FOSTERING ENERGY EFFICIENCY DYNAMICS THROUGH EX-ANTE STRATEGIC NICHE MANAGEMENT: THE UK PERSPECTIVE

Thakore, R.*, Goulding, J.S., and Toogood, M.

Centre for Sustainable Development, The Grenfell-Baines School of Architecture, Construction and Environment,
University of Central Lancashire, Preston, PR1 2HE, UK

*Corresponding author: rthakore@uclan.ac.uk

ABSTRACT

The United Kingdom building sector has been challenged to retrofit a huge stock of existing buildings in order to increase its adaptive capacity for climate change impacts. Addressing such challenges will require systematic structural changes in both, socio-technical and socio-political infrastructure. A numbers of studies have suggested the approach of strategic niche management of transition for sustainable technological regimes. Accordingly, any such transition would follow processes: early stages of niche formation; creation of policy mechanism required to harness the niches; niche expansion into incumbent regime; and the regime transition into more sustainable technological regime. Following this, the UK Government has introduced a raft of initiatives; one of which is "Green Deal" to enable buildings to become energy efficient through retrofit technologies, ultimately contributing towards the national goal of achieving 80% reduction in carbon emission by 2050. This paper serves three purposes. First, the paper introduces multi-level socio-technical system for construction/retrofitting in building industry. Second, the ex-ante strategic niche management approach has been used to analyse the dynamic of "Green Deal" initiative. Thereby the paper would critically assess technological, organisational and institutional reforms undertaken for the initiative in the processes for sustainable socio-technical transition. Third, the paper would contribute towards strategic niche management literature which lacks in practical examples of using it as an ex-ante tool for niche building and regime transition.

Keywords: *socio-technical transition, strategic niche management, mitigation and adaptation, Green Deal, retrofit technologies, energy efficiency*

1 INTRODUCTION

Anthropogenic activities resulting from technological and medical advances; and the consequential growth of population, agriculture and animal husbandry since last two centuries has led to exponential increase in carbon-dioxide concentration (Turner II *et al.*, 1990; Crutzen, 2000; McNeill, 2001; IPCC, 2001; Crutzen, 2002; IPCC, 2007). Particles of other gases such as methane, halocarbons, nitrous oxide and soot have also increased due to the burning of fossil-fuel, large-scale land-use changes, different energy uses, combustion and manufacturing processes. These all have collectively intensified climate change which would need careful mitigation and adaptation processes to accomplish societal sustainable development (Wilbanks *et al.*, 2003; Wilbanks, 2005; Wilbanks *et al.*, 2007; Bierbaum *et al.*, 2007; IPCC, 2007; Klein *et al.*, 2007a; Klein *et al.*, 2007b; Holdren, 2008; Moser, 2012).

Recognising the responsibility of tackling climate change and depending upon their capacity, the international community has set targets to reduce carbon emissions (UNEP, 2009). Consequently, the United Kingdom (UK) has set ambitious targets to reduce greenhouse gas (GHG) emissions by 80% by 2050 compared to the base year 1990 (DECC, 2009). Given this, buildings would need to be zero emissions by 2050 (DECC, 2010). UK has large existing building stock constructed ostensibly in 20th century and 87% will still exist in 2050. These buildings are heated and equipped with traditional energy intensive technology and appliances which use twice the energy used in Nordic countries (Lapillonne and Pollier, 2007). They account for 37% of the UK emissions. Also, it is posited that these buildings may not offer comfort, safety and resource efficiency to the users' expectations in coming years; instead their use would have unsustainable impacts on societal development. Moreover, the analysis show that the domestic consumers will pay 7.1% lower in 2020 than they would pay without policy interventions in place (DECC, 2011b). Thus energy efficiency plans for buildings are very crucial and retrofitting is required at a massive scale and at a very fast pace (Boardman, 2007; Hunt, 2008; Three Regions Climate Change Group, 2008). Retrofitting in buildings is not a new concept; however, speedy mass retrofitting of all existing buildings to increase energy performance in accordance to the Building Directive (European Union, 2010), in the domestic sector and bringing properties to bands A and B on the Energy Performance Certificates (Op. cit. Boardman, 2007) is certainly a huge challenge.

The UK Coalition Government has announced an initiative to make UK buildings more energy efficient. The initiative, "Green Deal", is a voluntary government policy propelled by an innovative financial mechanism. Accordingly, the consumer in the form of a household would implement energy efficiency measures in the building that are recommended by the "Green Deal" assessor and fully or partly financed by the "Green Deal" provider. The 'Golden Rule' associated with the "Green Deal" is that "the financial savings resulting from installing measures must be equal to or greater than the cost of repayment over the term of the "Green Deal" Plan" (DECC, 2011a). It is expected by the government that the "Green Deal" would improve energy efficiency immensely, contributing towards carbon reduction targets (DECC, 2010).

Socio-technical transitions are complex, multi-level, long-term transition processes that change existing, relatively stable, socio-technological regimes to drive the societal development with increased sustainability (Geels, 2002; Geels, 2004; Geels and Schot, 2007; Geels, 2010; Markard and Truffer, 2008; Smith *et al.*, 2010). The number of papers (for example: Schot *et al.*, 1994; Smith *et al.*, 2002; Smith *et al.*, 2005; Elzen and Wieczorek, 2005; Geels, 2005; Kemp and Loorbach, 2006; Hekkert *et al.*, 2007; Van der Laak *et al.*, 2007; Loorbach, 2007) within the remit of Socio-technical change, transition and management have analysed the transition process, factors affecting them, actors involved in the process and challenges of governing such transitions to assist the practitioners in facilitating and managing transitions. These studies have used strategic niche management (SNM) and transition management approach to analyse radical sustainable innovations. Mourik and Raven (2006) propose that SNM approach can be used as an ex-ante analytical tool to analyse the performance of state-of-the-art experiments and support project managers and niche developers. But "lack of detailed and practical guidelines for practicing project- and niche builders" (Mourik and Raven, 2006) have not allowed SNM to play an efficient role in promoting sustainable technologies (Caniëls and Romijn, 2006).

Transition management is the management of interrelated processes through the multi-layered complex system directed by an identified 'ex-ante' vision (Kemp and Rotmans, 2001, pp. 4). 'Niches' are innovative experimental projects that play a critical role for realisation of the 'ex-ante' vision sought through this transition. 'Strategic niche management' has been successfully used as an 'ex-post' tool to analyse the transition process (Caniëls and Romijn, 2006) and thus it is believed by number of studies that it can be used as an 'ex-ante' tool to manage such promising niches for diffusion into the system through policy intervention, building competencies and new skills, or creating new demand/markets (Berkhout *et al.*, 2003 and other authors cited elsewhere in the paper).

The main aim of this paper is to analyse the dynamics of the "Green Deal", an innovative programme that has been proposed to "foster the building of green technology manufacturing capability in the UK" (The Green New Deal Group, 2012). The "Green Deal" makes an interesting case study because over the time, it would bring significant socio-technical change: for example, 14 million energy efficient buildings would be retrofitted with energy saving measures such as increased insulation, smart meters and renewable energy wherever applicable; reduce costs on energy imports; create employment and stimulate the economy (The Green New Deal Group, 2012). The aim is achieved by introducing socio-technical system for construction/retrofitting in building industry comprising of multi-levels and using SNM to critically assess various reforms undertaken for the initiative to help the niches flourish and contribute towards the transition of sustainable technological regime. Novelty of the paper lies in its contribution towards SNM literature which lacks in practical examples (Mourik and Raven, 2006; Healey, 2008; Raven *et al.*, 2010).

The SNM literature has already identified processes responsible for successful transition to sustainable regimes (Kemp *et al.*, 1998; Kemp and Rotmans, 2001; Geels, 2002). Analysing dynamics of the "Green Deal" programme using SNM ex-ante approach would help to critically assess the reforms undertaken for the programme and guide the practitioners (different actors at different levels) for improved actions. The case study is carried out purely based on documentation which is the primary source of information easily available for any "Green Deal" stakeholder. They include research papers, reports, policy reviews, special group reports, consultation papers and information from websites. Though, the authors acknowledge weaknesses lying with documents such as unintentional bias in selected documents or documents' authors, and no access to confidential documents. Empirically, the paper will scrutinise the activities related to the "Green Deal" and discuss the existing arrangements to foster green technologies related to high uptake of energy efficiency measures in buildings adopting constructivist/interpretivist approach. This would result into better understanding of the conceptual contexts and perceptions of various actors to collectively strengthen the normatively-desirable transformation.

The paper is structured as follows: Section 2 discusses characteristics of strategic niche management. Section 3 introduces construction/retrofitting socio-technical regime and discusses the "Green Deal" modus operandi. Section 4 critically assesses whether the innovative financial reform introduced for the "Green Deal" would help the transition of retrofitting incumbent regime into sustainable technological regime. Finally, Section 5 concludes with some practical suggestions for the practitioners.

2 STRATEGIC NICH MANAGEMENT

Kemp *et al.*, (1998), Hoogma *et al.*, (2002) and Raven (2005) have suggested SNM for the transition of technological innovations into the mainstream. Number of studies (for example, Kemp, 1994; Kemp and Soete, 1992; Rip, 1995; Schot *et al.*, 1994; Schot and Rip, 1996; van den Belt and Rip, 1987) have effectively analysed the socio-technical transition to understand the importance of underlying dynamics and mechanisms responsible for technological transitions. Kemp *et al.* (1998) analysed results of early market introduction of sustainable technologies and identified various factors hampering its widespread growth. They include lack of technical stability, weak regulatory framework; societal preferences and values; lack of demand; incompetent infrastructure for maintenance; and unknown impacts of new technologies. Even so, scholars argue that radical innovations succeed (Winskel, 2002; Correljé and Verbong, 2004; Geels, 2005a; Geels, 2005b) and the transition takes place involving two levels: the 'socio-technical landscape' and 'niches' (Rip and Kemp, 1998; Geels, 2002; Raven, 2005). The scholars have effectively analysed the success of historical transitions of innovative technologies using SNM and multi-level transition perspectives, emphasising the role of innovative technological niches, diverging from the existing regime, emerging as a new regime and subsequently transformed into sustainable technological regime (Smith, 2002).

Weber *et al.* (1999) suggests that SNM is instrumental in organising projects of innovative sustainable technologies. They suggest two stage processes and make distinction between experimental projects and niche. The

experimental projects are carried out in isolation for interacting, networking and learning process, simultaneously acting as the starting point (first stage) for the development of a niche. Projects when carried out on multiple scales accumulate to form an innovative technological niche (second stage). Niche is the result of more developed experimental interrelated projects in time. Moreover, Leonard (1998) recognises that SNM is particularly advantageous in the early development process of niche formation, especially when there is considerable uncertainty in terms of technological specification and the users' preference (market). It pinpoints that SNM is a market research tool which would help to identify critical information of the users' preferences and technology suitability and assist in developing an absolute design for the potentially radical and sustainable technologies.

Geels and Raven (2006a, 2006b) define that SNM is the valuable tool for practitioners who are managing cluster of interrelated experimental projects, striving to transit innovative technologies into the mainstream. The tool is particularly useful in ex-post analyses of the actions for management of projects at local niche level rather than management of individual project. The analyses show that the actions aligns with the local expectations and rules of global niche level, guiding the managers for more consistent actions at local level and making all relevant resources admissible for the development of the niche. The evolutionary interactions of local success with the global targets, contributes towards the formation of a stabilised niche. Based on ex-post analysis, number of researchers (for example, Hoogma *et al.*, 2002; Schot *et al.*, 1999; Weber *et al.*, 1999; Caniëls and Romijn, 2006; Rotmas and Loorbach, 2006; Loorbach, 2007) have attempted to develop a conceptual framework and enable the practitioner to understand "real life" complexity from "multi-stakeholder approach" (Grablowitz *et al.*,1998). However, there is very little evidence of using SNM as an ex-ante tool. In order to enhance the use of SNM tool as an ex-ante tool for regime transformation, the case of "Green Deal" is appropriate for a number of reasons: It illustrates the niche formation process at micro-level as a result of successful experimental projects, collectively contributing towards the formation of a socio-technical landscape of energy efficient building technology. The dynamics of the "Green Deal" well illustrates that regime solutions are appropriate for societal challenges. Though some (practitioners?) doubt if the "Green Deal" would be able to bring about accepted stimulation and effective policy and practices integration for these actions at all levels of the regime (Silverman, 2012), the prominence of the "Green Deal" issue (HMSO, May 2013) makes it especially appropriate case for analysis by sustainability transition managers.

3 THE "GREEN DEAL": MODUS OPERANDI

For this study, the "Green Deal" niche formation is conceptualised by collection of successful experimental projects, linking innovations within the existing socio-technical regime of building industry. This section will introduce socio-technical regime, multilevel perspective of SNM, discuss experimental projects and innovative financial mechanism attached to the "Green Deal" modus operandi.

3.1 Socio-technical regime

Socio-technical regime consisting of physical, natural, social, economic, cultural and cognitive attributes (Rip and Kemp, 1998). The regime is a combination of components such as artefacts, material networks, economic system dependent on the artefact, lifestyles adapted to the artefacts, infrastructure and technology, and supply chain created by and for the artefacts. The technical systems of production and distribution when incorporate the components related to the users, they are called socio-technical regime (Geels, 2004). The socio-technical regime of construction/retrofitting in the building industry is shown in Figure 1. Complementarities between components make these systems function; nevertheless these complementarities are equally responsible for making them dynamically rigid, standard, stable, or locked-in (Staudenmaier, 1989; Rycroft and Kash, 2002; Arthur, 1988; Rip and Kemp, 1998; Walker, 2000). Socio-technical systems established in the form of "wider, linked processes" and "embedded with firms and technologies" support societal needs such as housing, mobility, food, communications and so on (Smith *et al.*, 2005; Rip and Kemp, 1998; Geels, 2002a, b). Modern societies are challenged by serious problems such as increasing carbon emissions and adverse effects of

climate change. Thus, radical changes and a new technology shift in these socio-technical systems are necessary more than ever (Berkhout, 2002).

The regime constitutes of the environment provided by (1) rules and regulations: for example, Climate Change Act, 2008 and Climate Change Agreement (DECC, 2012); (2) institutional and technological capacities: such as energy efficient heating, ventilation and air conditioning appliances, efficient building fabric material, energy saving lighting and water heating, and appropriate micro-generation technologies (DECC, 2011c); and (3) regime actors such as Green Deal provider, installers, accredited assessors, approved products suppliers and Energy companies in context of this study (See Figure 2). Such regimes are the facilitator for the change (Van der Vleuten and Raven, 2006). Moreover, regime members are making conscious efforts to address recognised challenges; and resources and responses are directed towards innovative activities with high coordination to solve the problem.

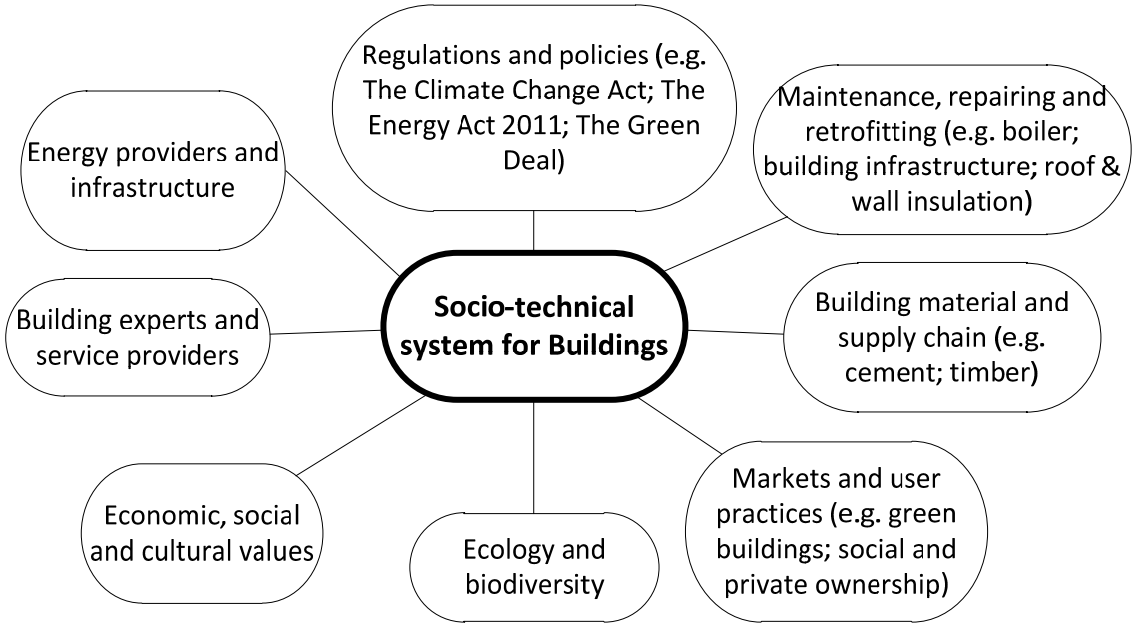

Figure 1: Socio-technical system for Building industry (Adapted from Geels, 2005b)

Niches are protected 'spaces' from the existing regime. They are experimental projects to test new and innovative practices. Successful niches change the whole constellation attached to those practices and provide solutions to the existing regime problems. They allow "building of social networks", "learning and articulation processes" and "articulation of expectations and visions" before diffusing into market (Geels and Raven, 2006; Raven *et al.*, 2010).

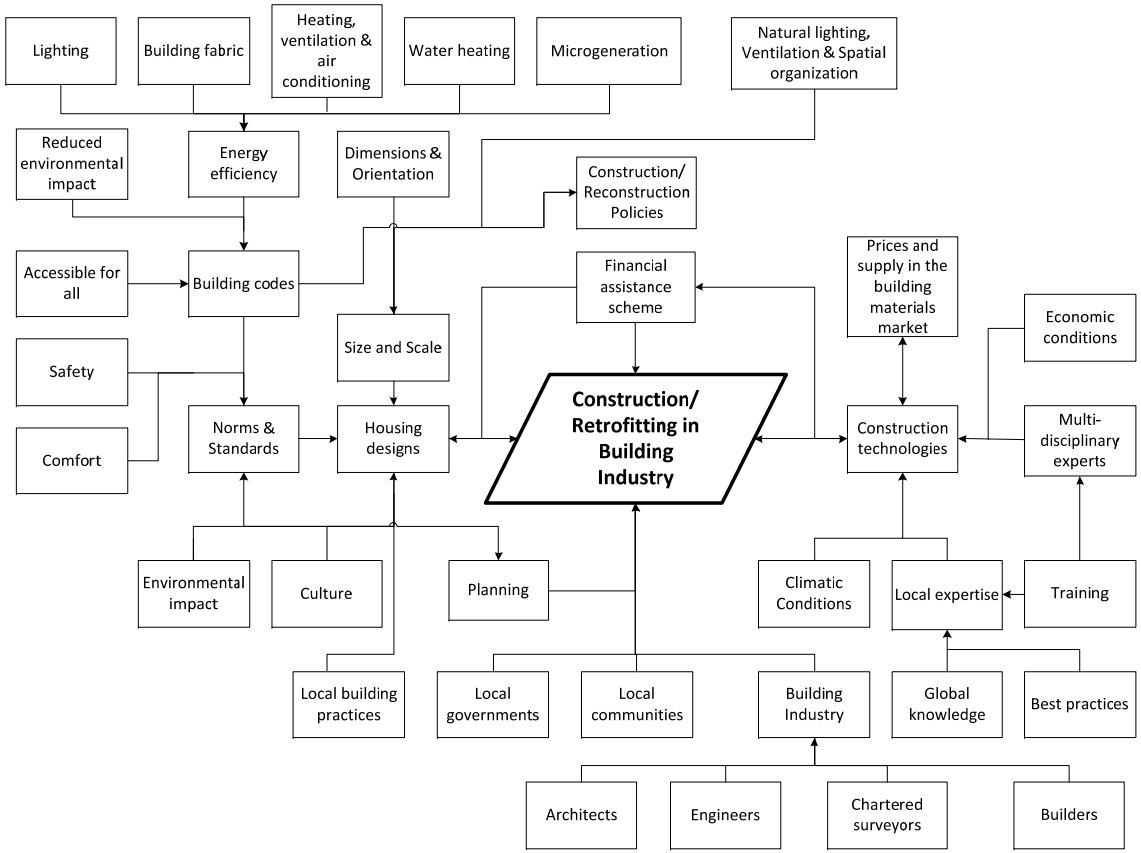

Figure 2: Socio-technical regime for construction/retrofitting in building industry (Adapted from DECC, 2011c; Geels, 2002; Jha et al., 2010)

3.2 Multi-level perspective

Multi-level perspective is widely accepted in transition theory (Rip and Kemp, 1998; Geels, 2002). Accordingly, the transition occurs at three operational levels: macro, meso- and micro- embedded within three analytical concepts: landscape, regimes and niches respectively.

Landscapes constitute of macro- level strategies and policies that play a major role in developing regimes and niches (Raven *et al.*, 2010). In this study of the "Green Deal" case, the external and internal social contexts are: reduction of carbon emissions; save energy and reduce the cost of imported energy; and reduce the risk of climate change as shown in Figure 3. At meso- level, it would "support" 1000 "Green Deal" apprentices and create 100,000 jobs by 2015; and stimulate economy by adding £10 billion into the

economy (through feedback mechanism). It will also develop a new regime comprising of the competent and skilled actors dealing with the retrofitting industry such as "Green Deal" providers, approved assessors and approved product suppliers. At a micro- level, 14 million buildings would be energy efficient. It would decrease consumption of energy, reduce energy bills and increase comfort (DECC, 2010).

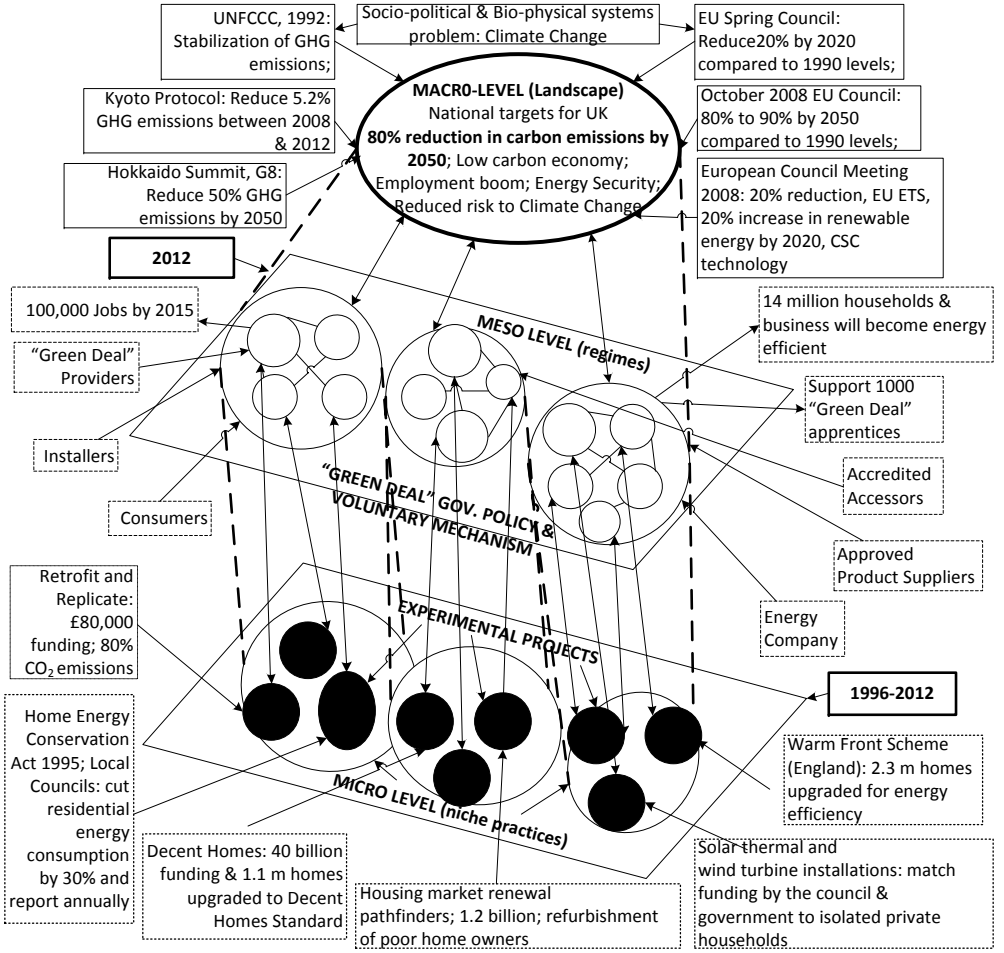

Figure 3: Multi-level perspective of the "Green Deal

3.3 Innovative financial mechanism

The "Green Deal" is propelled by "a market mechanism, funded by private capital". It is available to the consumers with no upfront or additional cost. The cost for improving energy efficiency of the building is paid back through savings on energy bills (See Figure 4). The "Green Deal" plans have some prerequisites such as the energy efficient measures should be advised by an accredited adviser and installed by an accredited installer. The "Green Deal" provider should obtain the consent of relevant parties and provide the deal within the terms of the Consumer Credit Act. The "Green Deal" measures are attached to the building and thus financial obligation also remains with the building. When the building owner moves out, the financial obligation moves to the next bill payer. The "Green Deal" also promotes a 'whole building' approach, which means that the improvements have to be carried out only once without having repeated disruptions. It could include hot water efficiency measures within energy efficiency measures. Moreover, micro-generation technologies will be encouraged wherever applicable. Energy performance certificates will be issued to every consumer (DECC, 2011b). A full review of the building based on water, heating and other sources of energy use would be given as part of broader sustainability information under the "Green Deal".

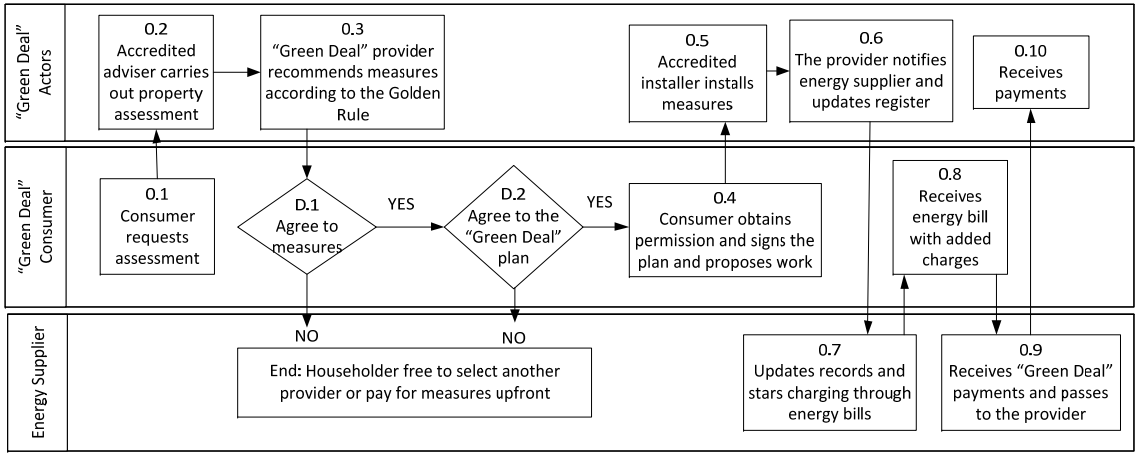

Figure 4: The "Green Deal" plan modus operandi. Source: DECC, 2011

4 THE GREEN DEAL: CHALLENGES AND OPPORTUNITIES

This section critically assesses the role of experimental projects in early stages of niche formation; and whether the innovative reforms attached to the "Green Deal" would harness the niches and lead into incumbent regime, ultimately transforming to a sustainable technological regime.

4.1 Experimental projects and niche formation

Since 1996, the UK Government and local authorities have been supporting local experimental projects in retrofitting buildings through various incentives and funding. These experiments have shown successful results such as: reduction of 80% of carbon emissions for buildings in Retrofit and Replicate project; solar thermal and wind turbine installations to isolated private buildings in Wear Valley District Council; 2.3 million buildings upgraded for energy efficiency and further 230,000 buildings will receive

assistance in 2010-12 through Warm Front Scheme; reduction of 30% of energy consumption through energy efficiency programmes by local councils; 1.1 million buildings brought to Decent Homes Standards (NAO, 2011); and refurbishment of buildings of poor owner-occupiers. Both, technology and actors have matured in acquiring expertise, training and knowledge exchange, theory development through empirical examples, workforce and relevant skills (Hunt, 2008; DECC, 2011c). Carbon emissions from buildings fell by 18%, £800 million were saved on energy bills and £1.3 billion on heating in 2011 (DECC, 2011b). Joh de Souza, director of sustainability, regions, and demonstrations at Constructing Excellence (Hunt, 2008, pp. 5) adds that these experiments have contributed towards the adapting capacity in housing industry, for example, good high density office accommodation; 'Cooldeck' night cooling system, or 'phase change material' to increase the 'virtual mass' to avoid use of energy intensive cooling system for day and night time. Thus, the experimental projects have been successful in stimulating niche formation process, especially in technological aspects.

4.2 Supported reforms and incumbent niche

The "Green Deal" is supported by various policy reforms for the niche expansion. Additional measures such as planning measures: Building Regulations Part L1B[1] (HM Government, Oct 2010); and regulatory measures: Energy Act 2011 [2] (HM Government, Oct 2011) would put pressure on private landlords (nearly three quarters of the UK buildings are owned by private landlords (Hunt, 2008)) to have minimum energy efficiency measure. The low-income and vulnerable households would be supported directly by the Government to implement energy efficiency retrofit measures. Further, the UK Government is developing similar policy instruments for low carbon heat to increase the options for consumers. Issuing consumer friendly Energy Performance Certificate would add security and validity for the energy efficiency measures. The broader sustainability review of the natural resources used in the building will be carried out which would serve several objectives such as awareness of energy consumption; development of strategy to decrease energy consumption; and uptake of sustainable lifestyles. Special provisions would encourage local authorities to support social landlords, stimulate the "Green Deal" and provide guarantee to suppliers. Furthermore, the government is working on expensive energy measures and bring the cost down (DECC, 2011b). Thus the uptake of "Green Deal" plans would increase energy efficiency in many properties, improving management practices at institutional level, increase local employment and training opportunities align processes for adaptations and enhancing local awareness on climate change as expected by the Department for Communities and Local Government (2011c).

System-level change is accomplished through the involvement of actors at all levels; and coordination and steering of actions and resources, all contributing towards the transformation processes (Jacobsson and Johnson, 2000). Though, the actors measure the legitimacy of emerging technology differently (Healey, 2008), the niche should be equipped with high profiled and competent actors at all levels falling into institutional, technical and social categories to increase the potential of actualising sustainable transition Berkhout *et al.*, (2003). This would allow creation of new knowledge; influence search directions; increase supply of resources; create positive external economies and formation of markets. In this process the role of governance is very important. Whenever there is a shortage of resources or adaptive capacities, efforts or intervention should be made to deploy and monitor sustainable transition process (Smith *et al.*, 2005). Special publication from the forum for the future (Hunt, 2008) has identified agents for change which include local and regional authorities; housing associations; energy and technology companies; and mortgage providers; estate agents; surveys; communities and individual building owners. These all actors would have to collectively contribute towards achieving targets of 80% reduction of carbon emissions by 2050. SNM literature is not clear about how the values, ideas and interests of various influencers (actors) could be accommodated for the radical shift to sustainable technological regime (Berkhout *et al.*, 2002) and thus the discussion on this does not fall

[1] The Building Regulations 2010 Part L1B is an approved document for 'Conservation of fuel and power' in existing dwellings to provide practical guidance on compliance with 'energy efficiency requirements' for England and Wales.

[2] Energy Act 2011 is introduced to make provision for the arrangement and financing of energy efficiency improvements within the properties.

in the scope of this study. The UK government has recognised the need for a competitive market for the "Green Deal" delivery. It has developed training programmes, guidelines and essential support for the development of consumer-facing roles for following actors: "Green Deal" Adviser, "Green Deal" Provider and "Green Deal" Installer.

The "Golden Rule" of the "Green Deal" expects savings from the energy efficiency measures to be greater than the cost for the measures implement (DECC, 2010). Paying no upfront cost and savings earned through energy efficiency would undoubtedly be attractive to the consumers. However, not government or the installer can guarantee actual cash savings because the use of the building is subject to the users' awareness, practices and sense of ownership and responsibility (Cullen, 2005). The implementation of energy efficiency measures at the building site is again subject to owner's preferences and affordability. The consumer is the decision maker in modus operandi of the "Green Deal" plan as shown in Figure 4. Energy efficiency techniques will involve many technical specifications which would be difficult to understand for a consumer. Also the efficiency techniques would depend on the local social-technical niche. These would constrain a consumer from having easy choice for the "Green Deal". The niche expansion would depend on the expansion of the local niche. The local niche would have its own characteristics with building types, technologies, efficiency measures and consumers. These characteristics should be measures, quantified and translated into meaningful sustainability indicators for consumers to use in measuring and monitoring sustainability.

The "Green Deal" policy has a long term implications on the energy efficiency of the households and at the time of writing this paper, there are no reports available to comment on the improvements carried out by it. Initial monitoring and evaluation report by the government (See HMSO, 2013) states the fact that 62% of the UK residents were not aware of this initiative and demonstrates a very challenging time ahead. From 19,000 homes assessed for the green deal programme, only 200 homes have signed for it, against the accepted figure of 10,000 homes by the Energy Minister Greg Barker (BBC NEWS, 7 June, 2013). The "Golden Rule" which was thought to be the key to success is proving to be the most "complicated rule" for the homeowner (Owen, 2013). A slow uptake of this policy shows that the anticipated results would not materialise without taking steps for effective marketing and offering attractive incentives to the consumers. The 'visions and expectations' would need to be translated into the 'requirements' of the society. Moreover, data collection and analysis of the actual carbon savings using energy efficiency measures would help to demonstrate the advantages of this policy.

5 CONCULSION

The dynamics of the "Green Deal" were analysis using SNM ex-ante approach, it is posited that the "Green Deal" is an innovative mechanism and has the potential of creating sustainable technological regime. Experimental projects, essential for the niche formation process were funded and that allowed innovation for development of essential complementarities of incumbent niche. The skills and knowledge developed by the experimental projects have reinforced the transitions flow. Eighty percent of reduction in energy consumption was received through retrofitting the buildings with the mix of energy efficiency measures; development of institutional and technological capabilities; and building social networks. With the UK government committed to cut 80% of carbon emissions by 2050, there is an urgent need for such projects to scale up widely and go beyond the local level in an integrated way and develop into a sustainable technological regime, where sub-systems can support each other in a coordinated way for a common goal. The "Green Deal" has been advocated as a pivotal initiative of the UK Government to address the challenges of energy efficiency. This has a natural interface with the global initiatives in response of the global climate change and sustainability agenda.

Analysis of the "Green Deal" show that it is a systematic coordinated response programme, however the role of government is very important in such long term sustainability transition process. As advised by Smith *et al.* (2005), whenever there is a shortage of resources or adaptive capacities, efforts or intervention must be made to deploy and monitor sustainable transition process. Also the role of consumers is very important. The savings

through the "Golden Rule" depends on the actually energy consumed in the building. The Consumer will have to take ultimate responsibility for reducing energy consumption and turn the "Green Deal" into a real financial deal. Though the "Green Deal" has been reinforced by accreditation and consumer protection measures; the government would have to take strategic approach to educate consumer to maximise the benefits. Research findings advocate the need for full engagement with stakeholders. Moreover, it is posited that the delivery and dynamics highlighted in the Figure 4 should also be extended to include a greater granularity of details, particularly in the unit of analysis and metrics employed for measuring and quantifying energy efficiency sustainability indicators.

REFERENCES

Arthur, W. B., (1988). 'Competing technologies: an overview'. In (Eds.). Dosi, G., Freeman, C., Nelson, R., Silverberg, G., Soete, L. Technical Change and Economic Theory. Pinter. London. pp. 590–607.

BBC NEWS. (2013). 'Only 200 homes' signed up for Green Deal energy loans.' [Online] Available at: http://www.bbc.co.uk/news/uk-politics-22815902 (Assessed on 08 June 2013).

Berkhout, F. (2002). 'Technological regimes, path dependency and the environment.' Global Environmental Change. V. 12. pp. 1–4.

Berkhout, F., Smith, A., and Stirling, A. (2003). 'Socio-technological regimes and transition contexts.' Science and Technology Policy Research. Paper No. 106.

Berkhout, F., Smith, A., and Stirling, A. (2002). Technological regimes, transition contexts and the environment. Paper presented to the Twente workshop onTransitions and System Innovations. Enschede. 4-6 July.

Bierbaum, R. M., Holdren, J. P., MacCracken, M. C., Moss, R. H., and Raven, P. H. (2007). Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable. Report prepared for the United Nations Commission on Sustainable Development. April 2007.

Boardman, B. (2007). Homes Truths: A low-carbon strategy to reduce UK Housing emissions by 80% by 2050. A research report for The Co-operative Bank and Friends of the Earth. University of Oxford. UK.

Caniëls, M. C. J., and Romijn, H. A. (2006). Strategic Niche Management as an Operational Tool for Sustainable Innovation: Guidelines for Practice. Paper for the Schumpeter Conference 2006. 21 -24 June. Nice. France.

Coreljé, A., and Verbong, G. P. J. (2004). 'The transition from coal to gas: radical change of the Dutch gas system'. In Elzen, B., Geels, F. W., Green, K. (Eds.). System Innovation and the Transition to Sustainability. Edward Elgar. Cheltenham and Northampton. pp. 114-133.

Crutzen, P. J. (2000). 'The "Anthropocene".' Global Change NewsLetter. Issue 41. pp. 17-18. The International Geosphere-Biosphere Programme (IGBP).

Crutzen, P. J. (2002). 'Geology of mankind'. Nature. V. 415. pp. 23.

Cullen, S. (2005). Involving users in supported housing. A good practice guide. Shelter. London.

DECC. (2009). Climate Change Act 2008 Impact Assessment. Department of Energy and Climate Change. London. UK.

DECC. (2010). The "Green Deal". A summary of the Government's proposals. HMGovernment. London. UK..

DECC. (2011a). What measures does the "Green Deal" cover? Department of Energy and Climate Change. London. UK.

DECC. (2011b). The Carbon Plan: Delivering our low carbon future. Department of Energy and Climate Change. London. UK. December 2011

DECC. (2011c). the warm front team. connecting with communities. Department of Energy and Climate Change. London. UK.

DECC. (2012). Climate Change Agreements. Department of Energy and Climate Change. [Online] Available at: http://www.decc.gov.uk/en/content/cms/emissions/ccas/ccas.aspx (Assessed on 07 September 2012).

Department for Communities and Local Government. (2011). Assessment of the Decent Homes Programme. Her Majesty's Stationery Office. 2011.

Directgov. (2012). Warm Front Scheme. Her Majesty's Stationery Office (HMSO). England. UK.

Elzen, B., Hoogma, R., and Schot, J. (1996). Mobiliteit met Toekomst; Naar een vraaggericht technologiebeleid (Mobility with a Future. Towards a demand-oriented technology policy). Report to the Ministry of Traffic and Transport (in Dutch). Rotterdam: Adviesdienst Verkeer en Vervoer. Rijkswaterstaat.

Elzen, B., and Wieczorek, A. (2005). 'Transitions towards sustainability through system innovation'. Technological Forecasting and Social Change. V.72 (6). pp. 651–661.

European Union. (2010). 'Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.' Official Journal of the European Communities. The European Parliament and the Council of the European Union. Strasbourg.

Geels, F. W. (2002). 'Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study'. Research Policy. V. 31. pp. 1257-1274.

Geels, F.W. (2004). 'From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory'. Research Policy V. 33 (6–7). pp. 897–920.

Geels, F. W. (2005a). 'The dynamics of transitions in socio-technical systems: A multilevel analysis of the transition pathway from horse-drawn carriages to automobiles (1860-1930)'. Technology Analysis and Strategic Management. V. 17 (4). pp. 445-476.

Geels, F.W. (2005b). 'Processes and patterns in transitions and system innovations: refining the co-evolutionary multi-level perspective'. Technological Forecasting and Social Change. 72 (6). pp. 681–696.

Geels, F. W. (2005). Technological transitions and system innovations: A co-evolutionary and socio-technical analysis. Edward Elgar. Cheltenham

Geels, F. W., and Raven, R. P. J. M. (2006a). 'Socio-cognitive evolution and co-evolution in competing technical trajectories: Biogas development in Denmark (1970-2002)'. International Journal of Sustainable Development and World Ecology. V. 14 (1). pp. 63-77.

Geels, F. W., and Raven, R. P. J. M. (2006b). 'Non-linearity and expectations in niche development trajectories: Ups and downs in Dutch biogas development (1973-2003)'. Technology Analysis and Strategic Management. V. 18 (3/4). pp. 375-392.

Geels, F. W., and Schot, J. (2007). 'Typology of sociotechnical transition pathways'. Research Policy. V. 36. pp. 399–417.

Geels, F. W. (2010). 'Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective'. Research Policy V. 39 (4). pp. 495–510.

Grablowitz, A., Board, P., Craye, M. and Weber, M. (1998). Strategic Management of Sustainable Transport Innovations. Institute for Prospective Technological Studies. Seville.

Healey, G. P. (2008). Fostering technologies for sustainability: Improving Strategic Niche Management as a guide for action using a case study of wind power in Australia. PhD Thesis. RMIT University. February 2008.

Hekkert, M.P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S., and Smits, R. E. H. M. (2007). 'Functions of innovation systems: a new approach for analysing technological change'. Technological Forecasting and Social Change. V. 74 (4). pp. 413–432.

HM Government. (2010). The Building Regulations 2010. Conservation of fuel and power. The Office of Public Sector Information. Oct 2010.

HM Government. (2011). Energy Act 2011. 2011 CHAPTER 16. The Office of Public Sector Information. 18 Oct 2011.

HMSO. (2013). Energy and Climate Change – First Report: The Green Deal: watching brief. Reported by the House of Commons. Printed on 14 May 2013.

Holdren, J. P. (2008). 'Science and Technology for Sustainable Well-Being'. Science. V. 319 (5862). pp. 424-434.

Hoogma, R., Kemp, R., Schot, J., and Truffer, B. (2002) Experimenting for sustainable transport: the approach of strategic niche management. Spon Press. London UK.

Huhne, C. (2011). In DECC. (2011b). The Carbon Plan: Delivering our low carbon future. HMGovernment. London. UK. December 2011. pp. 1.

Hunt, M. (2008). 'The Future is Retro-fit. Bringing the housing stock up to scratch'. Green futures. Forum for the future. Special publication. pp. 1-28.

Leonard, D. (1998) 'Learning from the market'. In Leonard, D., Wellsprings of Knowledge. Harvard Business School Press. Boston/Masachusetts. Ch. 7. pp. 177-212.

IPCC. (2001). Climate Change 2001: the scientific basis. Contribution of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Report Number 22. Cambridge University Press. Cambridge, UK, and New York, USA.

IPCC. (2007). Climate Change 2007: contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, New York.

Jha, A. K., Barenstein, J. D., Phelps, P. M., Pittet, D., and Sena, S. (2010). 'Housing Design and Construction Technology.' In Safer Homes, Stronger Communities: A Handbook for Reconstructing after Natural Disasters. Chapter 10. The International Bank for Reconstruction and Development/The World Bank. Washington DC.

Jacobsson, S., and Johnson, A., (2000). 'The diffusion of renewable energy technology: an analytical framework and key areas for research'. Energy Policy. V. 28. pp. 625–640.

Kemp, R. (1994). 'Technology and the transition to environmental sustainability – The problem of technological regime shifts'. Futures. V.26 (10). pp.1023-1046.

Kemp, R., and Loorbach, D. (2006). 'Transition management: a reflexive governance approach.' In Voß, J. P., Bauknecht, D., and Kemp, R. (Eds.). Reflexive Governance for Sustainable Development. Cheltenham / Northampton: Edward Elgar. pp. 57-81.

Kemp, R., and Soete, L. (1992). 'The Greening of Technological Progress'. Futures. V. 5. pp. 437-457.

Kemp, R., Schot, J., and Hoogma, R. (1998). 'Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management'. Technology Analysis and Strategic Management. V. 10 (2). pp. 175–195.

Klein, R., Sathaye, J. and Wilbanks, T. (2007a) 'Challenges in integrating mitigation and adaptation as responses to climate change'. Mitigation and Adaptation Strategies for Global Change. V.12. pp. 639-962.

Klein, R. J. T., Huq, S., Denton, F., Downing, T. E., Richels, R. G., Robinson, J. B., and Toth, F. L. (2007). 'Inter-relationships between adaptation and mitigation'. In Parry M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., and Hanson, C. E. (Eds.). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge. UK. pp.745-777.

Lapillonne, B., and Pollier, K. (2007). Energy efficiency trends for households in EU New Member Countries (NMC's) and in the EU 25. Odyssee.

Loorbach, D. (2007). Transition management: new mode of governance for sustainable development. Ph.D. Thesis. Erasmus University Rotterdam, Utrecht: International Books.

Markard, J., and Truffer, B. (2008). 'Technological innovation systems and the multi-level perspective: towards an integrated framework'. Research Policy V.37 (4). pp. 596–615.

McNeill, J. R. (2001). Something New Under the Sun: An Environmental History of the Twentieth-Century World. W. W. Norton and Company. United States of America.

Moser, S. (2012) 'Adaptation, mitigation, and their disharmonious discontents: an essay'. Climate Change. V. 111 (2). pp. 165-176.

Mourik, R., and Raven, R. (2006). A practioner's view on Strategic Niche Management Towards a future research outline. Energy research Centre of the Netherlands. Report No. ECN-E—06-039. December 2006.

National Audit Office. (2010). The Decent Homes Programme. Report by the Comptroller and Auditor General. HC212 Session 2009-2010. 21 January 2010.

Owen, P. (2013). In BBC NEWS. (2013). 'Only 200 homes' signed up for Green Deal energy loans.' [Online] Available at: http://www.bbc.co.uk/news/uk-politics-22815902 (Assessed on 08 June 2013).

Raven, R. P. J. M. (2005). Strategic Niche Management for Biomass. A Comparative Study on the Experimental Introduction of Bioenergy Technologies in the Netherlands and Denmark. Ph D Thesis. Eindhoven University of Technology. Eindhoven.

Raven, R. P. J. M., Heiskanen, E., Lovio, R., and Hodson, M. (2007). Local negotiation and alignment of expectations and transfer of lessons in niche development trajectories. Meta-analysis of 22 new energy projects in Europe. Paper for the workshop on Innovation, Institutions and Path Dependency. Zürich. April 15-18, 2007.

Raven, R., van den Bosch, S., and Weterings, R. (2010). 'Transitions and Strategic Niche Management: Towards a Competence Kit for Practitioners.' Internation Journal of Technology Management. V. 51. (1). pp. 57-74.

Rotmans, J., and Loorbach, D. (2006). 'Transition management: reflexive steering of societal complexity through searching, learning and experimenting'. In Van den Bergh, J.C.J.M., and Bruinsma F.R. (Eds). The transition to Renewable Energy: Theory and Practice. Cheltenham: Edward Elger.

Rip, A. (1995). 'Introduction of New Technology: Making Use of Recent Insights from Sociology and Economics of Technology'. Technology Analysis and Strategic Management. V. 7 (4). pp. 417-431.

Rip, A., and Kemp, R. (1998). 'Technological Change'. In Rayner, S. and Malone, E. L. (Eds.). Human Choice and climate change. V. 2. pp. 327-399. Batelle Press. Columbus.

Rycroft, R. W., and Kash, D. E., 2002. 'Path dependence in the innovation of complex technologies'. Technology Analysis and Strategic Management V.14 (1). pp. 21–35.

Schot, J., Hoogma, R., and Elzen, B. (1994). 'Strategies for shifting technological systems. The case of the automobile system'. Futures. V. 26. pp. 1060-1076.

Schot, J. and Rip, A. (1996). 'The Past and Future of Constructive Technology Assessment'. Technological Forecasting and Social Change, 54, 251 - 268.

Schot, J., Kemp, R., Maruo, K., Pratorius, G., Truffler, B., Potter, S. and Sorup, P. (1999). Strategic Niche Management as a tool for the transition to a sustainable transportation system (SNMT). Summary Final Report. CORDIS. Report No. ENV4-CT96-0275.

Silverman, K. (2012). The Green Deal: property implications. Articles: know how. Published on 27-Nov-2012. England. [Online] Available at: http://www.tltsolicitors.com/docs/plc__the_green_deal_property_implications_0.pdf (Accessed on 08 June 2013.

Smith, A. (2002). Transforming Technological Regimes for Sustainable Development: a role for Appropriate Technology niches? Science and Technology Policy Research. Electronic Working Paper Series. Paper No. 86.

Smith, A., Stirling, A., and Berkhout, F. (2005). 'The governance of sustainable socio-technical transitions'. Research Policy. V. 34 (10). pp. 1491–1510.

Smith, A., Voß, J. P., Grin, J. (2010). 'Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges'. Research Policy V. 39 (4). pp. 435–448.

Staudenmaier, J. M., (1989). 'The politics of successful technologies'. In. Cutliffe, S. H., Post, R. C. (Eds.). In Context: History and the History of Technology: Essays in Honor of Melvin Kranzberg. Lehigh University Press. Bethlehem. PA. pp. 150–171.

The Green New Deal Group. (2012). Turn the '"Green Deal"' into a Green New Deal: The first step to saving the economy. A Call to Action From the Green New Deal Group. Report by the Green New Deal Group, UK.

Three Regions Climate Change Group. (2008). Your home in a changing climate. Retrofitting Existing Homes for Climate Change Impacts. Report for Policy Makers. Greater London Authority. London. UK.

Turner II, B. L., Clark, W. C., Kates, R. W., Richards, J. F., Mathew, J. T., and Meyer, W. B. (1990). The Earth As Transformed by Human Action. Global and Regional changes in the Biosphere over the Past 300 Years. Cambridge University Press with Clark University. Cambridge.

UNEP. (2009). Buildings and Climate Change. Summary for Decision-Makers. United Nations Environment Programme. Sustainable Consumption and Production Branch.

UNFCCC (1992). United Nationas Framework Convention on Climate Change. United Nations. FCCC/INFORMAL/84 GE.05-62220 (E) 200705.

UKCIP (The UK Climate Impacts Programme). (2012). UKCIP. About us [Online] Available at: http://www.ukcip.org.uk/about-ukcip/ (Accessed on 29 August 2012).

van den Belt, H. and Rip, A. (1987). 'The Nelson-Winter-Dosi Model and Synthetic Dye Chemistry'. In Bijker, W. E., Hughes, T. P. and Pinch, T. (Eds.). The Social Construction of Technological Systems. The MIT Press. Cambridge. Massachusetts. pp. 135-158.

Van der Laak, W., Raven, R. P. J. M., and Verbong, G. P. J. (2007). 'Strategic niche management for biofuels. Analysing past experiments for developing new biofuel policies.' Energy Policy. V. 35. pp. 3213-3225.

Van der Vleuten, E., and Raven, R. P. J. M. (2006). 'Lock-in and change: distributed generation in Denmark in a long-term perspective'. Energy Policy. V. 34. pp. 3739-3748.

Weber, M., Hoogma, R., Lane, B. and Schot, J. (1999). Experimenting with Sustainable Transport Innovations - A workbook for Strategic Niche Management. Institute for Prospective Technological Studies. Seville.

Wilbanks, T. J., Kane, S. M., Leiby, P. N., Perlack, R. D., Settle, C., Shogren, J. F. and Smith, J. B. (2003). 'Possible Responses to Global Climate Change: Integrating Mitigation and Adaptation', Environment: Science and Policy for Sustainable Development. V. 45 (5). pp. 28-38.

Wilbanks, T. J. (2005). 'Issues in developing a capacity for integrated analysis of mitigation and adaptation.' Environmental Science and Policy. V. 8 (6). pp. 541-547.

Wilbanks, T. J., Sathaye, J., and Klein, R. J. T. (2007). Introduction to the special issue entitled 'Challenges in Integrating Mitigation and Adaptation as Responses to Climate Change'. Mitigation and Adaptation Strategy for Global Changes. V. 12 (5). pp. 639-641.

Winskel, M. (2002). 'When systems are overthrown: the 'dash for gas' in the British electricity supply industry'. Social Studies of Science. V. 32. (4). pp. 563-598.