between 2008-2012. Therefore it is incumbent upon the industry invested in growing green to help more effectively make the business case for the market. This will require better measures and performance tracking, and building operators will need to become involved and educated on green so that they maximize the performance of green buildings, since even the greenest building can only yield results if it is operated and maintained efficiently" [6].

The lack of consistent measurable environmental has been identified by the Global Alliance for Construction [7]. The GABC (2015) [7] stress that "transparency and comparability rely on consistent data. Yet the way buildings are currently measured varies dramatically, this significant variability introduces high uncertainty in valuation and project-cost estimation". They highlight the need for the development of "international standardized and vertically integrated (inter-governmental) measurement and reporting to enhance the understanding and international comparison of energy efficiency data and relevant resource flows for reduced GHG emissions" and the "development of international data, measurement, and standards" in the built environment sector.

Fig. 1 shows the difference in global responses between the surveys undertaken by McGraw Hill (2013) [6] in 2008 and 2012 for the main challenges identified for increasing green building activity.

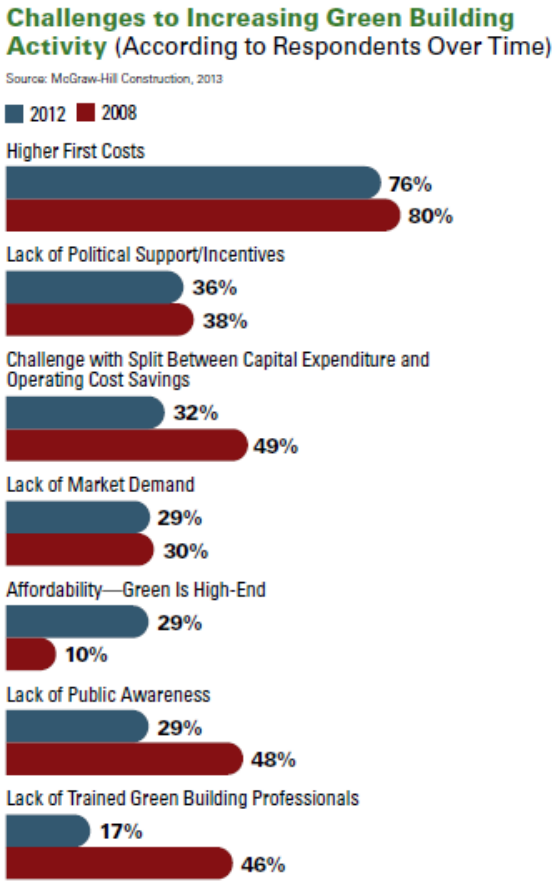

Fig. 1 Challenges to Increasing Green Building Activity (Difference in Survey Responses from 2008-2012) [6].

The McGraw Hill study showed that the next greatest issue after cost was a lack of government support and incentives followed by difficulties in articulating the business case to justify capital expenditure on green building. In countries where the green movement is less developed, a lack of public awareness was cited as a major inhibitor which highlights the importance of the education of not only the industry but also general society.

Sourani A. & Sohail M. (2011) [8] identified the following major barriers to green retrofits and green construction generally in the following categories:

- lack of funding, restrictions on expenditure and reluctance to incur higher capital cost when needed
- lack of awareness, understanding, information, commitment and demand
- insufficient/inconsistent policies, regulations, incentives and leadership commitment
- insufficient/confusing guidance, tools, demonstrations and best practice
- vagueness of definitions and diversity of interpretations
- separation between capital budget and operational budget
- lack of sufficient time to address sustainability issues
- lack of long-term perspective
- general perception that addressing sustainability always leads to incurring greater capital cost
- resistance to change
- insufficient integration and link-up in the industry
- insufficient research and development.

The World Bank (2014) [2] contend that "some barriers to greater energy efficiency (in existing bui are specific to certain stakeholder groups. For example, high transaction costs relative to returns and the perceived unreliability of repayment often deter commercial banks from financing building EE projects. Other barriers are sector-wide, such as energy subsidies and/or a widespread lack of data and information on EE opportunities, costs, and benefits. Addressing systemic problems such as these typically requires policy interventions and support at the national and regional level, although municipal governments can be influential in policy design and implementation".

6. Recommended Retrofit Policies & Incentives

The World Bank (2014) [2] has recommended the following policy and regulation instruments and tools to improve the energy performance of both new and existing buildings. They emphasize that to be most effective these measures need to be accompanied by a portfolio of support programs and actions. This type of holistic approach will generally be more effective than standalone strategies.

(1) Energy Regulatory Policies

Usually formulated at the national or regional level, energy regulatory policies address general inefficiencies in energy markets.

(2) Mandatory Standards and Codes

Generally developed at the national and regional level and updated periodically, mandatory standards and codes address key market failures or inefficiencies, in this case, defined as situations in which rational decisions taken by market participants have led to negative or suboptimal economic outcomes for society as a whole.

(3) Labels and Certificates

These are means of recognizing and encouraging efforts that go above and beyond the mandatory requirements outlined above.

(4) Financial Facilitation Schemes

These include fiscal and monetary incentives to encourage investments in energy efficiency. Examples include tax credits, cash rebates, and capital subsidies, as well as special funding vehicles and risk-sharing schemes to increase funding and lending for investments

(5) Requirements for Energy Management

Mandatory energy performance benchmarking and disclosure programs that require large public and commercial buildings to monitor and Improving Energy Efficiency in Buildings (continues on next page)

(6) Public Sector Financial Management and Procurement Policies

These can have a significant impact on municipal efforts to retrofit public buildings and upgrade inefficient energy-consuming equipment.

(7) Awareness-raising and Capacity-Building Initiatives

Outreach and public information initiatives can help increase the knowledge and know-how of stakeholders and enable the design and implementation of effective EE programs and investment projects.

The details of the World Bank (2014) [2] recommendations are provided in Fig. 2.

However, Matisoff D. et al. (2016) [9] warn against an over-reliance on government mandates and focusing on new construction rather than existing buildings. “Numerous policies have emerged that promote green building as a means to overcome market failures related to buildings. However, to date, these policies have been incomplete at best, and most rely on mandates. Pigovian taxes and subsidies for building construction and operation have the potential to be far more cost effective than the command-and-control approaches that are typical of the construction market. For example, policies that could align these incentives to improve market efficiency include construction permitting fees, impact fees, and targeting subsidies to buildings that provide positive externalities. Designing a tax and subsidy system that accurately characterizes and quantifies context-specific costs and benefits associated with building construction and operation is far from simple. Several jurisdictions have taken small steps to provide these types of incentives, often relying on the point structure provided by USGBC’s LEED program. Nevertheless, policymakers should be mindful of the unintended consequences of encouraging too much new (green) building on undeveloped sites rather than retrofitting existing (brown) building stock”.

Sourani A. & Sohail M. (2011) [8] identified four key parties that are most capable of reducing green retrofit barriers. These were government (including regulatory bodies), professional/educational bodies, the supply chain and the end-users.

The IEA (2013) [4] argue that ‘whole-building’ performance policies are required that incorporate affordable widely available products that can be integrated into advanced retrofit building systems. This should also include new and innovative technology development strategies supported by a wide range of policies that will “drive technical solutions from concept to full market saturation”. The IEA (2013) [4] also advocate new cross-sectoral policies across the industrial, power and building sectors to facilitate the

diffusion of co-generation, waste heat utilization and renewable technologies.

Policies also need to embrace "smart city" strategies that cover "whole-of-city/precincts" approaches rather than policies that solely target specific market sectors or building types.

Policy Tools	Issues Addressed	Examples of Intervention	What City Government Can Do
Energy Regulatory Policies	Weak financial incentive to invest in EE by consumers Disincentive for energy utilities to invest in DSM activities due to lost sales	Remove general price subsidies for public, residential, and commercial users Decouple energy utility revenue from sales*	Support and participate in national or regional policy reform programs
Mandatory Standards and Codes	Split incentives, fragmented building trades, fragmented building ownerships, etc. Underinvestment in EE by equipment makers	Building energy efficiency codes Minimum energy performance standards for equipment	Set and/or enforce standards Encourage or mandate (public sector) purchase of EE equipment
Labels and Certificates	Lack of credible and consistent energy performance information and/or recognition of excellence	Energy Star label for equipment or buildings Green building rating systems	Promote the adoption of nationally/internationally recognized labels and certificates
Financing Facilitation	Insufficient financial incentive Lack of commercial lending to EE Risk concerns of commercial lenders	Subsidies for EE investments Dedicated EE fund and credit line Partial risk/credit guarantee	Use public funds to leverage private and commercial investments
Energy Management	Lack of transparent and consistent monitoring and control of energy use	Energy performance benchmarking and disclosure	Require energy performance benchmarking and disclosure for large public and commercial buildings
Public Sector Financial Management and Procurement Policies	Disincentive for EE efforts in budget-supported public entities Difficulty for public entities to contract energy service providers, or make EE equipment preferred purchase choices	Revise budgetary rules to allow retention of energy cost savings for other justified public spending Revise public procurement rules to allow for contracting of energy service providers and adopt EE purchase requirements	Make adjustments based on a city's own policy-making authority
Capacity Building and Awareness Raising	Inadequate knowledge and skills for BEEC compliance Lack of general awareness and sensitivity to energy waste Lack of specific knowledge and skills to perform energy management duties	Train building trades on BEEC requirements and proper approaches Public campaign to promote efficient use of energy Train building managers of large public and commercial buildings	Organize trainings and sponsor awareness campaigns

Fig. 2 Key Policy interventions & support — matching barriers with policy tools [2].

7. Conclusion

The full potential of the retrofit market is not yet being achieved. Globalization and government leadership provide the key to more effective global implementation of environmental retrofit solutions for the built environment.

Globalization provides the ability to share information and knowledge about best practices, technologies, materials and long term strategic plans that are being developed around the world. This paper has demonstrated that government leadership has been at the core of successful implementation but it is acknowledged that government intervention can be complicated and varies from country to country. For example, McGraw Hill (2013) [6] point out that in more developed markets such as in the USA, the UK and Canada governments provided the initial catalysts for green development in their countries. This helped demonstrate the value of green building and retrofitting and the green markets in these countries has reached relatively advanced and sophisticated levels. In contract, in countries such as Brazil and Chile, the private sector has been important leaders in encouraging green development but have now reached points where they require government intervention to increase the depth of green building to more meaningful levels. The right combination of market and government forces in individual countries will vary with a key challenge being developing the right mix to suit.

However, ultimately, cost and the business case will be the key determinants. Effective sustainable retrofitting and design relies on solutions that not only reduce environmental impact but can do so as economically as possible. Quantity surveyors should therefore be well placed to take advantage of this opportunity via their economic input.

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Academic Star

Modern Environmental Science And Engineering
Volume 4, Number 3, March 2018
Academic Star Publishing Company
228 East 45th Street, Ground Floor #CN00000267,
New York, NY 10017
Tel: 347-566-2153 FAX: 646-619-4168
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ISSN :2333-2581