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Final Report for BERR Enterprise Directorate:

SMEs in a Low Carbon Economy

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Middlesex University Business School
The Burroughs, London NW4 4BT
Tel: + 44 (0)20 8411 6604/5514
Email: i.vickers@mdx.ac.uk

Research Team

Ian Vickers (project leader) and Prashant Vaze
with
Leah Corr, Eva Kasparova, Fergus Lyon

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Executive Summary

The purpose and context of the review

This report reviews the established evidence and thinking around the challenges and opportunities that will affect UK small and medium-sized enterprises (SMEs) in the transition to a low carbon economy.

The serious threat of global climate change is primarily caused by the burning of fossil fuels and land-use change and few now dispute that there is a need for urgent collective action to achieve a transition to a low carbon and more resource efficient economy. Although little has been written specifically on SMEs in a low carbon economy, a considerable body of relevant academic and policy literature has been identified.

The review indicates that there good reasons for treating the aim of achieving a low carbon economy as being closely aligned to that of achieving sustainable development – economic development which is environmentally and socially sustainable. The review draws in particular on literature relating to the following issues:

- ‘Green management’ and SMEs - concerned with the barriers and drivers to SMEs adopting environmental management systems and energy/natural resource conserving improvements;
- ‘Green innovation’ – focused on the development of new low carbon and resource efficient products and processes;
- Sustainable/green entrepreneurship - including the potential role of social enterprise/entrepreneurship;
- Ethics and corporate social responsibility in SMEs;
- Localisation / decentralisation associated with developing a low carbon infrastructure and productive capacity (e.g. decentralised renewable energy sources, local food production);
- Small business responses to different forms of regulation and their compliance behaviour;
- The roles of SMEs in changing, and responding to change in, consumer behaviour and changes in lifestyles to support sustainability.

Key characteristics of SMEs

SMEs play a crucial role in the UK economy through their contribution to gross domestic product, job creation, innovation and the promotion of entrepreneurship, making them key players in any transition to a low carbon future. From a policy point of view, however, the sheer numbers, heterogeneity and ‘low visibility’ of smaller enterprises pose a particular challenge, and they cannot be treated as scaled down versions of large businesses. Characteristics which influence the responses of smaller enterprises to challenges and opportunities include:

- Limited resources, including with respect to access to finance and managerial knowledge and skills;
- Organisational cultures which are dominated by the owner-manager;
- A preference for less formal approaches to the management of the business;
- Limited ability to influence and shape their operating environment compared to larger enterprises;

- Low levels of awareness of and a reluctance to access the advice and support that is available.

The challenges facing SMEs in a low carbon economy

The challenges facing SMEs relate to four main categories of low carbon drivers:

- i. The Government's climate change mitigation policies and the costs of understanding and responding to these.
- ii. The increasing cost of energy (and potentially of other raw materials and inputs) as Government seeks to internalise the environmental costs of climate change in the price of energy and goods.
- iii. Changes in patterns of market demand for goods and services as a result of changing attitudes underlying a shift towards sustainable consumption and lifestyles. Also involved here are changes in the purchasing and investment decisions of large organisations and of Government.
- iv. The impacts on SMEs of climate change itself, given that the effects are occurring more rapidly than expected and that adaptation as well as mitigation will be needed.

The literature on environmental management and green innovation shows that most SMEs have been slow to adopt environment-related improvements. This somewhat negative picture of limited responsiveness extends to the take up of 'win-win' and 'low hanging fruit' opportunities and to engagement with environment-related business support.

Studies attribute this limited responsiveness on the part of most SMEs to a number of internal and external barriers, but particularly to a lack of market, regulatory and fiscal signals and doubt amongst owner-managers relating to the business case for sustainability. Many SME owner-managers are also constrained by their business environment to adopt incremental changes that are compatible with existing practices. This may be beginning to change, however, as a result of the recent increase in concern about global climate change, climate-related policy activity and supply chain pressures, and increases in the costs of energy and other inputs to production.

The opportunities for SMEs in a low carbon economy

While many businesses may initially experience the low carbon drivers as threats, they also represent significant opportunities, particularly for businesses whose operations are already on a more sustainable basis and those that are able to respond more innovatively and opportunistically. The potential opportunities include:

- i. Increasing demand for low carbon / more sustainable goods and services, with opportunities for the development of innovative solutions and new markets, both domestic and international. There is particular potential for new start-ups and innovative SMEs in the areas of renewable energy technologies (e.g. solar photovoltaics, wind, geothermal power, tidal/wave, regional biomass), energy storage, local/regional (including organic) food provisioning, pro-biodiversity activities and novel transport options.
- ii. Opportunities for many existing SMEs to modify their processes and products/services to be more sustainable, which are particularly important in manufacturing (including product refurbishment/remanufacturing), construction, transport, farming and food production, and also professional advice services on carbon markets and sustainable business practice. For many SMEs this could result in lower costs and better profit margins as a result of deploying energy

- efficiency and other resource conserving measures and also gains to be made from pro-environmental consumer markets.
- iii. Other opportunities in sectors particularly associated with the development of a low carbon infrastructure and productive capacity. The relocalisation agenda, involving the strengthening and diversification of local/regional economies, is potentially of great significance for the majority of UK SMEs which do not trade internationally.

The review draws in particular on the innovation literature and that which relates to the development of learning capabilities in SMEs. Although smaller firms are resource constrained, limiting their ability to make significant innovations, they possess certain behavioural advantages, notably that they can respond more rapidly, flexibly and efficiently to customer needs than can larger organisations.

SMEs (including social enterprises) have other characteristics which, it is argued by some, are supportive of sustainability and responsible behaviour: they are more likely to be embedded in their local economy and environment, not necessarily driven by profit maximisation, rely on reputation and trust for many of their business transactions, and often show a strong commitment to their employees.

Small hi-tech start-ups and SMEs have been playing a particular role in the development of novel low carbon technologies. Particularly important here has been the role of supportive contexts, including venture capital, public sector and other forms of support. Case studies of low carbon start-ups in the recent literature also demonstrate the origins of novel technologies in research-intensive universities.

For most SMEs there is a need to increase the application of existing knowledge and (affordable) technologies for improving their sustainability. In order to understand why opportunities are taken or not taken by SMEs in particular contexts, there is a need to better understand the learning dynamics and competing pressures involved when firms seek to incorporate environmental concerns into their general business strategy. Studies draw particular attention to the importance of appropriate incentives and an institutional context that is supportive of the greening of SMEs.

A number of studies have identified the low carbon and sustainability related implications and opportunities for particular sectors, including areas where the UK has particular strengths and also where there are other social needs, such as for affordable (as well as low carbon) housing and in order to reduce dependence on increasingly volatile overseas markets, notably with respect to energy and food production.

It is important to note the powerful influence of existing practices and the interests of incumbent / high carbon businesses and industries which may act to constrain the transition to a low carbon economy. There are other uncertainties and complexities relating to the strength and consistency of the regulatory/fiscal and market drivers. There is a danger that such factors, in the context of an economic downturn, will undermine investment in low carbon technologies, products and services, also jeopardising the viability of leading edge enterprises that take real actions to make their operations more sustainable.

Policy for SMEs in a low carbon economy

Most of the recent literature views government as having a central role to play in driving the transition to a low carbon economy through establishing a strong and consistent regulatory and fiscal environment and also with respect to its own spending decisions. The nature of the regulatory and market environment - or selection environment - is clearly fundamental to how SMEs respond to the challenges and opportunities.

Government can support individual low carbon and pro-environmental consumer behaviour and lifestyles through education and further raising the profile of climate change policy.

Better regulation has a role to play, particularly the rigorous application and enforcement of energy efficiency related building and product standards and other environmental regulations to stimulate integrated and clean technology approaches to minimising waste and pollution.

Sustainable sourcing and procurement principles need to be more widely applied and a number of barriers to the greater involvement of SMEs overcome. Studies show that the more consistent application and extension of whole life costing (i.e. including the full environmental costs/benefits of products/services) in the public sector is particularly crucial.

Government has a key role to play in relation to supporting innovation and R&D, with a number of studies pointing to the need to increase both business and government expenditure on low carbon technology in order for the UK to be more in line with other leading industrialised nations.

Some recent contributions have warned against the danger of over-emphasising new technology as a solution to climate change, drawing attention to the need to speed up the deployment of existing technologies and also the need for behavioural change on the part of both businesses and consumers.

The technologies and business models seen as contributing most to the achievement of a low carbon economy and therefore most in need of support are essentially 'disruptive', involving step changes in both business practice and consumer behaviour. Other forms of change needing support include the wider implementation of new business and social enterprise models.

The low carbon agenda can also be furthered through sustainability related business support and capacity building in SMEs. There is a need to consider how the take-up and delivery of such support can be improved, given that previous studies have identified a limited impact of such support to date. A number of recommendations have been made with respect to the development of more coherent, effective and better targeted environmental business support services.

Strong external drivers, such as regulatory, market, supply chain and other stakeholder pressures, have an important role to play in increasing the demand for environment-related support and training in SMEs.

1. Introduction

1.1 Aims of the study

There is now overwhelming evidence of dangerous global climate change and of the urgent need to achieve a rapid transition to a low carbon, more resource efficient and sustainable economy. The aim of this report is to review the established evidence and thinking around the *challenges and opportunities* that will affect UK small and medium-sized enterprises (SMEs) in the transition to such an economy. The detailed research questions guiding the review have been *to identify and summarise available evidence relating to*:

1. The direct and indirect challenges posed by an increasingly low carbon economy and the competitive position of UK SMEs in relation to their international competitors;
2. The opportunities for new products and services and potential contribution to improved profitability and general competitiveness;
3. Relevant policy measures enacted or under consideration in developed market economies;
4. Examples of SMEs developing innovative approaches to cope with / capitalise on opportunities arising from an increasingly low carbon economy;
5. The information and support needs of SMEs;
6. Is new or better regulation needed to drive dynamic responses by SMEs or will the market provide effective drivers of adaptation and innovation?

1.2 Conceptualising the low carbon economy

The serious threat of global climate change is primarily caused by the burning of fossil fuels and land-use change and few now dispute that there is a need for urgent collective action to achieve a transition to a low carbon and more resource efficient economy. The report to the UK Government by Sir Nicholas Stern described climate change as “the greatest market failure ever seen”, suggesting that the potential global costs of unmitigated climate change being equivalent to a loss in average world economic output of between five and 20 per cent per year (HM Treasury/Cabinet Office, 2006, p.i). The report recommended that there was a need to invest one percent of global gross domestic product (GDP) per annum in order to avoid the worst effects of climate change. Stern himself has subsequently acknowledged that climate change is occurring faster than expected and other economists have also argued that stopping or significantly slowing climate change will require greater investment in cutting greenhouse gas emissions than originally recommended by Stern.¹ It is now widely accepted by economists and policy makers that in order to avert dangerous climate change severe reductions in greenhouse

¹ See the papers collected in *World Economic Review*, Volume 8, Numbers 1 & 2, including by Dietz et al (2007) and Hamid et al (2007).

gas emissions² are essential – probably of 80 per cent or more by 2050, against a 1990 baseline.

The target of reducing emissions by 80 per cent by 2050 was recently recommended by the new, independent Committee on Climate Change (CCC, 2008a) and accepted by the UK Government during the passage of the Climate Change Bill through parliament. The Climate Change Bill has also involved the establishment of a system of carbon budgeting and powers to establish trading schemes to limit emissions of greenhouse gases. Along with other members of the European Union (EU) the UK is due in 2009 to reach an agreement to reduce emissions by at least 20 per cent by 2020, and to increase to 20 per cent its share of energy consumption met from renewable sources. Whatever the precise targets involved, it is clear that there is a need for swift and radical change in systems of energy generation, production and consumption. As well as mitigation (reducing emissions) there will also be a need for significant adaptive actions, given the latest scientific evidence on the rate of climate change and that levels of mitigation action to date have been too low to pre-empt adverse socio-economic impacts (IPCC, 2007).

There is no precise definition or conceptualisation of what a **low carbon economy** would look like and the specific term has only recently entered common parlance in policy and academic circles. Moreover, the scale and complexity of the social and economic processes which drive greenhouse gas emissions make it difficult to envisage with any great certainty how a transition to a low carbon future will be achieved within a short timeframe. There are, however, a number of studies which have utilised scenario analysis to explore pathways to potential future outcomes by placing figures on emissions reduction and describing the different factors and assumptions behind the given outcomes (e.g. IPCC, 2000; Shell, 2008). Also, the Committee on Climate Change has recently published a set of three five year budgets covering the period 2008-22 on the emissions ceiling for the UK economy (CCC, 2008b). This has involved the assessment of low cost carbon opportunities, many of which - particularly on energy efficiency, combined heat and power and industry - are available to SMEs.

There is also a substantial body of literature going back over a number of decades around industry, economy and the environment and the related concepts of sustainable development, ecological modernisation and cleaner production. The concept of **sustainable development** - or 'sustainability' – has been particularly important and influential, with perhaps the most succinct and widely referred to definition being that provided by the United Nations World Commission on Environment and Development (WCED, 1987):

“development which meets the needs of the present without compromising the ability of future generations to meet their own needs.”

The sustainability agenda requires a broad focus involving the simultaneous pursuit of environmental quality, economic prosperity and social equity. The following definition by

² The main greenhouse gases are (in order of their abundance in the atmosphere): water vapor, carbon dioxide, methane, nitrous oxide, ozone, CFCs. Carbon dioxide (CO₂) is therefore the main anthropogenic contributor to global warming – hence the policy term 'low carbon economy'.

O’Riordan et al. (1998) gives an idea of the range of actions and processes involved in order for sustainable development to be achieved:

“a durable process of wealth creation which focuses on increasing social stability and cohesiveness while reducing ecological stress. In practice the achievement of sustainable development will involve a broad range of actions, including changes in cultural outlook, technological and managerial innovation, price signals to guide long term investment, and new forms of institutional governance.”

Three national sustainable development strategies have been produced by the UK Government (DoE, 1994; DETR, 1999; Defra, 2005), the most recent of which sets out five guiding principles relating to:

- Living Within Environmental Limits
- Ensuring a Strong Healthy and Just Society
- Achieving a Sustainable Economy
- Promoting Good Governance
- Using Sound Science Responsibly (Defra, 2005, p.7)

Our review of the literature indicates that there are good reasons for treating the aim of achieving a low carbon economy as being closely aligned to that of sustainable development. Broadly, the sort of techno-economic transformations anticipated and discussed in the wide ranging literature on sustainability³ relate to:

1. **Economic methodology and policy** - a fundamental change in how the environment and the resources and services it provides are valued and their use accounted for (i.e. including fossil fuels and other raw material inputs to production; the ability of the environment to absorb pollution and conserve carbon; land and also biodiversity). The changes required follow from the need to re-conceptualise wealth creation, how economic growth is accounted for, and the wider and more consistent application of the ‘polluter pays principle’: that environmental costs (or economic ‘externalities’) are paid for by those who impose them through their production and consumption activities. Such a change has already been prefigured by the gradual adoption of various environmental taxes and instruments, while the threat of easily accessible supplies of oil, natural gas and other inputs being outstripped by demand in the near future is also likely to exert increasing influence.
2. **Changes in business practice and the adoption of ‘green management’** across all sectors in order to economise on the use of energy and raw materials and to minimise pollution.
3. **A new wave of ‘green innovation’** - in low carbon energy sources and environment conserving products and services.

³ Justice cannot be done to the full range of relevant literature here, but examples include: Carson, 1964; Meadows et al., 1971; Daley, 1973; Schumacher, 1973; Ekins, 1986; WCED, 1987; Pearce et al., 1989; Jackson, 1994; Welford & Starkey, 1996; Baker et al., 1997; Allenby, 1998; Ekins & Newby, 1998; Elkington, 1999; Hawken et al., 1999; Hines, 2000; Langhelle, 2000; Cohen & Murphy, 2001; Mol, 2001; Morgan, 2004; Porritt, 2005; IUCN, 2006; Hart, 2007.

4. The adoption of **industrial ecology** and **eco-industrial development** approaches to the organisation of production, whereby through greater inter-company co-operation the outputs of certain processes (such as waste heat) become inputs for other processes, thus promoting eco-efficiency and 'win-win' cost and environmental savings.
5. **Investment in new infrastructure and refurbishment of the built environment** - to support energy conservation and the greater use of decentralised renewable energy sources.
6. **Changes in local / regional governance and community planning** – including a greater emphasis on employment and consumption/service needs being met locally where feasible, with increasing emphasis given to '**relocalisation**' and the sustainability of local/regional economies as a counter to the dominant trend towards globalisation of recent decades. Such changes need to be enabled by central government but a greater role for the 'bottom-up' development of local enterprise and the regeneration of disadvantaged communities is envisaged.
7. **Changes in patterns of consumption, lifestyles and related cultural and values change** - to support sustainability, including a greater emphasis on inter and intra generational equity, quality of life and an ethic of 'sufficiency', rather than ever increasing consumption and materialism in the developed world.

Visions and prescriptions for creating a more sustainable and 'ecologically modernised' (low carbon) economy are *heavily contested*, however, and subject to ongoing disagreement and debate. This applies particularly to the degree and nature of government and regulatory interventionism needed, conceptualisations of wealth creation and economic growth, the role of technological innovation, and issues relating to equity and the extent to which there is a need to curb modern consumer culture.

There is a spectrum of views, with some voices (particularly from the corporate sector) emphasising business-led innovation and technical change as the provider of appropriate solutions, albeit in response to tightening regulation and the fuller implementation of international carbon trading mechanisms (e.g. Vivid Economics, 2008). Other recent contributions have reiterated more fundamental questions about the sustainability of the dominant high growth economic model, particularly given the recent experience of profound failures of financial governance and the economic recession conditions affecting the UK and wider global economy. As well as being environmentally unsustainable, the prevailing economic model is seen to have been based on a lightly regulated, highly globalised financial system, consumption fuelled by high levels of personal financial debt and as being characterised by high levels of social inequality. From this perspective, there is a window of opportunity for concerted interventions that jointly address the immediate threat of economic recession while also addressing the threat of climate change and the need to achieve a rapid transition to a low carbon economy. Thus it is argued that there is great potential for mitigating the socio-economic impacts of economic recession while also addressing the environmental crisis through creating new mechanisms for economic governance and stimulating the 'green economy' and the creation of 'green jobs' (GNDG,

2008; UNEP, 2008). Such debates have important implications for SMEs and entrepreneurship policy.

1.3 SMEs in a low carbon economy

The current report is specifically concerned with the implications for UK small and medium-sized enterprises (SMEs) of a transition to a low carbon economy. SMEs are of crucial importance to the UK economy, making a significant contribution to gross domestic product, job creation, innovation and the promotion of entrepreneurship. There were an estimated 4.7 million private sector enterprises in Britain at the start of 2007, an increase of 212,000 (4.8 per cent) on the start of 2006.⁴ These are the highest levels since 1994, when the time series began. Almost all of these enterprises (99.3 per cent) were small, with 0 to 49 employees. Only 27,000 (0.6 per cent) were medium sized, with 50 to 249 employees, and 6,000 were large (250 or more employees). Other key statistics are:

- SMEs together account for 99.9 per cent of all enterprises, 59.2 per cent of private sector employment and 51.5 per cent of private sector turnover;
- turnover in SMEs is estimated at £1,440 billion, 83 billion (6.1 per cent) higher than in 2006;
- almost a quarter (24 per cent) of all UK private sector enterprises operate in the Business Services sector;
- one fifth (21 per cent) of all UK private sector employment is provided by enterprises operating in the Wholesale, Retail and Repairs sector.

From a policy analysis point of view, it is frequently argued that small businesses cannot be treated as scaled down versions of large businesses and that there are **distinctive characteristics** which influence how they respond to challenges and opportunities.⁵ These characteristics include:

- limited resources, including with respect to finance / access to finance and managerial knowledge and skills, also affecting the degree and nature of business development and innovation activity engaged in;
- organisational cultures which are dominated by the owner-manager (s), which, in many cases, extends to a lack of ambition with respect to the growth and development of the business;
- a preference for less formal approaches to the management of the business;
- limited ability to influence and shape their operating environment compared to larger enterprise;
- low levels of awareness of and a reluctance to access the advice and support that is available.

⁴ The statistics in this section are sourced from: BERR, Statistical Press Release, July 2008: <http://stats.berr.gov.uk/ed/sme/smestats2007-ukspr.pdf>

⁵ Blackburn & Smallbone (2008) provide a useful review of the considerable body of research on small firms and entrepreneurship in the UK over the last 30 years.

From a business support and regulatory policy point of view, the sheer numbers and 'low visibility' of smaller enterprises pose a particular challenge for those who wish to assist or otherwise have a positive influence on their growth and behaviour.

At the same time it is important to note the danger of over-generalising and that SME behaviour and capabilities are shaped by a range of factors. A number of studies emphasise the heterogeneity of the small business sector and that how enterprises respond to regulatory and other social pressures consequently varies considerably according to their particular characteristics (i.e. the awareness and motivation of owner-managers, and the capabilities and 'culture' of enterprises) and their operational contexts (i.e. the competitive conditions they face, as determined by the nature of product market and supply chain influences, as well as their exposure to regulatory pressures and the public eye) (e.g. Hutter & Jones, 2006; Vickers *et al.*, 2005; SBRC, 2008). Within the SME category, company size (as measured by the number of employees) as one of the most influential structural factors affecting the implementation of environmental practices (Gonzalez-Benito & Gonzalez-Benito, 2006, p. 91-92). Medium size enterprises (50-249 employees) will clearly possess more developed managerial and organisational structures than do most small enterprises. These characteristics need to be born in mind when considering the challenges and opportunities facing SMEs in the transition to a low carbon, more sustainable economy.

This study draws on a wide range of academic literature and related work by policy researchers and industry bodies. Given the amount and breadth of the relevant literature and also the limited scale of this project, it has not been possible to identify and review all relevant literature, although it is hoped that the major themes and contributions have been addressed. The literature identified can be seen as broadly falling under the following categories:

- 'Green management' and SMEs - concerned with the barriers and drivers to SMEs adopting environmental management systems and energy/environment conserving improvements;
- 'Green innovation' – focused on the development of new low carbon and resource efficient products, processes and services;
- International trade / competitiveness and ecological modernisation;
- Localisation / decentralisation associated with developing a low carbon infrastructure and productive capacity (e.g. decentralised renewable energy sources, local food production);
- Sector studies - relating to sustainability issues in key sectors, such as construction, energy supply and services, food and agriculture;
- Sustainable/green entrepreneurship - including the potential role of social enterprise/entrepreneurship;
- Ethics and corporate social responsibility in SMEs;
- The roles of SMEs in changing, and responding to change in, patterns of consumption and lifestyles to support sustainability;
- SME responses to different forms of regulation and their 'compliance behaviour'.

A recent taking off point for further exploring the implications for businesses is suggested by the key findings of a previous study for BERR - *Comparative Advantage and Green Business* (Ernst & Young, 2008):

1. A green economy will be one in which lower carbon and resource efficiency will permeate all products and services throughout the entire economy - therefore a wider definition and measure of green business is proposed that is relevant to all sectors of the economy:

"...those businesses that, across the whole economy, have made efforts to introduce low-carbon, resource efficient, and/or re-manufactured products, processes, services and business models, which allow them to operate and deliver in a significantly more sustainable way than their closest competitors." (p. 4)

2. More focus should be given to identify specific opportunities in the key sectors where the UK currently has comparative advantage, in order to stimulate green products and services;
3. The key success factors in a 'green business model' are entrepreneurship and innovation which seem to enable the development of green businesses that are likely to be more sustainable than through direct policy support, seeking to bestow comparative advantage in green businesses where no such advantage naturally lies;
4. The impact at a sectoral level is likely to be highly varied, with some developments boosting UK GDP and others having a negative impact on GDP, particularly for some sectors.

Another study, for Defra by the Commission on Environmental Markets and Economic Performance, similarly argues that there will be opportunities for innovation and business development:

"...the transition to a low carbon, resource efficiency economy will see the emergence of new technologies and innovations that will stimulate new business models, products and services, transforming existing sectors of the economy and creating entirely new industries." (CEMEP, 2007, p. 15)

This review aims to build on the developing understanding of a low carbon economy in order to explore in greater detail the challenges and opportunities facing UK SMEs. The remainder of the report is organised as follows:

Section 2 identifies and discusses the specific challenges for SMEs in the transition to a low carbon economy, including the impact of government and other policies to reduce greenhouse gas emissions, the impact of higher energy prices, and concluding with insights from the 'green management' literature on the adoption of environment-related improvements by SMEs.

Section 3 explores the specific opportunities for SMEs in a low carbon economy, drawing in particular on the literature on innovation and the development of learning capabilities in SMEs in response to environmental pressures. It also examines the role of technologically innovative SMEs and venture capital, and sustainable entrepreneurship / social enterprise. This section concludes by summarising insights from recent sector studies on low carbon / sustainability related opportunities for SMEs.

Section 4 further examines policies to support SMEs in the transition to a low carbon economy, including the role of market drivers, fiscal measures, better regulation, and green business support and capacity building.

Section 5 presents the conclusions and recommendations for further policy research.

Appendix 1 gives examples of policies in other countries aimed at encouraging the adoption of energy efficiency and other environment-related improvements in SMEs.

Appendix 2 presents a selection of case study examples of innovative low carbon SMEs and developments referred to in the recent literature and media.

2. The challenges facing SMEs in the transition to a low carbon economy

2.1 Introduction - what are the main challenges?

While the impact of individual SMEs on the environment is small, their collective impact is considerable – indicating that there are significant opportunities for the adoption of resource conserving measures which could potentially also contribute to business competitiveness in an increasingly low carbon economy. The following figures give an idea of the environmental profile and carbon footprint of UK SMEs:

- SMEs account for approximately 45 per cent of total UK business energy use, this being broadly proportional to their share of the economy (BERR/ONS 2008 data);
- almost a third of SME expenditure on energy is thought to be wasted through inefficient practices – with potential waste equal to £1.1 billion out of a total of £3.5 billion (BERR, 2008 – citing Carbon Trust 2006 data);
- SMEs caused about 43 per cent of serious industrial pollution incidents and generated 60 per cent of all commercial waste in England and Wales (Environment Agency, 2006, p. 11). Commercial waste, as well as being an issue of concern in itself (House of Lords, 2008) is an important source of ‘embedded’ emissions of greenhouse gases;
- more positively, SMEs that are directly regulated by the Environment Agency had a higher than average rate of waste minimisation and recovery – 62 per cent compared to all directly regulated sites (i.e. including large organisations) (Environment Agency, 2006).

The potential challenges facing SMEs can initially be summarised as falling under four main categories of **low carbon economic drivers**:

1. The costs of understanding and responding to Government’s mitigation policies. Note, however, that these immediate costs may be offset (for more adaptive and forward looking businesses at least) by subsequent savings and innovation/ development contributing to competitiveness, as will be seen.
2. The increasing cost of energy (and potentially of other raw materials and natural inputs to production), with carbon pricing (or equivalent regulatory/fiscal instruments) as policy makers seek to internalise the environmental costs of production and consumption.
3. Changes in patterns of demand for goods and services as a result of increasing consumer awareness and a growth in ‘pro-environmental’ consumer behaviour and ‘ethical purchasing’, with consequent impacts on businesses and their competitiveness. Also included here are changes in the allocation of capital

and the strategic investment decisions of large organisations and of Government through its purchasing and investment decisions. A low carbon / more sustainable economy is therefore predicated upon the development of:

- increased demand for products and services that are seen to be more environmentally sustainable;
 - a decline in demand for products/services that are increasingly seen as unsustainable, also associated with an end to the era of conspicuous consumption;
 - for more established and conservatively managed businesses, increased competition from 'green businesses' that are more able to anticipate and respond to such changes in demand.
4. The impacts of climate change itself, given that the effects are occurring more rapidly than expected and that adaptation as well as mitigation will be needed to meet the challenges. As well the impact of rising sea levels, weather-related impacts on businesses include incremental changes (e.g. in temperature, rainfall etc) and also an increase in the frequency of draughts, floods and storms and associated impacts on businesses' operations. Sectors that will be most immediately vulnerable to such change are agriculture, forestry, fisheries, healthcare, insurance, tourism, water and property - although all sectors will be affected in some way (CBI, 2007; IPCC, 2007; Sullivan, 2008).

SMEs constitute a highly diverse and heterogeneous group of businesses, including with respect to their environmental impacts and degrees of exposure to the vulnerabilities outlined above. It therefore follows that existing SMEs will be variously affected by the challenges, with some being better positioned to respond and adapt than others. It is also important to note, however, the powerful influence of **existing practices, incumbent industries and other vested interests** which will act to constrain any transition to a low carbon economy, as well as other uncertainties and complexities relating to the strength and consistency of the regulatory and market drivers identified. There is a danger that such factors, in a context of economic recession, will undermine investment in low carbon technologies, products and services, also jeopardising the viability of businesses that take real actions to make their operations more sustainable.

2.2 The impact of policies and regulations to reduce greenhouse gas emissions

An immediate concern for SME's is the extent to which they will be impacted by recent policies to reduce greenhouse gas emissions and their ability to respond to these. The past five years have seen concerns about climate change rising in the political and media agendas. There has been a rapid rate of climate change related policy development and implementation in Organisation for Economic Cooperation and Development (OECD) countries in particular and political leadership shown by the EU and its member states, resulting in the introduction of various regulations and economic instruments to reduce emissions of greenhouse gases, most notably the EU Emissions Trading Scheme on 1 January 2005. According to the recent collection of papers edited by Sullivan (2008), most large businesses appear to have been actively responding to such actions by establishing governance and management systems to reduce their greenhouse gas emissions,

notwithstanding that serious questions are also raised as to the sufficiency of such actions to date.⁶ In principle, smaller businesses could be disadvantaged compared to larger organisations in that they have less capacity to track and respond to new government policies, regulations and incentives and therefore might face proportionately higher costs and receive lower benefits.

The main UK policies aimed at reducing greenhouse gas emissions which impose a cost upon business are summarised in the Box 2.1. As can be seen, the main impact for most SMEs will be that of the Climate Change Levy through its influence on energy prices.

Box 2.1: UK policies for reducing greenhouse gas emissions and implications for SMEs

Climate Change Levy: a tax on electricity, gas and fuel oil use by business. Reduced levy rates are paid by businesses who deliver reductions in energy use in line with their sector's climate change agreements. Small enterprises in particular may experience greater difficulty or be unable to meet the reporting requirements for the sector agreement and miss out on the reduced levy rate.

Carbon Reduction Commitment: from 2010 a compulsory requirement for businesses consuming 6000 MWh of gas and electricity (about £0.5 million). This mainly covers large firms but will include some SME's in manufacturing (see Defra, 2007a) and also has implications for tenants whose landlords have commitments of their own (see Defra, 2008).

Building Regulations Part L 2006: This revision of the Buildings regulations requires all new buildings and renovations of existing buildings with a surface area of >1000m² to meet energy performance standards for the whole building.⁷ The European Commission is proposing to remove the >1000m² cut-off, which if adopted will mean all major renovations irrespective of floor area will have to install cost-effective energy efficiency measures retrospectively.

EU Directive on Energy Performance of Buildings - Article 7: This requires all buildings to obtain Energy Performance Certificates (EPCs) with information on the building's energy usage, and for all public buildings (such as hotels, large restaurants) to display them. These are called Display Energy Certificates (DECs). The directive also requires (Article 8 and 9) compulsory regular inspections of boilers and air conditioning units. These have to be implemented by January 2009.

EU-Emissions Trading Scheme: a compulsory carbon trading scheme that all plants which operate 10MW boilers have to participate in. This will mainly apply to the largest emitters in energy intensive sectors, including cement, glass, pulp and paper and oil refineries. SMEs are unlikely to fall within this policy but will be affected by ripple effects from the price of carbon, such as through the increased cost for power.

There are also incentives available to businesses to help reduce their emissions, although responding to and benefitting from these schemes may also pose a challenge for many SMEs:

⁶ See Schuchard et al. (2007 & 2008) for accounts of what is currently seen as best practice in climate change and emissions management in large businesses.

⁷ http://www.carbontrust.co.uk/climatechange/policybuilding_regs_partl.htm

- The **Carbon Trust** provides free on-site advice to businesses. These advisory visits have a good track record in inspiring cost-reducing investment in clients. However free advisory resources appear to be skewed to bigger companies where possible savings are higher. Twelve pilot energy advice centres for SME's in England were funded by the Carbon Trust and Energy Saving Trust. These were terminated in March 2004, however, because of poor cost effectiveness.⁸ The experience of some other initiatives suggests that support for SMEs may be more cost-effectively delivered in the form of a comprehensive environmental audit approach, addressing the full range of potential environment related improvements rather than being narrowly focused on energy efficiency (see Section 2.4).
- Government also offers a **reduced rate of corporation tax** (through advanced depreciation allowances) and some business rates relief to alleviate the high up-front cost of investing in certain energy efficiency equipment (e.g. combined heat and power). However the cost of professional advice to access these allowances makes it less attractive to smaller enterprises.
- The Government recently announced the launch of the **UK Energy Transformation Fund** strategy (BERR, Defra, & DIUS 2008). This will consist of £400 million of grants – largely bringing together pre-existing Department of Energy and Climate Change grants to develop and deploy low carbon technologies. Of particular relevance to SMEs is the stated aim to help build the skills and capacity within businesses needed to deploy low carbon technologies.

The funds that have been brought together under the UKETF are shown in the table below.

Existing business support measures incorporated in the ETF		
BERR	Defra	Carbon Trust
Hydrogen Fuel Cell and Carbon Abatement Demonstration Programme	Bio-energy Capital Grants Scheme	Innovation programme, including applied research scheme, research accelerators, technology accelerators, and incubators
Marine Renewables Deployment Fund	Bio-energy Infrastructure Scheme	Funding for new low carbon technology enterprises, including Partnership for Renewables
Low Carbon Buildings Programmes		Investments in clean energy technology businesses
Offshore Wind Capital Grants programme		Energy efficiency loans scheme for small and medium sized enterprises
		Salix Finance public sector invest-to-save loan schemes

Source: BERR, Defra & DIUS, 2008

A further challenge for some SMEs relates to their ability to react to low carbon initiatives and reporting required by other corporate bodies: either from the investment community, customers, or from within their own sector, often brokered by trade bodies. Such initiatives include:

⁸ Source: Centre for Sustainable Energy: <http://www.cse.org.uk/cgi-bin/projects.cgi?business&&4>.

- The **Carbon Disclosure Project** – this provides a secretariat for institutional investors with a combined \$57 trillion of assets under management. It analyses and publishes information on risks and opportunities presented by climate change.
- **Supply chain initiatives** - Wal-Mart and Tesco, for example, are both engaging with their supply chains to report and reduce emissions through their products whole life-cycle.⁹ *Carbon reduction labelling* aims to make the ‘carbon footprint’ of products or services more visible to consumers, also helping participating businesses to differentiate their products/services, enhance their brand and corporate reputation and help create a critical mass of companies and consumers to drive significant carbon reductions.¹⁰
- **Sector based initiatives** - such as the construction industry’s *UK Green Building Council*, the hospitality sector’s ‘*hospitable climates*’ which provide advice and support to businesses but also act as pressure groups within these sectors.

Other governments have also been active in implementing policies aimed at improving energy efficiency amongst businesses, whether through regulations, voluntary agreements, research or advice. Further detail on these are given in Appendix 1.

2.3 The impact of increasing energy prices on UK SMEs

An immediate question which we were asked to address is the extent to which UK SME’s may have been adversely affected by high energy prices compared to larger competitors or firms operating in other countries. Energy costs for UK businesses have risen significantly in recent years, with lower volume users facing higher costs per unit of energy, as can be seen in Figure 2.1.

Despite the price rises, for most SMEs energy costs remain only a small proportion of operating costs. Patterns of energy consumption amongst SMEs are likely to vary considerably, however, and detailed data (by size, sector and number of premises) is not currently available. The npower winter 2007-08 Business Energy Index examined the energy use of a small SME sample¹¹ almost entirely from the manufacturing and engineering sector – a sector likely to have higher energy use than others. Amongst these SMEs, energy costs were on average 6.4 per cent of total operating costs. The majority of the energy cost (72 per cent) was for electricity, 23 per cent for gas and 5 per cent for oil and liquefied petroleum gas (LPG). When added together the potential for savings by SMEs could be £1.1 billion out of a total £3.5 billion.

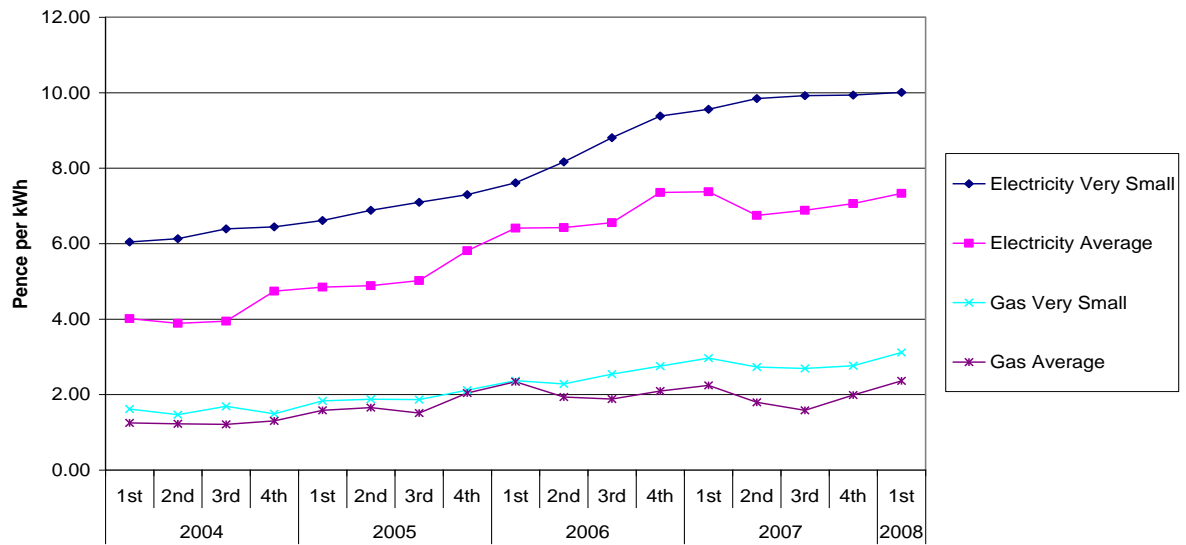
⁹ <http://www.tesco.com/climatechange/speech.asp>

¹⁰ For details and case studies see: <http://www.carbon-label.com/>

¹¹ The sample contained 100 SMEs, of which 93 were in the manufacturing and engineering sectors.

Figure 2.1:

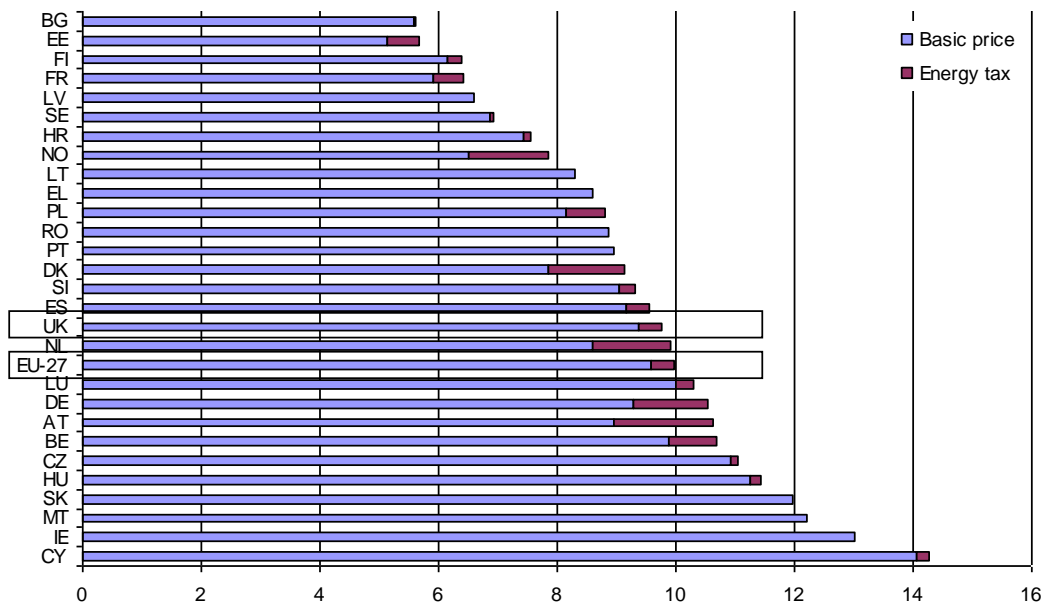
Prices of fuels purchased by non-domestic consumers in the UK (including the CCL)



Source: BERR Quarterly energy prices

To put this in a wider international context, Figure 2.2 below shows that UK industrial electricity prices in January 2008 were close to the EU average and broadly in line with competitor countries. The UK's Climate Change Levy is a lower proportion of the cost of industrial electricity than comparable energy taxes in other countries.

Figure 2.2: Average industrial electricity prices 1 Jan 2008 (€cents/kWh)



Source: Eurostat - "Electricity prices for EU household and industry consumers on 1 January 2008"

There is some anecdotal evidence that rising energy prices affect SMEs differently from larger firms. For example, smaller road haulage firms have complained that they are not able to hedge against high diesel price as well as larger competitors as they are paid a fixed haulage rate which takes no account of increases in fuel costs. However, even if this is so, it is only a temporary advantage as the larger competitors will be less competitive when the contract is being renewed. Gas and electricity suppliers also offer large customers lower tariffs but there is no evidence that the discount widens as fuel prices increases. It needs to be born in mind, however, that even though for most SMEs energy costs remain only a small proportion of operating costs, in the context of the recent credit crunch and deepening economic recession such increases can still be difficult to bear, and particularly for more marginal businesses which may already have been 'underperforming'. This reinforces the importance of access to support to those SMEs which can benefit from deploying low carbon technologies and conservation measures but need assistance to do so.

Finally, some useful insight is provided by the study by de Groot et al (2001) on decision making around energy saving in a sample of Dutch firms (including SMEs). This found that firm size, energy intensity and competitive position were important factors in distinguishing differences in behaviour and attitude towards policy. The most important driver behind investment decisions was the economic potential for cost savings, but that the existence of other, more attractive, investment opportunities and the incomplete depreciation of existing capital stock were important obstacles for not (yet) investing in energy-saving technologies. Stricter environmental policy to drive the adoption of energy efficiency measures was acceptable to most firms provided that this measure did not affect profitability and the competitive position of firms. The authors identify the task of how to develop effective policies for stimulating the adoption of energy efficient technologies in energy-extensive SMEs as an important challenge.

2.4 Insights from the 'green management' literature

2.4.1 Drivers and barriers to the adoption of green management

There is a substantial literature on 'green management' that is generally concerned with the adoption of **environmental management systems and standards** (such ISO14001) and other environment related improvements and innovations in SMEs. Other formal green management techniques available (in principle) to businesses include environmental reporting, auditing and accounting practices, product life cycle analysis (or ecodesign), and eco-labelling.

Broadly, four key drivers are commonly identified as motivating SME owners to improve their environmental performance:

- government regulations and taxes;
- green market pressures and opportunities;
- efficiencies in resource use and / or minimisation of waste (environmental or eco-efficiency) and the promise of 'win-win' improvements that benefit both the business and the environment;

- the environmental awareness and concern of owner-managers (e.g. Environment Agency, 2005; 2007; Observatory of European SMEs, 2002; Hillary, 1995 & 2000; Smith and Kemp, 1998; Revell, 2008).

The extent to which owner-managers / businesses are motivated by such factors has been shown to vary considerably, according to business size, sectoral and market context, degree of exposure to regulatory and stakeholder pressures, and so on. On the whole, however, studies indicate that most SMEs have been lagging behind in the environmental field compared to larger organisations, and that they tend to be re-active rather than pro-active in their responses to the various drivers and influences. Studies commonly identify a number of barriers, both internal and external to the firm, to improvements in the environmental performance of SMEs.¹² External barriers include:

- the lack or limited nature of green consumer demand;
- the low environmental visibility and exposure of smaller firms to regulatory and stakeholder pressures;
- lack of an organisational network supporting the environmental activities of SMEs and limited infrastructure supporting environmental management, such as poor local recycling facilities;
- little or no supply chain pressure for greening.

Also identified are internal obstacles which are said to contribute to a “culture of environmental inaction” amongst SMEs (Hillary, 1999). Key internal barriers identified in the literature are:¹³

- lack of awareness of the environmental impacts of firms’ activities on the part of owner-managers;
- perceptions that environmental measures are costly and likely to result in a loss of competitiveness;
- poor management skills and a lack of strategic awareness, leading to environmental improvements not being translated into competitive advantage
- limited time and resources;
- low levels of compliance with regulations due to a lack of awareness combined with a perception and/or reality that enforcement is weak.

Other internal barriers referred to in the general literature include:

¹² This section draws in particular on the work of Revell (2008) who usefully summarises much of the relevant literature, which includes: Baylis et al., 1998; Biondi et al, 1998; Bianchi and Noci, 1998; Hillary, 1999, 2000, 2003; Verheul, 1999; Wycherly, 1999; Tilley, 1999; Bowen, 2000; Rutherford et al, 2000; Holt et al., 2000; Hunt, 2000; Pederson, 2000; Fanshaw, 2000; Berger et al. 2001; Schaper, 2002; Vernon et al., 2003; Drake et al. 2004; Simpson et al, 2004; Jones & Greenwood, 2003; Masurel, 2007; Revell & Blackburn, 2007; Revell, 2003a, 2007.

¹³ See also Environment Agency 2005, 2003, 2002; Fanshawe, 2000; Rutherford et al, 2000; Holland and Gibbon; 1997, Smith and Kemp 1998; Baylis et al, 1998; Hillary, 2000; 1995; Petts, 1999; Simpson et al. 2004; Drake et al, 2004; Schaper 2002; Observatory of European SMEs, 2002; Gerstenfeld and Roberts, 2000; Hutchinson and Chaston, 1994; Simpson et al, 2004; Tilley et al., 2003; Bianchi and Noci, 1999; Primanova, 2004; Friedman et al 2000; Fischer 2003; Epstein and Roy, 2000; Revell and Blackburn, 2007; Revell, 2003a, 2002, 2007.

- low awareness of the benefits of environmental management systems, coupled with a perception that EMS adoption is costly and that the tools and techniques available are unsuited to the needs of SMEs (Schaper, 2002; Hillary, 2000; Holt et al., 2000; Drake et al, 2004);
- low levels of 'eco-literacy' and a lack of knowledge or skills to undertake environmental improvements (Tilley, 1999a; Vos, 1998; Hillary, 2000; Gerstenfeld and Roberts, 2000; Biondi et al. 2002; Perez-Sanches et al. 2003);
- a lack of organisational capacity for change amongst SMEs and inflexible work habits, making it difficult for them to translate complex environmental regulations into workplace responsibilities (Petts, 2000).

A number of authors have identified a *value-action gap*, with SME owners finding it difficult to translate their environmental attitudes (aspirations) into concrete operational changes to reduce their firm's environmental impact (Tilley, 1999a; McKiever and Gadenne, 2005; Schaper, 2002; Revell et al., 2007). For instance, the studies of SMEs in the UK and Japan by Revell (2002, 2003a & 2003b) found that most owner-managers viewed environmental management as costly and therefore mostly 'win-lose' rather than 'win win', i.e. benefitting the environment but not their business. There was also scepticism that customers could be won or competitive advantage gained by investing in environmental improvements. The return from environmental investments was often perceived to be too slow or too small to justify the initial outlay, particularly where firms were struggling to survive in highly competitive market conditions. In some cases, the paybacks from relatively simple measures, such as recycling, were not felt to be worth the expenditure of time and resources needed. Similarly, a typical experience of environmental support programmes and demonstration projects has been that, while SMEs are willing to pick the 'low hanging fruit', they are less willing to make larger and more fundamental changes (Tilley et al., 2003).

It is important to be sensitive to the context and capabilities of smaller enterprise and the relevance/appropriateness of the various green management techniques. It is wrong to assume that SMEs are 'small large organisations' and techniques developed or tested in larger organisations may not be suitable for small businesses (Palmer & van der Vorst, 1996; Le Pochat et al., 2007). Tools such as product life cycle analysis and carbon footprinting may be too complex/difficult and therefore far beyond the capability of most small businesses. It may also be the case that where such approaches are engaged with there is a risk of detracting from other issues, such as compliance with minimum health, safety and environmental standards and transparency with key stakeholders.¹⁴

Despite the somewhat pessimistic analysis presented by previous studies, a number of authors have argued that 'win-win' opportunities for greening will be more obvious to business owners where there is clear growth in customer demand for products and services that are more environmentally sustainable. There is therefore a need to focus on how consumption that is more sustainable can be linked to the ecological modernisation of production (Bianchi & Noci, 1999; Verheul, 1999; Vickers & Cordey-Hayes, 1999; Drake et al. 2004; Hillary, 2003; Schaper, 2002; Revell and Blackburn, 2007; Revell, 2007a, 2003a, 2003b, 2002).

¹⁴ For some recent discussion see http://www.csr-asia.com/weekly_detail.php?id=11458

Some other recent studies indicate that market drivers are beginning to have an influential role on the greening of SMEs, with owner-managers citing cost savings, new customers, good publicity and higher staff retention as some of the potential benefits of adopting environmental improvement measures (Revell et al., 2007). The *SME-nvironment 2007* survey showed a growth in awareness on the part of UK SMEs since 2005 of how their activities could cause harm to the environment (Environment Agency, 2007). In principle, the recent sharp rise in public awareness and policy attention to the threat of global climate change and associated policy actions ought to encourage owner-managers to see greater potential in translating environmental action into business opportunities. For instance, with respect to 'eco-friendly purchasing', results from the *2007 Survey of Public Attitudes and Behaviours Towards the Environment* show that:

- 52 per cent strongly agreed or tended to agree that they "try not to buy products from a company whose ethics they disagree with";
- roughly the same proportion strongly agreed or tended to agree that they "make an effort to buy things from local producers";
- 45 per cent strongly agreed or tended to agree that they would be prepared to pay more for environmentally friendly products, with over a quarter disagreeing (Defra, 2007).

There is growing understanding of the issues that drive ethical / green consumer behaviour and the implications for product/service development and marketing strategy (e.g. Cowe & Williams, 2001; SDC, 2006; Wheale & Hinton, 2007; Defra, 2008). This understanding needs to be applied by more SMEs and supported by policy in order for this type of demand to be encouraged as a mechanism for achieving a more sustainable economy. The opportunities for SMEs arising from green/ethical consumer behaviour will be further explored in Sections 3 and 4.

2.4.2 Typologies and segmentation models of environmental behaviour

An influential way of explaining and categorising different business responses to environmental pressures has been to develop typologies and segmentation models of **(pro)environmental behaviour** or **business greening**, often in terms of a spectrum, ranging from resistant to proactive and/or from unsustainable to sustainable. For instance, Roome (1994) outlines four strategic responses to environmental legislation: *Non-Compliance*; *Compliance*; *Compliance-Plus*; and *Excellence*. The latter category - Excellence - involves the cleaner technology and integrated management systems and structures adopted in previous phases but also fundamental changes in organisation and individual values and culture to support a 'sustainability ethic'. Tilley (1999b) draws on her own and other empirical studies to suggest four key environmental strategies or development stages that apply in the case of small firms:

1. **Resistant strategy:** ignoring any pressures to improve the firm's environmental performance, because it does not want to, does not think it needs to or is unaware of improvements that could easily be made. Large numbers of firms are likely to fall in this category.

2. **Reactive strategy:** where a firm becomes subject to pressures to improve its environmental performance, which may be in response to minimum compliance standards and often results in a piecemeal, cost-driven approach. Many small firms that do respond to environmental pressures fall into this category.
3. **Proactive strategy:** involving a more positive and considered effort to reduce environmental impacts. Environmental improvements become ongoing and more innovative but are not always fully integrated into the business and are unlikely to involve a fundamental questioning of business systems or practices. Firms in this category are more likely to be operating in environmentally high-profile sectors or have owner-managers who are personally committed to the environmental cause.
4. **Sustainable or ecological strategy:** an innovative and perhaps radical strategy requiring a “holistic integration of the environment into the structure and management of the business.”

Tilley (writing in 1999) suggested that businesses (small or large) employing a sustainable / ecological strategy are likely to continue to be the exception without substantial change in the wider industrial and policy context. This would need to entail the ‘ecological modernisation’ of business and economy and a new wave of industrial innovation involving the integration of ecological principles and concerns at the point of product and service inception and design.

It is also worth mentioning a further segmentation model developed by Defra (2008), the outcome of an extensive research process to investigate individual attitudes and behaviour to the environment and how these relate to consumption choices – as summarised in Box 2.1. As well as providing valuable insight into consumption behaviour, this model may also help explain the behaviour of businesses where the values and beliefs of the owner-manager play a dominant role, notably with respect to micro-businesses.

Most typologies developed to explain business greening are inevitably rather stylized simplifications of a complex and dynamic reality and there has been some criticism of models which assume progress along a unidirectional path (e.g. Schaefer and Harvey, 1998). For instance, some firms may regress back to previous stages or exhibit mixtures of behaviours in response to different stimuli or pressures. The highly heterogenous nature of SMEs as a group of businesses and also the characteristics referred to in Section 1.3 clearly also limits the applicability of generalised models. Questions have also been raised as to the extent to which the concept of sustainability is applicable at the micro level and to individual (and particularly small) organisations, given the nature of the interdependencies involved (i.e. within supply/ value chains, technology etc). For instance, there are clearly limits to the extent to which SMEs in the retail sector can be held responsible for all the health and environment-related impacts associated with the products they sell, including for products which may be ‘fair trade’ sourced (Young & Tilley, 2006). The concept of ‘sustainable development’ may best be applied in a wider sense to the economy as a whole and modes of production and consumption.

A further issue which has received increasing attention is the claim that some businesses have been increasingly adopting proactive stances to the environment which are more to do with symbolism than substance, with environmental claims used as a marketing device and/or as arguments for reduced regulation. The phenomena of business

environmentalism as **greenwashing** has been mainly analysed in relation to the corporate sector (e.g. Tokar, 1997; Beder, 2002; Lyon & Maxwell, 2004) although in principle the concept may also apply to some SMEs. This emphasises the importance of the wider and more transparent application of the **whole life costing** of products and services, such that environmental impacts and benefits are more explicit and visible to consumers and other stakeholders in order that they can make more informed decisions.

Box 2.1: Summary of Defra’s segmentation model of individual attitudes and behaviour towards the environment

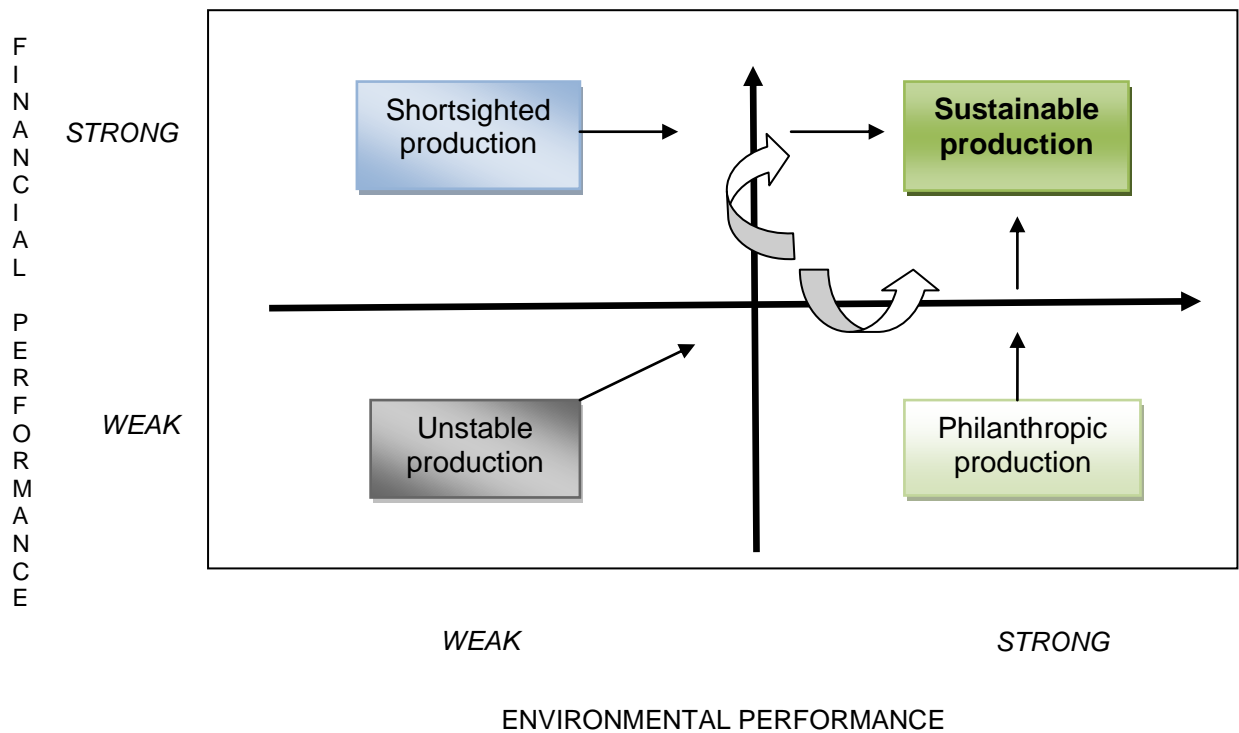
1. *‘Positive greens’* (estimated to be 18% of the population) – who are driven by a very strong concern for the environment and high levels of personal responsibility to limit their impact on the environment. While they are doing more than any other group to reduce their environmental impact, there is scope for them to do more, particularly in relation to their travel behaviours. They are most likely to be in the AB socioeconomic groups and have the highest household incomes – of 40k and over per annum.
2. *‘Wastage watchers’* (12% of the population) – who are motivated by a desire to avoid waste of any kind, although they often lack awareness of other pro-environmental behaviour and may be more sceptical than average about the scale and urgency of environmental problems.
3. *‘Concerned consumers’* (14% of the population) – who broadly hold pro-environmental beliefs, but with less conviction than groups 1 and 2. They make some compromises for environmental benefit, but balance this with a sense that they ‘deserve’ to do certain things, like flying.
4. *‘Sideline supporters’* (14% of the population) – who have a generally pro-environmental worldview but whose green beliefs are not translated to their behaviours. Most say they are doing one or two things to help the environment and would like to do more.
5. *‘Cautious participants’* (14% of the population) – whose environmental worldview is close to the average for the population. Although recognising their impacts they are pessimistic about our ability to tackle climate change and quicker to say that efforts will be negated by other individuals and countries than groups 1, 3 and 4.
6. *‘Stalled Starters’* (10% of the population) – holding somewhat confused environmental views: mostly negative, with many seeing climate change as too far in the future to worry about and, with group 7, with the 3 highest numbers believing the environmental threat has been exaggerated. They are also the most likely, however (with group 1), to agree that there are limits to growth and that humans are damaging nature, despite not wanting to act on this.
7. *‘Honestly disengaged’* (18% of the population) – whose ecological worldview is shaped by a lack of interest and concern and who are sceptical about the current environmental threat. They display no interest or motivation to change their current behaviour to make their lifestyle more pro-environmental and are unmoved by debates about the environment and climate change.

Source: Defra 2008, p. 41-45

A recent model suggested by Søgard and Madsen (2007) is particularly useful and relevant in that it captures the **dynamics and competing pressures** involved when firms seek to

incorporate ecological concerns into their general business strategy. This approach draws on case study evidence and builds on the assumption that *success in the market* is a necessary condition for business survival but is no longer sufficient in the context of *tightening regulatory and other stakeholder pressures*. Figure 2.3 illustrates the dynamic pressures faced by the firm in its market and political (regulatory) context.

Figure 2.3: Typology of firm strategic responses to market and environmental/political pressures



Source: adapted from Søgard & Madsen (2007)

Drawing on evolutionary economic theory, the authors define two axes to represent the pressures facing the firm in its **selection environment**. The dynamic pressures exerted by the two axes are interlinked and may be mutually supportive – as represented by the curved arrow shown as reinforcing the pressure towards *sustainable production*. In the bottom two quadrants, firms will be forced out of business for financial reasons, i.e. if they are unable to improve their financial performance. Firms in the left-hand quadrants are weak in terms of their environmental performance, and therefore vulnerable to regulatory sanctions. In the long run it is those firms in the top right quadrant – combining financial and environmental performance – that evidence long term sustainability. *Shortsighted* firms in the top left quadrant may make good profits in the short term but fail in the longer term due to their inability to adapt to increasing environmental pressures. The worst possible position is that of the *unstable producers* in the bottom left quadrant who are both financially and environmentally unviable. Finally, the *philanthropic* or idealist producers in the bottom right quadrant are seen as “sticking unwaveringly to principles of ecological sustainability, until they are driven to the wall by financial losses” (p. 437). The model is applied by Søgard and Madsen with more environmentally exposed businesses subject to ongoing contact with regulators in mind - and specifically their case study of a co-operative fishmeal factory in Denmark. The extent to which such dynamic political and stakeholder

pressures will play a role in the more widespread greening of SMEs which have hitherto had little exposure to such pressures remains to be seen. Consistency in the policy/regulatory environment is clearly important if firms that make investments to improve their environmental performance are not to be put at a competitive disadvantage with less motivated competitors.

Finally, policy interventions for removing internal barriers to sustainability related change in SMEs have tended to focus on **information and education initiatives** and **free consultancy**, which help owner-managers become more 'eco-literate', thus raising their awareness of the environmental impacts of their firm, what they can do to reduce these impacts, and how their firm might be able to profit from environmental action (Tilley, 1999b; Tilley et al., 2003; Clark, 2000; Holt et al., 2000; Hunt, 2000; Pederson, 2000; ; Fanshawe, 2000; Bichard, 2000). A number of authors emphasise the necessity to augment such initiatives with the introduction of **more interventionist policy strategies** such as regulations and taxes, given that the barriers previously identified have created a context where owner-managers are often resistant to joining environmental support programmes (Simpson et al, 2004; ten Brink, 2002; Rutherford et al. 2000; Revell, 2008). Crucial here is the extent to which the policy measures recently introduced for reducing greenhouse gas emissions will be sufficient to catalyse action and innovative responses from a greater number of businesses. There is also some evidence of changing market and stakeholder pressures increasingly impacting on SMEs and potentially stimulating more proactive responses to the sustainability agenda. These issues will be further addressed in the following Section 3 and also Section 4 on policies towards SMEs in the transition to a low carbon economy.

3. Opportunities for SMEs in a low carbon economy

3.1 Introduction

The opportunities provided by the transition to a low carbon economy and more sustainable economy will vary considerably according to the sectoral context, with the more innovative and entrepreneurial businesses tending to take the lead. This section builds on the previous discussion on the adoption of green management by drawing on the literature which is concerned more specifically with innovation and the development of learning capabilities in SMEs. In principle, the potential opportunities for SMEs in a low carbon economy relate to:

1. An increasing demand for low carbon / more sustainable goods and services, with opportunities for the development of innovative solutions and new markets, both domestic and international. There is particular potential for new start-ups and innovative SMEs in the areas of renewable energy technologies (e.g. tidal/wave, solar photovoltaics, geothermal power), energy storage, local/regional food provisioning, pro-biodiversity activities and novel transport options.
2. Opportunities for many existing SMEs to modify their processes and products/services to be more sustainable. This is particularly important in manufacturing, construction, transport, farming and food production, and professional advice services on carbon markets and sustainable business practice. For many SMEs this could result in lower costs and better profit margins as a result of deploying energy efficiency and other resource conserving measures.
3. Other opportunities in sectors particularly associated with the development of a low carbon infrastructure and productive capacity, also associated with the priority accorded to employment and consumption needs being met locally to a greater extent than hitherto. The relocalisation agenda, involving the strengthening and diversification of local/regional economies, is of particular significance for the majority of SMEs which do not trade internationally.

Key themes explored in the literature relate to the nature of innovation processes - how innovations that may be environmentally and socially desirable are developed, particularly where market demand is initially weak; the role of innovative small firms in introducing 'radical' or 'disruptive' technologies that challenge existing practices; and the debate relating to the contribution of regulation in driving innovation and improved (international) competitiveness.

3.2 'Green innovation': theory and evidence

Innovation is recognised as playing a major role in environmental degradation through its contribution to increased economic growth and consumption (Porter & Van der Linde, 1995). The 'green innovation' literature is particularly concerned with the role of innovation in providing solutions to a range of environmental issues, including:

- *Green (or cleaner) products* – with reduced environmental impact over their full life cycle and with greater scope for them to be refurbished/remanufactured;
- *More efficient processes* – to minimise, treat and reuse/recycle waste;
- *Alternative technologies* – to reduce emissions of greenhouse gases and other pollutants and provide renewable energy;
- *Systems innovation* – to measure and monitor environmental impacts, also including new socio-technical systems.

In the recent study for BERR - *Comparative Advantage and Green Business* (Ernst & Young, 2008, p. 38-39) case study analysis highlighted six key factors that have facilitated success in the development of a low carbon, resource efficient business model and (primarily) technological innovation. Four of these are 'supply side' factors and are not exclusive to 'green innovation':

- access to capital and investment;
- high levels of, and investment in R&D;
- skilled workforce;
- existing/developing clusters of knowledge and transferable technology (including proprietary rights).

The two other driving factors identified are:

- a favourable market environment in terms of customer demand - providing a market for new and more sustainable products;
- a favourable regulatory regime - providing certainty and incentives.

This study also identified early involvement in developments in innovative areas, anticipating changes in the regulatory regime and in customer demand as a key element for successful green business. These insights are broadly supported by the extensive academic literature on innovation, which is selectively reviewed below.

Cumulative and disruptive entrepreneurial activity has long been recognised as playing a crucial role in economic development and structural change, involving as it does the creation of new industries and the destruction of others (Schumpeter, 1911). The role of 'radical' or 'disruptive' innovation in economic transformation to meet the challenge of sustainability has also been an important theme in the green innovation literature. In order to understand the arguments, there is a need to briefly review current theory about innovation and innovation processes. In recent decades thinking about innovation has shifted away from simple, linear models, where new products are driven by scientific/technological advance and/or market needs, to more sophisticated models which emphasise multiple feedback mechanisms, interactive learning and the relationship between innovating firms, research institutions, suppliers, customers and regulatory regimes. Recent theories highlight the role of strategic integration in the value chain and common development processes (systems of innovation) at both the horizontal and vertical levels. The complexity of innovation processes are such that it is difficult to apply a general model of innovation, and studies in different sectors demonstrate that

innovations take place in and are supported by complex systems of suppliers, producers, users and regulators (e.g. Gardiner, 1994). Bessant and Tidd (2007, p. 83) capture this complexity in their description of a ‘spaghetti model’ of innovation involving multiple interactions between actors and flows of knowledge and its deployment.

The concept of **technological regimes** has been introduced to help explain the success or otherwise of particular innovations. Technological regimes comprise the complex of scientific knowledge, engineering practices, institutions and infrastructure that support existing practices and pose obstacles to radical innovation (Kemp et al., 1998; Nelson & Winter, 1982). The role of SMEs in technological regime change will be further explored in the following section (3.3). It is useful to further consider the different ways in which innovation can contribute to sustainability / the low carbon economy, drawing on a typology developed by Bessant and Tidd (2007, p. 325). In Figure 3.1, the vertical dimension represents the *degree of novelty of the knowledge* involved and the horizontal dimension the *degree of novelty of the application* of that knowledge.

Figure 3.1: Typology of Innovations

	<i>NEW</i>	Development of alternative technologies in existing applications	Co-evolution of new socio-technical systems
KNOWLEDGE	<i>EXISTING</i>	Improvements in the performance and quality of existing products and services	Creation of novel product and service niches
		<i>EXISTING</i>	<i>NEW</i>
		APPLICATION	

Source: Bessant and Tidd (2007)

The most common type of innovation is within the bottom left quadrant, which generally involves *incremental improvements* to existing technologies, products and services. More radical improvements may also be involved but the goals and performance criteria remain the same, as in increases to the efficiency of a car engine. In the top left-hand quadrant *new knowledge* is applied to *existing problems*. Examples include the application of alternative materials, processes and technologies, such as in the case of food packing, where different materials and designs have different energy requirements over their life cycle, including with respect to reuse or recycling. Innovation in the bottom left quadrant involves the application of existing knowledge to new market niches – described as ‘*architectural*’ innovations, since they involve re-applying existing components and sub-systems in new configurations. Such innovations often develop and co-exist in niches alongside existing mass market applications, which they may well usurp, and are therefore

seen as very important for sustainable innovation; Bessant and Tidd give the example of safety features in cars, which were not considered significant until the early 1980s.

The most important contribution of innovation to sustainability is in the top-right quadrant and involves the *co-evolution of new socio-technical systems*. This type of innovation is characterised by close interaction between developers, users and other actors. Success is likely to depend on a range of externalities, including supporting infrastructure, complementary products and services, finance and new training and skills. A good example of such innovation would be the micro-generation of energy, which requires changes in energy regulation and pricing, an infrastructure that allows the sale of energy back to the national grid, and new skills and services in the installation and service of generators. Top-down policy change and co-ordination, and bottom-up social change and firm behaviour are critical to support the evolution of such socio-technical systems.

NESTA (2007, 2008) follows a similar line of argument and the imperative to break out of 'lock-in' to high carbon technologies by promoting 'disruptive innovations' – as opposed to 'radical innovations'. Whereas radical innovations involve significant technical advance, disruptive innovation achieves a shift in behaviour.¹⁵ Willis et al. (2007) give the example of low cost airlines as a disruptive innovation, combining old technology with a new business model; and Concorde as a radical innovation, using advanced technology but an old business model. Despite not utilising new technical knowledge, it is low cost airlines which have been the most successful from a business point of view and which have also had the greatest impact on peoples' lives. This technology, however, now looks increasingly problematical given its high dependence on cheap fossil fuel and the associated environmental burden.

3.3 SMEs and green innovation

Much of the literature and policy concern around green innovation has been focused on large firms since they are seen to possess the financial resources, technical knowledge, organisational capacity and influence within the supply chain needed to drive significant innovation in environmental products and services. There are a number of studies, however, concerned with the adoption of innovations by SMEs and also the role of SMEs in developing and commercialising innovative low carbon / green technologies and solutions (e.g. Brown et al., 2007; Hansen et al, 2002; Vivid Economics, 2008). Many of the studies referred to in Section 2 can also be seen to be concerned with innovation in the former, wider sense – i.e. the adoption of incremental improvements and application of existing (good practice) knowledge/technologies.¹⁶

¹⁵ The term 'disruptive technology' was introduced by Bower & Christensen (1995) and further developed in Christensen (1997) and replaced by 'disruptive innovation' by Christensen & Raynor (2005).

¹⁶ Interestingly, the paper by Könnölä and Unruh (2007) links the debate on the adoption of environmental management systems (EMS) to that on more significant innovation by describing how EMSs, through their prescriptive/standardised nature, can contribute to inertia in existing production systems by inhibiting dramatic shifts towards more sustainable technologies and systems. The authors recommends instead an 'ambidextrous' management approach that integrates foresight and broader stakeholder collaboration.

An important insight from the general literature on innovation is that it is misleading to conceptualise innovation as a discrete activity occurring within isolated firms since R&D and innovative activity often spans organisation boundaries and entails co-operative links between large and small firms. Thus both large and small firms play important, if different, roles over the life cycle of the innovation and there are *dynamic complementarities* between small and large enterprises (Rothwell, 1983, 1989; Kaplinsky, 1983). While large firms have the advantage of access to resources, small firms have *behavioural advantages of flexibility and adaptability* and an ability to respond rapidly and efficiently to the needs of customers.

Building on the concept of technological regimes – the complex of knowledge, practices and institutions that support existing practices - it has been argued that two distinct technological regimes can be identified: **entrepreneurial** regimes and **routinised** regimes:

“An entrepreneurial regime is one that is favourable to innovative entry and unfavourable to innovative activity by established firms; a routinised regime is one in which the conditions are the other way around” (Winter, 1984, p. 297)

Thus, in **routinised regimes**, innovation-generating knowledge arises through experience (e.g. learning by doing) and regimes tend to be dominated by large firms. They also seem to be marked by technological maturity, established consumer preferences, scale and learning economies, capital intensity and relatively high entry barriers. In **entrepreneurial regimes**, knowledge from outside the industry plays a more important role in producing innovations and such regimes are characterised by market conditions that favour small firm innovation. They also seem to be marked by technological immaturity, uncertain consumer preferences, relatively low capital intensity and development costs, niche markets and the absence of scale economies, and lower entry barriers.

While research shows that SMEs have the advantage over larger firms of higher flexibility and responsiveness to customers, the innovative and adaptive capacity of most SMEs tends to be restricted to incremental changes within existing product/service configurations and supply chain relationships. Thus decisions relating to the adoption of environmental innovations take place within the context of existing routines, preferences and values. This perspective is somewhat different to the traditional ‘rational choice’ decision model where enterprises have complete information, examine different possibilities and assess the range of optimal choices. It is therefore essential to understand adoption decisions as an organisational process, involving the enterprise’s interpretation of environmental communications (demands from regulators, customers and within business relations) and the decision making process, including the ‘bounded’ rationalities which guide searches and decisions (Hansen et al., 2002).

Other relevant insight from the innovation and knowledge management literature is focused around the concept of **absorptive capacity** (Cohen & Levinthal, 1990), referring to the ability of firms to absorb and apply new external knowledge, or their **learning capability**. The diverse range of literature is usefully reviewed by Bessant et al (2005).

These authors add to this literature the notion of a *tipping point*¹⁷ – the idea that beyond a certain point the rate of change in a given process accelerates rapidly, or that ideas, products, messages and behaviours spread like viruses. Bessant et al combine the notion of the tipping point faced by the firm alongside its *knowledge state of key issues* into a two dimensional framework for classifying firms growth states. Four knowledge states or levels of absorptive capacity are defined:

1. ignorance of key issues;
2. awareness of key issues;
3. knowledge and understanding of key issues and solutions;
4. implementation of key issues and solutions (Bessant et al. 2005, p. 38-43).

The analysis of Bessant and his colleagues also suggests different interventions aimed at building absorptive capacity according to the particular state of the firm. Although not addressed as such by these authors, this analysis has clear relevance to the challenges and tipping points associated with sustainability. Thus, many of the studies on green management referred to in Section 2.4 seem to suggest that most SMEs have been, at best, knowledge state 2 - awareness of key issues around sustainability - and therefore need to be further motivated to respond to the sustainability agenda.

Other studies more specifically concerned with environmental/green innovation also build on the key role of absorptive capacity (or 'receptivity'), learning capabilities and the processes by which various environment-related influences and sources of new knowledge are assimilated and applied within businesses. Based on analyses of specific environmental adoption processes, Hansen et al. (2002, p. 39) develop a 'dynamic triangle' framework based on:

- strategic orientation – the importance of how environmental issues are communicated and perceived by actors;
- network relations – importance of improving the selection environment from which SMEs obtain their knowledge regarding solutions to their competitive problems;
- internal competencies – the importance of strengthening the ability of SMEs to adjust to new technological paths.

The case study analysis of Vickers and Cordey-Hayes (1999) shows the importance of (a) good linkages with external sources of knowledge, including regulators, and (b) the extent to which the organisational culture involves the workforce in encourages a pluralistic and participative approach, including with respect to workplace conditions and occupational health and safety. The importance of employees as key stakeholders, stimulating improvements in working conditions and associated environmental improvements is also supported by Masurel (2007).

Some policy implications are usefully summarised Hansen et al (2002) emphasising the need for a systemic approach and that "*actions directed at SMEs alone will inevitably miss*

¹⁷ This idea originates in the sociological literature although it has been popularised by Gladwell (2000).

the target and the ultimate goal of assisting SMEs to innovate environmentally will not be met." (op cit p. 54) The further policy implications of their analysis are that:

- successful regulation requires a mix of different means and needs to be integrated with the different forms of regulators' actions targeted at SMEs;
- the mixture of means of regulation has to depend on the specific context (sector, technology etc);
- policy should address the development of the competencies, strategic orientation and network relations of SMEs (Hansen et al., 2002, p.52).

The paper by Brown et al (2007) examines the potential for **new small firms working with a radical technology** to act as **agents for change in an established technological regime**. They focus on the development of fuel cell technology, because of its potential to be significant in a number of different application areas (power generation, transport and consumer electronics) and because it has already attracted many new start-ups. Other research indicates that such transitions happen as a result of the development of a number of niche markets, often in a hybrid form in conjunction with existing technologies, and supported by other changes in society at a higher level (Geels, 2002). The development of 'green' technology can be particularly difficult where market demand has yet to emerge and the main driver is societal good. The work by Brown et al, based on case studies of two firms with quite distinctive approaches, highlights the role of *technology specific advocacy coalitions*, involving extensive partnering arrangements and with the leading players being the companies promoting the new technologies.

3.4 Innovation, regulation and competitiveness

Regulation is seen in much of the literature as playing a crucial role in driving necessary environmental improvements in more environmentally exposed businesses and stimulating innovation in cleaner technologies. Regulation can therefore be seen as representing both a challenge and an opportunity for businesses. It has also been argued that strict regulation, by driving more efficient and environment-friendly processes can help businesses to become more competitive, capturing new (including international) markets and 'first mover' advantages.¹⁸ The Porter hypothesis (Porter and van der Linde, 1995) has been particularly influential as a statement of how environmental regulations may result in 'win win' outcomes for businesses. Thus, any regulatory costs that result from environmental legislation are seen to be outweighed by the resulting business growth, constituting a 'win-win' scenario. An alternative, 'pollution haven' hypothesis supports the traditional view that the introduction of more stringent environmental regulations harms the productivity and competitiveness of the national industry as firms are confronted by higher costs. Following from this, national policy makers may be motivated to apply more lenient environmental regulation, reducing the production costs of their manufacturers and their ability to export, despite the possibility that their national territories will become 'pollution havens' (e.g. Brock & Taylor, 2005).

¹⁸ Note that in 2005 5 per cent of EU SMEs reported having subsidiaries or joint ventures in other countries. Nine per cent of UK SMEs reported *any revenue from exports*, compared to Spain 3 per cent), France 6 per cent, Germany 9 per cent, Netherlands 13 per cent, Austria 14 per cent, Denmark 17 per cent (Observatory of European SMEs, 2007).

This is a complex debate, however, and there has been a **lack of consensus as to the extent to which regulation inhibits or stimulates innovation** (and also how innovation and regulation variables should be defined) and the resultant **contribution to business competitiveness**. This is broadly the conclusion of three systematic reviews of the empirical evidence: by Wagner (2001) Mahdhi et al (2002) (focused on the impact of health, safety and environmental regulation on the chemical industry) and SQW (2006). Thus Wagner (2001) concludes that:

“although there is ample anecdotal evidence on the considerable economic benefits of individual firms from environmental performance improvements/corporate environmentalism, systematic evidence for larger samples of firms across several industries is much more inconclusive” (p. 44).

In their report to the Royal Commission on Environmental Pollution on the impact of health, safety and environmental (HS&E) regulation on the chemical industry¹⁹, Mahdi et al (2002, p. 1-2) further conclude that:

- regulation appears to play a *modulating* role and that in many countries the most successful firms also face the highest levels of regulation (e.g. pharmaceuticals in the UK, chemicals in Germany, pulp and paper in Sweden and aerospace and finance in the US);
- evidence supports that regulation causes a *temporary shock* to innovative activity that negatively influences the overall rate of innovation, although the level and persistence of this shock varies from case to case;
- major methodological problems in the studies reviewed mean that they are of limited value in terms of informing policy. In particular, studies are often preoccupied with the *private costs of regulation* and rarely consider their effectiveness in screening out new technologies with potentially adverse effects, a primary goal of environmental and social regulation;
- insofar as accurate assessments of the overall costs and benefits of different regulatory regimes are possible, their relative rankings cannot be definitively resolved by policy research since they involve *political judgments*. Care needs to be taken in extrapolating findings from one context to another, given different public attitudes to technological risk in different national contexts.
- it is important to consider the uncertain, time lagged costs associated with lax regulatory regimes in order to avoid major social and environmental costs in the future.
- the impact of HS&E regulation needs to be considered in a wider context of other policies that impact on the rate of innovation (e.g. R&D, intellectual property rights and pricing policies) which play a major role in differential rates of innovation between Europe, the USA and Japan.

Some very recent studies provide some support for the Porter and van der Linde hypothesis in the field of energy and environment related innovation:

¹⁹ A highly differentiated and heterogeneous sector, with smaller firms co-existing with large firms in particular sub-sectors.

- Costantini and Crespi (2008) examine the case of the export dynamics of energy technologies and conclude that it is the *stringency of environmental regulation supplemented by a strong National Innovation System* which is a crucial driver of export performance.
- Wagner (2008), using evidence from the European Business Environment Barometer 2001/2 survey in 9 European states found that environmental management systems are associated with process innovations, whereas product innovations are positively associated with market research, informing consumers and eco-labelling activities. Firm size was not found to have any positive effect on the probability of enterprises carrying out product or process innovations. In terms of country effects, the strongest was found in Germany, whereas negative effects were found for Hungary, Switzerland and the UK. In the case of the UK, the author attributes this to a less stringent regulatory environment.

Environmental economists have tended to argue that, as a rule, tighter regulations are likely to have a negative impact on profits, since such regulations are normally applied to internalise the external costs of production (Palme, et al., 1995; Gabel & Sinclair-Designe, 2001). There is a need to take account, however, of definitional problems related to how to interpret *competitiveness* and its changing nature, particularly in a policy/market context where sustainability concerns are assuming greater priority. A crucial effect is that of the **policy spillover** – the extent to which national policies are emulated by other countries. Such policy spillovers on competitiveness have been particularly apparent within the EU since the late 1980s and early 1990s – developments which Søgard and Madsen (2007, p. 436) see as supporting the expectation of a **more level playing field** and that, in some cases, “*stricter national regulations might translate into competitive first-mover advantages in international markets*”. In the context of climate change, clearly there have been mounting pressures and actions taken globally to create a more consistent policy framework to support emissions reduction globally. This has contributed to the considerable growth in investment seen in low carbon technologies in recent years, and with businesses in some countries having gained a competitive edge in some areas - as will be further discussed in Section 3.6.2. However, most businesses are still likely to continue to see competitive advantage in short-term sense and narrow business cost-benefit terms. Ongoing uncertainties relating to the lack (or variability of) of market signals and lack of consistency in the policy environment may continue to deter more widespread investment in low carbon innovation, even including with respect to investment in tried and tested technologies by the corporate sector.²⁰

There have been a number of further criticisms of win-win in the context of the regulation and greening of business:

²⁰ The recent decision of Shell to withdraw from investing in the London Array Windfarm due to the “margins being too thin” appears to be a good example of the current fragility of business confidence in the ‘renewables revolution’ in a context where oil has dropped from a high of nearly \$150 a barrel in summer 2008 to \$40 a barrel in January 2009. Both Shell and BP have made it clear they are no longer interested in pursuing wind farms in the UK when the returns on investment seem more attractive in the US due to tax breaks (*The Guardian*, 2 January 2009).

- ‘First mover’ advantages only last as long as it takes for other businesses to catch up. It is difficult to sustain competitive advantages arising from costly leadership or product differentiation when other firms can simply copy the innovation or strategy (Simpson et al, 2004).
- The cost-benefits of environmental improvements are, once a certain threshold of investment has been reached, likely to suffer from the law of diminishing returns (Walley & Whitehead, 1994).
- The true extent of environmental benefit in win-win case studies has been questioned by some critics, given that most do not include a full product life-cycle analysis (Cerin & Carlson, 2002).

There is also a broader concern observed in the literature on the contribution of technological innovation to sustainability – that ‘eco-efficiency’ improvements within production and product design may be overwhelmed by ongoing economic growth, albeit growth which is ostensibly ‘greener’ in nature (Fleming, 1996; Mol, 2000). Production efficiencies may give rise to a **rebound effect**, whereby efficiency gains lead to lower costs which, in turn, lower prices and encourage a growth in consumer demand and associated environmental impacts. If the rebound effect is sufficiently large it may undermine the rationale of policy measures to encourage energy efficiency / environmental improvement (Greening et al., 2000).

The issue of **economic growth and sustainability**, and the role of innovation in this, is a complex and contested area (e.g. see Daly, 1987; Huber, 2000). Thus some commentators argue that there are real ecological ‘limits to growth’ which may not be overcome by technological innovation, but require change involving such notions as ‘sufficiency’ and ‘voluntary simplicity’ and also greater equity in how resources are distributed.²¹ In the short term at least, however, the sort of investments needed in low carbon energy sources and other infrastructure (some of which are discussed in Section 3.6) will inevitably give rise to some increased emissions of greenhouse gas emissions before real cuts can be made.

3.5 Sustainable entrepreneurship and social enterprise

It has been suggested that the value commitments and beliefs of owner-managers and entrepreneurs have an increasing role to play in driving the greening of business. Some studies focus on the role of **sustainable entrepreneurship** and the potential of **social enterprise / entrepreneurship** in promoting environmental sustainability (e.g. Schaper, 2002; Korunka et al, 2003). Sustainable entrepreneurship is closely associated with phenomena such as **corporate social responsibility** and **business ethics** (Masurel, 2007). Thus *green entrepreneurs* or *ecopreneurs* are people who are specifically motivated to create green businesses in order to radically transform the sectors in which they operate and who want to make a living while also contributing to solving environmental problems (Isaak, 2002; Schaper, 2002). Walley and Taylor (2002) identify

²¹ It has been estimated that if the whole world consumed as much as the average American citizen there would be a need for six to eight planets (Dauvergne, 2008). Even countries which may be relatively ‘ecologically modernised’ have considerable ecological footprints which extend beyond their national boundaries (e.g. Revell, 2007a and 2007b).

four types of ecopreneurs who seek to occupy new niches and reconfigure existing business models and practices:

1. *Innovative opportunists* - primarily financially oriented, having spotted a green niche;
2. *Visionary champions* - embracing a transformative, sustainability orientation;
3. *Ethical mavericks* - sustainable orientation, influenced by friends, networks and past experiences;
4. *Ad hoc* or accidental green/enviropreneurs.

Grayson and Dodd (2007) identify the increasing number of initiatives to support CSR in SMEs within Europe. They argue that European small enterprises have a key role to play with respect to sustainability and that the CSR/sustainability agenda is shaping the competitive environment in which SMEs operate in a number of ways, through:

- social and environmental supply chain requirements;
- the values of young people and young entrepreneurs;
- competition for skilled workers;
- the importance of trust, reputation and relationships in the networked economy;
- the evolving regulatory environment;
- the rise of ethical and green consumerism.

These authors further highlight a number of characteristics (citing Gibb, 2006) that suggest that many small businesses, by their very nature, have a predisposition to responsible behaviour (see also Spence & Rutherford, 2001). Such characteristics include:

- the owner is the business – their image and behaviour is perceived substantially as that of the firm;
- most SMEs are based in one location for their entire life, often with the owner-manager and family living and working in the same community;
- as such they are embedded in the local environment – their children grow up in local schools, they frequent local pubs, clubs, places of worship etc;
- their status is closely tied to their local social status;
- they have a well documented tendency to regard their employees as extended family;
- decisions and objectives are not driven by the same motives as managers in large companies. It is doubtful from the evidence that the vast majority are driven by the goal of profit maximisation;
- there is no divorce of ownership from management and therefore no narrow goal to meet the needs of shareholders, i.e. the owner's job is not on the line to maximise shareholder value;
- a much greater volume of their stakeholder relationship and transactional activity is based upon trust rather than formal contract, with local networks often being critical.

Despite the evidence relating to the impact of company size on CSR being contradictory, owner-managed SMEs often show a strong commitment to their employees, are more likely to be embedded in their local environment, are not necessarily driven by profit

maximisation, and rely on reputation and trust for many of their business transactions (Grayson & Dodd, 2007, p. 10-11).

There is relatively little research on **social enterprise** and environmental sustainability, although many social enterprises aim to address environmental issues as well as social problems, with examples in community renewable energy (see Section 3.6.2), recycling and refurbishment (e.g. furniture) and environmental education. There is a need for more research on how pro-environmental organisations (e.g. community groups, charities, trusts) can become more financially viable and secure by becoming more enterprising. Issues of social enterprise involvement in procurement processes present specific challenges (DTI, 2003).

In keeping with other previous discussion, the spread of green/ecopreneurship is likely to be dependent on a closer conjunction of commercial, social and environmental values and changes in the wider economic/policy environment and associated incentive structures and competitive environment.

3.6 Some sectoral implications of the low carbon economy

3.6.1 Introduction

This section further explores some of the main implications and opportunities arising as a result of the low carbon imperative, drawing on recent literature which addresses the sustainability issues facing particular sectors and types of businesses. Important here will be changes in the patterns of demand for goods and services, with a leading role played by changes in the allocation of capital and strategic investment decisions of large organisations and of Government through its investment and purchasing decisions. The sectoral implications for SMEs are also closely tied to the local/regional dimension of low carbon development. As previously indicated, a more sustainable economy implies a **rebalancing of priorities away from short-term consumption** and with substantial investment in **low carbon infrastructure** and the productive capacity needed to develop and support this.

An important theme in the literature on sustainability suggests that low carbon restructuring requires the **relocalisation of wealth creation** in local/regional economies, such that employment and consumption/service needs are met locally to a greater extent than hitherto. Contributors that emphasise the benefits of greater local/regional self reliance have been critical of the emphasis in previous decades on relatively free markets and global competitiveness as the overriding determinant of economic policy (e.g. Ekins & Newby, 1998; Haughton, 1998; Murray, 1999; Hines, 2000; Morgan, 2004; Pike et al., 2006). These and other authors suggest a need for 'fair trade' rather than 'free trade', supported by stronger rules on how international trade is organised, particularly with respect to environmental and labour standards. Others, however, remain critical of the potential of relocalisation and greater economic self reliance as a means of addressing global climate change, prioritising instead the role of technological innovation (e.g. Vivid Economics, 2008). The possibilities are more complex than any stark dichotomy between 'globalisation' and 'localisation', however, and the low carbon economy is likely to involve

the development of new interdependencies between the local and global scales.²² Moreover, given that most SMEs are dependent upon their home markets, with many focused on local or regional markets, the localisation agenda is highly significant for SMEs. As well as the environmental / low carbon advantages of more diversified local economies, other advantages referred to in the literature include:

- a greater role for SMEs, including community based / social enterprises;
- reducing the vulnerability of specific industries or firms and also consumption needs to external volatilities;
- the retention of local investment and wealth;
- the strengthening of human and social/organisational capital, also fostering local identity, social integration, cohesion and well-being (e.g. Ekins & Newby, 1998; Haughton, 1998; Murray, 1999; Hines, 2000; Morgan, 2004; Pike et al., 2006).

The recent study for BERR (Ernst & Young, 2008) focused on comparative advantage and green business and provides a useful entry point for considering some of the specific **sectoral implications** in greater detail, concluding that:

“The impact at a sectoral level is likely to be highly varied, not just in outcome but also in terms of transmission (from action to outcome). Spillover effects in some types can be significant, and therefore, under these conditions, simulations indicate that while some developments could boost UK GDP others could have a negative impact on GDP – particularly for some sectors.”²³

The authors of this study see the traditional definition of Environmental Goods and Services as being too narrow to fully encompass the implications and opportunities for comparative advantage. They therefore identify eight sectors where they see UK businesses as having comparative advantage and further identify the following sectors where the UK could develop green business opportunities: software, electronic equipment, business services, financial services, and machinery equipment.²⁴

Other studies take a broader approach to examining the opportunities (e.g. CBI, 2007; GNDG, 2008). The CBI report (2007), for instance, identifies five key areas for SMEs where it argues there are markets worth nearly £3 billion in the UK until 2010 - commercial buildings, renewable electricity, renewable road transport fuels, domestic energy efficiency and housing. There have been a number of other recent studies that address issues relating to sustainability / the low carbon economy in specific sectors where there are opportunities for SMEs and small start-ups. The findings of these studies are briefly summarised below, the sectors considered being energy supply and services, construction, and food and agriculture.

²² Further insight relevant to articulating and exploring policy options and the role of values and interests in shaping socio-economic outcomes is offered by the Futures Scenarios commissioned by the Natural Resource and Environment Panel of the UK Government’s Foresight programme (Berkhaut et al, 1998; OST, 1999). These scenarios were further developed as a generic planning tool (DTI, 2002; also Eames & Skea, 2002).

²³ It is important to note, however, the limitations of the modelling techniques used in such studies (in this case conducted by Oxford Economics), including that “traditional economic analysis of the type we have undertaken might not reflect the nature of a significant discontinuity such as climate change.” (Ernst & Young 2008, p. iii)

²⁴ See Ernst & Young, 2008 Paper 2: p. 18-35 for full details.

3.6.2 Energy supply and services

The energy supply industry is dominated by large providers, with electricity typically generated by large power stations linked to a centralised grid. It has been estimated that the industry is responsible for approximately 38 per cent of current UK greenhouse gas emissions (Defra, 2006a) and that technical inefficiencies result in losses of 65 per cent of the primary energy input, this being mainly due to heat that is wasted during centralised production (DTI, 2005). The solution to this problem, as argued by a number of commentators, is that of the greater use of renewable sources of energy, including **decentralised small scale generation** which is closely linked to users' needs, such as combined heat and power (CHP), wind, solar (photovoltaics), geothermal and biomass energy (e.g. Patterson, 2007; Allen et al., 2008). However, the large power generators may be uninterested in relatively marginal developments and also lack the necessary local knowledge to make such schemes work. Within the UK, the development of renewable energy led by large private enterprise has been disappointing, falling well below government targets. Much of the development and construction work has been undertaken by SMEs, some of which are carving out a niche internationally. However, their growth has not been as rapid as firms in mainland Europe; in Denmark (off-shore wind) and Germany (solar photo-voltaics) have become internationally highly competitive. New renewable technologies, such as tidal power, are still being tested but UK firms could yet achieve success in this area. At the smaller end of the scale, Government has sought to support the wider adoption of micro-generation technologies – these are still not cost-effective and are reliant on capital grants.²⁵ The recent appraisal by Allen et al. (2008) supports that there is potential for micro-generation and other decentralised technologies to radically reduce the inefficiencies of large power stations linked to a centralised grid. Alternative configurations for micro-generator installation involve various levels of decentralisation / national grid dependency. In principle, there would seem to be great potential for such technologies/services to be delivered by smaller enterprises.

Venture capital has been particularly important in enabling access to finance for technologically innovative SMEs and start-ups in this sector. Venture capital investment in low carbon innovation has been a rapidly growing market, until recently experiencing more than 30 per cent annual growth. In 2007 venture capital and private equity investment alone in low carbon technologies totalled \$4.6 billion (£2.6 billion) in the EU and \$5.3 billion (£3 billion) in the United States (Vivid Economics, 2008). The US leads Europe due to the considerably larger amount of capital funds that US capital markets can direct at the sector, but also the strength of the sector in terms of its knowledge base, entrepreneurial capabilities and experience of innovation in new technologies.²⁶

The UK has the largest 'clean' venture market in Europe and the focus has been on generation and energy storage technologies and alternative fuels. In 2007 venture capital (VE) and private equity (PE) investment in renewable and energy efficiency technologies was \$1.9 billion (£1.1 billion) in the UK - 41 per cent of the EU total and more than double that of any other EU country. Similarly when SMEs alone are examined, the UK attracted

²⁵ The grants for domestic renewables proved so popular that allocated funding was rapidly spent and the programme put on hold.

²⁶ Ernst & Young (2008 p. 10-12 and p. 14) gives further details, comparing the UK, France and Germany.

a significant share (43 per cent) of VC/PE investment in European low carbon SMEs between 2006 and the first quarter of 2008 (Vivid Economics, 2008, p. 3). This success has been attributed to the strength of the UK's financial sector, allowing easy access to capital, and the growth of clusters of activity around the headquarters' of key companies and key scientific sectors in high quality universities (Ernst & Young 2008, p. 14-15). Regulation has also been a key driver of the clean technology sector in Europe; also government – according to a study by Library House and Carbon Trust, the public sector participates in 45 per cent of such projects in the UK and 15 per cent in the rest of Europe (Library House, 2007). The recent study commissioned by Shell Springboard (a fund for ethical small businesses) further suggests that:

- 'climate change entrepreneurship' could be a more significant and enduring opportunity than the dot-com boom of the late 1990s, when global sales of personal computers were growing at 15 to 20 per cent;
- the global low carbon energy market opportunity could reach £2,000 billion per annum by 2030 (Vivid Economics, 2008).

Despite the recent influence of low oil prices and the credit crunch it is hoped that the increasing engagement of governments globally will contribute to perceptions of climate change as a long term global issue with real growth potential for investors. However, the high level of VC/PE investment in low carbon technologies in the UK contrasts markedly with the low proportion of its energy needs met through renewable energy, at only 1.3 per cent compared to 20-40 per cent in the best performers such as Sweden and Austria. This would seem to reinforce the need for greater policy attention to be given to investment in low carbon infrastructure and related regulatory/fiscal incentives in order to speed up the application of tried and tested technologies.

Van der Horst (2008) focuses on the potential of energy systems which, both from an economic and carbon emissions reduction point of view, may be best operationalised at the **community scale** and where certain models of **social enterprises** may have comparative advantage over conventional enterprises. The technologies involved include regional biomass energy systems, district heating, smaller wind turbines closer to built up areas, wind to heat and ground-source heat pumps. Currently there are very few examples in the UK of social enterprise focused on the production of renewable energy.²⁷ The study by van der Horst (2008) examines the experience of the Highlands and Islands Community Energy Company (HICEC) in enabling such social enterprise activity, highlighting the importance of partnership working between HICEC staff and the staff at local social enterprises and the emergence of 'communities of practice' as a key benefit. Questions are raised, however, as to the replicability of this model in more urbanised parts of the UK.

Allen et al. (2008) conclude that there remain substantial barriers to a significant rise in the use of micro-generation in the UK - in particular a lack of financial backing needed to support and stimulate the market. There would therefore seem to be a need for further government intervention to provide a stable, consistent and long term framework in order

²⁷ See Baywind case study in Appendix 2.

to reduce risk and provide greater incentives for investment in micro-generation and renewables in general.

A selection of case study examples of 'low carbon' innovative SMEs drawn from the studies referred to is given in Appendix 2. Of particular note is the role of the supportive context in these cases and also the origins of many of the ideas in research intensive universities.

3.6.3 Construction

It is widely recognised that construction is a key sector, given that homes contribute 27 per cent of the UK's total carbon emissions and also given the social need for affordable new homes which are energy efficient and low carbon. Thus a number of studies concerned with environmental sustainability refer to construction (dominated by SMEs) as a key sector, including with respect to the creation of 'green jobs' (e.g. CBI, 2007; GNDG, 2008) and given that government strategy and spending is also crucial here.

The study by Killip (2008) commissioned by the Federation of Master Builders (FMB) on the role of the SME construction firms argues that:

- deep cuts in carbon dioxide emissions and energy use in housing are possible;
- there is a need to create low-carbon standards for refurbishing of the existing housing stock, and extending the measures already used in new house-building such as cavity wall insulation, draught-proofing, efficient heating boiler, high-performance glazing, and use of low- and zero- carbon technologies (LZCs);
- proposes a strategy based on the development of effective partnerships and collaboration with other sectors in refurbishing the UK's housing stock.

Killip further argues that over £23 billion per year spent on repair, maintenance and improvement is ineffective in terms of low carbon refurbishment. Significant investment is required in renovating housing, developing LZCs, products and supply chains as well as in training and skills development. The study estimates that the introduction of Energy Performance Certificates (EPC) and other financial incentives could amount to business opportunities for construction firms, product manufacturers and suppliers, of between £3.5 billion to £6.5 billion per year. Similarly, the study by Boardman (2007) argues that modifications to current stock of housing that will still be in use in 2050 can be reduced by 80per cent and that 'zero-carbon' new build homes are a realistic possibility. Along with the Government's ambitious target to build zero carbon new homes by 2016 in England and by 2011 in Wales, similar targets are needed in the refurbishment sector given that 85 per cent of UK's homes will still be standing in 2050.²⁸

²⁸ Note also that there are 672,924 empty homes in England, accounting for 3.2 per cent of the housing stock. It is recognised as important to maximise use of the existing housing stock in order to minimise the number of new homes that need to be built each year, particularly in areas of the country where housing demand is high, such as the south east of England (see: <http://www.communities.gov.uk/housing/housingmanagementcare/emptyhomes/>).

3.6.4 Food and agriculture

Food production and agriculture, as well as making a significant contribution to greenhouse gas emissions, are also particularly vulnerable to the increasing effects of climate change, adding to serious concerns about national and global food security (Battista & Naylor, 2009). Recent years have seen a growth of interest in how food systems can be transformed from a sustainability perspective, since this is seen to be one of the most effective and comprehensive ways of reducing the ecological footprints of regions while also addressing issues of food security, poor nutrition and providing more local jobs (e.g. Donald, 2008; Morgan, 2008). Also of particular concern is the growing evidence confirming that climate change is disproportionately impacting on the poor, and particularly subsistence farmers in developing countries (Battista & Naylor, 2009).

According to UK Energy Research Centre (UKERC) the food sector broadly defined (i.e. including agriculture, food manufacturing and transport and supermarkets), is responsible for some 22 per cent of the UK's total emissions of carbon dioxide. Besides carbon emissions from energy use (e.g. transport, processing), emissions of methane and nitrous oxide from farms contribute 7.7 per cent of total UK emissions of greenhouse gases (White, 2007). The Government's 'Facing the Future' strategy for sustainable farming and food notes that while agriculture generates significant benefits for the environment, it also has negative impacts estimated to cost around £1-1.5 billion (Defra, 2002). The strategy outlines a number of key principles for the development of sustainable farming and the food sector including reducing energy consumption by minimizing resource inputs and increased use of renewable energy.

Within the food supply chain, food transport (or 'food miles') contributes 3.5 per cent to UK's CO₂ emissions (Garnett, 2003). Research suggests that in order to reduce CO₂ emissions from food as well as meeting consumer demands, there is a need for a rebalancing between global and local food systems. Transport 2000's research into food supply chains suggests several measures for reducing CO₂ emissions in food transport (e.g. including the greater use of indigenous and seasonal produce, the more efficient operation of processing plant and greater logistical efficiency). In addition, shorter supply chains with continuous logistical efficiency can reduce food miles, while avoiding the danger of creating more energy intensive production as a result of that (Defra, 2006b). Changes in SME operations (and opportunities) will therefore require changes in consumer behaviour, such as eating less meat, increasing demand for seasonal produce and reducing demand for produce that can only be grown far away or under energy intensive systems (e.g. greenhouses). It is argued that there is a need for measures adopting a regional and national approach while shifting businesses away from long distance food transport (Garnett, 2003).

Morgan (2008) examines the further potential of **green public procurement** as a mechanism for promoting sustainable practices throughout the UK economy, focusing on public sector food provisioning. There has been a growing commitment to sustainable procurement in the UK, although the Simms report for Defra (SPTF, 2006) registered concern that this is still being expressed within a *cost-cutting* rather than *value-adding* business model (SPTF, 2006). How and where food is produced has also assumed increasing importance in recent debates about the moral economy and ethical business,

including with respect to the social and economic as well as the environmental dimension of sustainability. Food chains that are more sustainable are generally seen to involve **re-localisation**, thus benefiting local (SME) producers and local employment although Morgan (2008, p. 1244) notes that “a more robust definition would include fairly traded global food chains as well.” Barriers to public procurement led re-localisation efforts include that of ‘regulatory ambiguity’, i.e. uncertainty on the part of procurement managers about what is permissible under the rules, tending to make them very risk averse. One example of this is the European Union procurement rule that it is illegal to specify ‘local’ food in public catering contracts (although this is less of a barrier than is often thought). Other issues raised by Morgan include:

- the need to apply **whole life costing** and to overcome the knowledge deficit within the public sector in relation to this - hence the Simms Report on sustainable procurement expressed that “the efficiency message was being interpreted throughout the public sector in ways which drowned out sustainability considerations” and that there needed to be “a clear message from the top that value for money must be assessed on a whole life basis” (SPTF, 2006, p. 52-53);
- the longer term need to **stimulate demand for local food**, through a wider process of consumer education, challenging the instinct that ‘cheapest is best’;²⁹
- the need for local farmers and producers to develop the **skills and distributional infrastructure** to get locally produced food ‘from farm to fork’. For instance, the lack of local processing ability has been inadvertently exacerbated by European Union hygiene regulations that are rendering small abattoirs uneconomic;
- while the public sector food supply chain is complex, fragmented and inefficient, Morgan cites a number of examples of food service companies and NGOs effectively calibrating demand and supply at a local level.

Both Morgan and the Simms report conclude that there is a need for greater **political leadership** in order to overcome barriers and to fully realise the potential of sustainable, low carbon procurement.

Although neglected by many recent reports on the low carbon economy / climate change, another subset of enterprises which are likely to assume increasing importance are **pro-biodiversity enterprises**. These have been the subject of a recent EU funded study (Dickson et al., 2007) and are defined as SMEs which are *dependent on biodiversity for their core business and also contribute to biodiversity conservation for their core business*. The study involved consultations with over 50 SMEs and a number of case studies. Examples are mainly in the area of agriculture (often organic farms), fisheries, forestry and conservation management, but involving diversification including in recreation, eco-tourism and education. Such activities are important from the point of view of combating the increasing adverse effects of climate change on the biosphere. Key findings relate to the role of the evaluative commitments of entrepreneurs to conservation and also the role of markets and how these are shaped in various ways, particularly by the state, which is

²⁹ Note the important point to emerge from the study by Wheale and Hinton (2007) that ethical/green purchasing behaviour appears to be strongest in relation to food products, as compared to electric goods, such as stereos and TVs.

primarily responsible for biodiversity conservation in Europe. Pro-biodiversity enterprises also face issues around knowledge, expertise and research; the value of networks of different types; and the availability and retention of appropriately trained staff. The study identifies a number of further research questions relating to the promotion of the role of SMEs in achieving the EUs 2010 biodiversity target.

Finally, Buller et al. (2007) address the potential for growing markets for meat produced on unimproved pasture with high biodiversity, although noting also that biodiversity services related to livestock production can have a negative impact on climate change through contributing to increased methane production.

4. Policy for SMEs in a low carbon economy

4.1 Introduction

A key question we were asked to address is whether *new or better regulation is needed to drive dynamic responses by SMEs or will the market provide effective drivers of adaptation and innovation?* Previous discussion has highlighted the weakness of market mechanisms alone as a driver of environment related improvements in businesses and it is generally recognised that there is a need for a comprehensive policy response to tackle the problem of dangerous climate change and achieve a transition to a low carbon and resource efficient economy. Hence the Stern Review argued that innovation to tackle climate change will require a combination of market mechanisms, technology policy, and policies that effect behaviour and preferences (HMT/Cabinet Office, 2006, Part IV). This need for a 'portfolio' of responses extends to the policy environment affecting SMEs.

At the same time, different views as to appropriate solutions are apparent, with voices from the corporate sector in particular tending to emphasise business-led innovation and technical change (e.g. Vivid Economics, 2008). Others, while emphasising the need for technical innovation, also emphasise the wider application of existing knowledge and proven technologies and the need for behavioural change on the part of both businesses and consumers (e.g. GNDG, 2008; SDC, 2006; NESTA, 2007, 2008).

Previous sections have examined the opportunities and challenges for SMEs in the context of the need for radical (or 'disruptive') innovation and step changes in existing practices. Studies show that many SME owner-managers are constrained by their business environment to adopt incremental changes that are compatible with existing practices and/or are inherently conservative. It is therefore argued that government has a key role to play in establishing the case for change, developing incentives and building capacity in the context of an overall strategy that is consistent and integrated. There is a considerable history of policy measures which are relevant to the promotion of business environmental sustainability and also competitiveness within a low carbon economy, some of the general experiences of which is referred to in previous sections of this report. Such measures include environmental regulations, market incentives, public procurement, and capacity building support to encourage the adoption of environmental management and innovation amongst SMEs. It is important that the history and lessons of such experiences are applied in order to improve their contribution and inform further policy development.

At the same time, the credit crunch and the worsening economic recession is also a priority for policy makers. Increasingly debated is the extent to which solutions can be applied which address immediate socio-economic needs for employment and wealth creation but which are also compatible with the development of a low carbon, more sustainable economy. Policy measures discussed in the recent literature that are also of relevance to SMEs and entrepreneurship include:

- new infrastructural developments in key sectors such as in energy supply, building and construction, transport, and information and communications technology (i.e. broadband connectivity in particular);
- tightening legislation relating to products/building standards and other environmental regulations to drive integrated clean technology solutions
- other regulations relating to finance and financial governance, including for the adoption by credit institutions of low carbon/green standards, and the reform of institutional investors such as pension funds, banks and insurance companies;
- the extension of sustainable public procurement, and measures to support ethical/low carbon consumption more generally;
- support for innovation and R&D, including support for 'low carbon' entrepreneurship and start-ups (e.g. Murphy 2001; GNDG, 2008; NESTA, 2008).

The remainder of this section summarises some of the main evidence on different drivers and policy measures, their advantages and disadvantages: economic incentives, the role of government procurement and investment (including innovation support), better regulation, and finally capacity building targeted at SMEs. Examples of SME policy measures enacted in other developed market economies are given in Appendix 1.

4.2 Economic incentives

4.2.1 Changes in demand conditions

Previous discussion has identified the importance of transforming patterns of demand for goods and services through increased consumer awareness and nurturing the growth of pro-environmental / ethical purchasing and lifestyle change. The market-related changes associated with the transition to a low carbon economy can therefore be summarised as entailing:

- increased demand for products and services that are more environmentally sustainable and which support low carbon lifestyles;
- a decline in demand for products/services that are increasingly seen as unsustainable (also associated by some commentators with an end to the 'era of conspicuous consumption');
- for more established and conservatively managed businesses, increased competition from 'green businesses' that are more able to anticipate and respond to such changes in demand.

Most recently, it seems likely that economic contraction has important (though to some extent contradictory) implications for the greening of production and consumption. Some recent commentary in the media anticipates that current economic recession conditions presage a new 'age of austerity' where consumers (and businesses) will be compelled to save more and reduce 'wasteful' consumption.³⁰ This trend would also seem to link to

³⁰ For example, some commentators have likened the changes to those of postwar austerity conditions, as the chief executive of the Asda supermarket chain has commented: *"This won't be a recession where it is a blip and then we are back to where things were [...]. The era of conspicuous consumption is over. Saving money by cutting waste of all kinds will be the priority. I*

debates in the academic literature relating to the need for a shift in societal values to curb conspicuous consumption in the developed world and the need for absolute reductions in material and energy consumption and a greater focus on quality of life improvements and 'sufficiency as policy' (e.g. Darby, 2007; GNDG, 2008). On the other hand the credit crunch and economic downturn may pose a set-back insofar as green and more ethical products and services which continue to be more expensive lose market share to the cheaper products and services they seek to displace. SMEs in particular may find it harder to invest in developing and marketing their pro-environmental services and products.

Government has a role to play through influencing public behaviour through **education and political leadership**. Stimulating sustainable demand will also involve a long term commitment to a wider process of **consumer education and the creation of discerning and demanding consumers** and challenging the false economies of 'cheapest is best' (SDC, 2006; Morgan 2008). There is a need to support ethical / green consumerism and the current understanding of what drives such habits needs to be applied more widely by SMEs. Businesses need to be able to embrace the challenge of ethical drivers in order to gain competitive advantage while also contributing to the wellbeing of communities and the environment (Whelan & Hinton, 2007).

4.2.2 Market oriented policy instruments

There has also been much debate around the pros and cons of market oriented policy instruments - such as taxes, subsidies and tradable permits - versus command and control measures (ranging from voluntary agreements to regulations and standards) (e.g. see Tietenberg et al., 1999, for an overview; also de Groot et al., 2001). Economic incentives or market-based instruments, such as tradeable permits, are seen to have the advantage of **ensuring that the costs of environmental protection are more efficiently distributed and encourage innovation and investment in new technologies**. Thus, the Climate Change Bill enhances the role of carbon markets by introducing legally binding five yearly carbon budgets and permitting new carbon trading schemes to be introduced through secondary legislation and, not being prescriptive, allows scope for a variety of different approaches, although it has been suggested that a key issue is whether institutions have the capacity and will to respond (e.g. NESTA 2008, p. 4). As noted in Section 2, there also are questions as to the extent to which SMEs will be able to participate in markets such as carbon trading schemes due to the cost of establishing and managing transactions.

Approaches to supporting sustainable consumption have tended to focus on pricing (in the form of fuel or landfill taxes), standards (car emissions, boiler energy efficiency) and information (in the form of ecolabels). Fuel and landfill taxes in general have the advantage that they can be implemented with relative ease because there are a small number of sellers and easily applied across the whole economy. However, they are unpopular with businesses insofar as they are seen to hurt the competitiveness of UK firms that are exposed to international competition. With this in mind Government introduced climate change agreements along side the climate change levy so that

don't see this as being a short-term response to the recession, but a fundamental shift that will see the emergence of a new breed of customer." (quoted in *The Guardian*, 12 December, 2008).

businesses that achieved negotiated carbon performance targets would be rebated most of the climate change levy. While fiscal incentives to achieve environmental goals have been used by UK policy makers, the criticism often made is that prices have not always been set high enough to induce change in behaviour. SME owner-managers have therefore preferred to pay the tax rather than adopt significant and enduring changes in business practice (e.g. Revell & Blackburn, 2007). A recent review of the climate change levy and agreements negotiated by Government found that, although the levy had raised managerial awareness of climate as an issue, the impact on energy prices had been limited and had therefore insufficient to stimulate behavioural change (National Audit Office, 2007).

4.3 Better regulation

Regulations have long played an important role in driving environmental improvement, particularly in those businesses which operate more environmentally sensitive processes. Important **energy efficiency** and **greenhouse gas mitigating regulations** include prohibitions on the release of fluorinated gases (from fridges and industrial processes – the F-gases regulations), building energy efficiency standards (Energy Performance of Buildings Directive and its UK transpositions), and energy efficiency regulations such as the Carbon Emissions Reduction Target and standards which apply to vehicles. Regulations are important where the innovation or behaviour change being sought is not visible to the market (as in the energy efficiency of a window in the purchase of a house) because the costs of acquiring information is prohibitive, and because market failures (e.g. emissions of fluorinated gases from the disposal of fridges) mean there is no economic reward for good behaviour.

In the case of product standards, **ecodesign principles and techniques** are being widely adopted by larger organisations as tools for minimising the full range of environmental impacts throughout the entire life cycle of products. The adoption of such approaches over the last 10 years has been particularly driven by regulation at the EU level, in the form of directives aimed at fostering environmental responsibility in manufacturing industry and relating to wide categories of products (vehicles and electronic products in particular). SMEs, although operating within supply chains in which environmental obligations increasingly apply, have found it difficult to apply ecodesign techniques, which are tending to remain ‘tools for experts’. Thus, Le Pochat et al. (2007) propose a method which initiates and guides change management by establishing connections between the businesses main preoccupations (strategy, design) and environmental aspects and with the assistance of sector advisory centres.

Other environmental regulations that apply to pollution and waste also play a role by stimulating the adoption of ‘**closed loop**’ and **integrated waste minimisation processes**, also optimising energy use. Environmental regulations have been shown to be most successful where they are designed to encourage innovative pollution prevention and ongoing ‘compliance plus’ improvements, rather than prescriptive ‘end of pipe’ measures which can lock firms into achieving minimum compliance but no more (Schaper, 2002). SMEs cause about 43 per cent of serious industrial pollution incidents and generate 60 per cent of commercial waste in England and Wales (Environment Agency, 2006, p. 11). Commercial waste, as well as being an issue in issue of concern in itself (House of Lords,

2008) is an important source of 'embedded' emissions of greenhouse gases. It has also been argued that health and safety considerations are a key aspect of business sustainability and that there is a **synergy between health safety and environmental improvements** in SMEs. Experiences suggest that support initiatives targeted at SMEs can successfully build on such synergies rather than focusing exclusively on greenhouse gas emissions.

There has been a great deal of policy development and debate about what might constitute **better regulation** in recent years.³¹ In the UK, the influential Hampton Review (Hampton, 2005; also BRTF, 2005) focused on ways of reducing the administrative burden of regulation while also seeking to maintain or improve regulatory outcomes. This is to be achieved by further entrenching a risk-based approach which also aims to be transparent, accountable, consistent and better targeted. Better regulation also accords an increased role for non-state actors in regulatory regimes, whether 'economic actors' (businesses, trade associations etc) or 'civic actors' (a range of non-governmental organizations and advocacy groups) (Hood *et al.*, 2001; Hutter, 2006).

There has been ongoing debate about the guiding philosophy, and also the practical difficulties involved in implementing, better regulation.³² Better regulation in the UK has particularly emphasised the greater use of advice, information provision and education. But a key difficulty is that of enforcing legislation given the large numbers of SMEs and that enforcement agencies have limited resources to regularly inspect all enterprises. The credible threat of inspection - or at least the perception of a credible threat - can be achieved by occasional prosecutions accompanied by publicity and industry blitzes, also accompanied by on-the-spot fines and notices. The issue of **regulatory sanctions** was the subject of an important review undertaken by Richard MacCrory (MacCrory, 2006) and the subsequent Regulatory Enforcement and Sanction Act 2008, which streamlines and increases the range of penalties for regulatory offences.

The environmental field has also seen the greater adoption of **voluntary agreements**, including the use of self-reporting tools, such as environmental audits, environmental management systems (EMSs), eco-labelling, environmental reporting and community rights to know (CRTK). Voluntary agreements and self-regulation have been much criticised by environmental and consumer groups and trade unions, but have been shown to work best where external agents play an active role and, crucially, there remains the *effective threat of punitive sanctions or clear rewards for compliance*, in accordance with responsive regulation theory (Gunningham & Grabowsky, 1998, p.55; also Foley, 2004; Braithwaite, 2008).

A number of studies emphasise the heterogeneity of the small business sector and that how enterprises respond to regulatory pressures, including the extent to which they find them burdensome, consequently varies considerably according to their particular characteristics (i.e. the awareness and motivation of owner-managers, and the capabilities

³¹ Other terms and approaches such as 'smart regulation' and 'responsive regulation' are also part of the debate, e.g. see Ayres & Braithwaite, 1992; Gunningham *et al.*, 1998; Braithwaite, 2008; Hutter, 2005.

³² See for instance the volume edited by Weatherill (2007), particularly the contributions of Baldwin, Kitching and Ogus.

and 'culture' of enterprises) and their operational contexts (i.e. the competitive conditions they face, as determined by the nature of product market and supply chain influences, as well as their exposure to regulatory pressures and the public eye) (Kitching, 2006; SBRC, 2008; Hutter & Jones, 2006; Vickers *et al.*, 2005). There is also evidence that owner-managers of smaller businesses avoid voluntary environmental compliance programmes and prefer targeted enforcement and insurance requirements that promote a level playing field (see also Mir, 2008 in relation to micro-enterprises).

The Dutch model is seen by a number of commentators as being one of the most sophisticated approaches to environmental regulation and a good example of how to effectively target the SME sector with a strict legislative and inspection system (Gunningham & Sinclair, 2002; Revell, 2003), while Japan is also increasingly extending environmental controls to SMEs (Revell, 2007b, 2008). One conclusion to be drawn from recent debates around better regulation in the UK is the need for ongoing review in order to continue to improve the quality of regulatory data (e.g. relating to risk, compliance and regulatory outcomes) and to further enable policy learning over time (Weatherill, 2007).

4.4 Government spending: public procurement and support for innovation, research and development

4.4.1 Sustainable public procurement

It has been argued that government expenditure has the potential to play a much greater role in relation to sustainability and supporting the low carbon economy. The UK public procurement budget amounts to around £150 billion per annum (equivalent to 13 per cent of gross domestic product) and public procurement is increasingly seen as an important mechanism for promoting sustainable practices throughout the economy (SPTF, 2006). Some examples of the potential role of public procurement in relation to particular sectors have already been given in Section 3.6. Much public procurement relates to goods – such as stationary, IT equipment or vehicles – which are supplied by large, often multinational companies. Nevertheless, a small number of studies have examined the role of SMEs in sustainable supply, particularly in relation to the procurement of food and services (Walker & Preuss, 2008; Morgan, 2008). As previously discussed, procurement from regionally-based SMEs can lead to reduced greenhouse gas emissions (e.g. the issue of 'food miles' in relation to food production) while also contributing to other economic and social aspects of sustainability. SMEs may also be innovative providers of greener products or technology, with Walker and Preuss (2008) citing organic food and some environmental services emerging from their case study research.

A number of barriers to the furtherance of sustainable sourcing from SMEs have been identified. For instance, the need for firms to supply several years' financial accounts, participate in pre-tender rounds in order to get onto approved supplier lists and for larger contracts to be subjected to EU wide competitions, often make Government contracts expensive to win or unachievable for SMEs. SMEs are seen by many procurement staff as posing a greater risk than larger firms that have an established track record and recommendations that the public sector aggregate its demand to achieve great cost effectiveness could also undermine SME sourcing. Local government procurement is particularly fragmented and with no common procurement format, although there are

examples of good practice. Walker & Preuss (2008, p.1607) therefore make a number of recommendations relating to:

- the need for public sector contracting opportunities to be made more transparent (e.g. through Meet-the-Buyer events);
- the wider use of innovative tools (such as adopting a partnership approach or inserting community benefit clauses in contracts) that are currently only applied by a small vanguard of public procurers;
- support for procurement staff themselves (e.g. training on EU legal issues and EU procurement rules).

Regarding the latter point a crucial issue for the low carbon economy relates to the need to **reduce ambiguity and mixed messages** about what are the most sustainable options. This includes the more consistent application of **whole life costing** and to overcome the knowledge deficit within the public sector in relation to this. Hence the Simms Report on sustainable procurement expressed that

“the efficiency message was being interpreted throughout the public sector in ways which drowned out sustainability considerations” and that there needed to be “a clear message from the top that value for money must be assessed on a whole life basis” (SPTF, 2006, p. 52-53).

4.5.2 Support for innovation, research and development

Public support for research and development (R&D) in clean technology and low carbon innovation is clearly of critical importance. A number of recent reports have argued the need to reinforce low carbon technology as an area of strength and to build a stronger link between climate change and innovation policy in the UK (CBI, 2007, 2008; Lockwood et al., 2007; NESTA, 2007, 2008; GNDG, 2008). Key areas where innovation is seen as having particular potential for delivering carbon reduction are buildings, energy production, transport and industrial processes.³³ The main arguments and recommendations in the recent policy literature relate to:

- the need to increase the proportion of R&D spending on low carbon technology;
- the need to speed up the deployment of existing technologies;
- to facilitate break out of lock-in to high carbon technologies by promoting ‘disruptive innovations’ – as opposed to ‘radical innovations’.

With regard to **increasing the proportion of UK R&D spending** (both business and government) on low carbon technology, this would need to include further measures to increase the overall commitment to R&D in order for it to be more in line with R&D investment in other leading industrialised nations.

There is also a need to consider the extent to which existing UK policies should be adjusted to support low carbon innovation and also to ensure that technologies which are supported do not run counter to the decarbonisation imperative. Such policies include: the

³³ The CBI (2008) has recently identified examples of low carbon ‘technology families’

Small Business Research Initiative (SBRI); R&D Tax Credits, Collaborative R&D Grants, and Knowledge Transfer Partnerships.

A number of contributions have emphasised the need to **speed up the deployment of existing technologies**, given the availability of such technologies and that new technologies may be slow to develop and diffuse. The UK Energy Transformation Fund strategy (BERR, Defra, & DIUS 2008), consist of £400 million of grants, is of particular relevance to SMEs, aiming to help build the skills and capacity within businesses needed to deploy low carbon technologies.

Other forms of change that could be supported include the implementation of new business and social enterprise models. Suggestions made by NESTA (2008, p.4) include:

- a need for the Government, working with the financial sector, to develop models of community ownership that will simplify the current legal and technical difficulties involved in setting up community-owned projects, encouraging greater participation and providing a more secure base for investment;
- the introduction (or extension) of funding streams to support non-technological innovation. It is suggested that such funding is needed to help with the costs of developing and trialling new business models;
- that the Committee on Climate Change should support environmental innovation – it is suggested that the creation of the Committee presents an ideal opportunity to deliver effective policy interventions by cutting across the proliferation of separate schemes and initiatives, also enabling a better match between innovation and environmental policy. The Committee, as part of its remit, should ensure that low-carbon innovations are being effectively supported, and that Government departments and agencies are collaborating effectively.

4.5 Support and capacity building for SMEs

There have been numerous supply-side policy initiatives aimed at encouraging SMEs to adopt greener management practices and exploit environmental (eco-efficiency and market related) opportunities, with the experience of such initiatives extending back to the early 1990s. Environment related business support involves the provision of information, advice, training and free consultancy. Other measures can involve developing the local infrastructure (e.g. recycling facilities and to support co-operative industrial ecology/eco-industrial development approaches). The range of support services made available has been highly diverse, but with a common element being the need for external finance, often provided in the form of local or European funds and, in the case of certain initiatives, also involving large organisations in their development and testing. Initiatives have often had a regional focus, reflecting the nature of European or local financial conditions, and also focused on spatial clusters of SMEs and/or on economically disadvantaged areas. Initiatives are often designed as examples of good practice and to demonstrate the benefits of environmental management and ecological modernisation. Web-based initiatives include Envirowise³⁴ - which has been managed by AEA Technology plc and

³⁴ <http://www.envirowise.gov.uk/uk.html>.

Serco Limited on behalf of Defra, the Welsh Assembly Government, Scottish Government and Invest Northern Ireland.

Unfortunately, while there are many examples of the benefits of such initiatives in particular localities and to participating businesses, there is little evidence to date of them having a pervasive effect on the majority of SMEs, or that there is any wider demand for such assistance (Tilley, 1999b; Tilley et al., 2003; Clark, 2000; Holt et al., 2000; Hunt, 2000; Pederson, 2000; Fanshawe, 2000; Bichard, 2000). The main experience of such initiatives appears to have been one of poor take-up of support, including where clear cost savings and generous grants have been offered. For instance, the UK Small Company Environmental and Energy Management Assistance Scheme (SCEEMAS) attracted only 136 participants – despite providing a 50 per cent subsidy for the costs of consultancy fees to assist with the implementation of environmental management systems (ECOTEC, 2000), although the environmental management schemes themselves only had limited take-up. Studies also refer to the limited dissemination of learning experiences beyond the participants of demonstration projects and a failure to maintain the impetus of environmental improvement once the formal period of support is ended (e.g. Tilley et al., 2003; also Holt et al, 2000).

Tilley et al (2003, p. 79) comment that the latter point is particularly damning since it conflicts with the logic of a progression through ‘stages of greening’ seen as crucial to the achievement of business sustainability and ecological modernisation. These authors therefore suggest two possible strategies for the future development of environmental support:

1. pragmatic acceptance of the limitations of business support to influence deeper, more radical responses but focusing on a wider diffusion of support, such that more businesses, at least, take advantage of the more easily achieved ‘low hanging fruit’ improvements;
2. a deeper engagement beyond immediate problem solving and focused on SME learning capabilities and a more fundamental challenging of existing practices and business models. This accords a greater role for business education and training with an environmental sustainability component.

On the basis of their review of the experience of a range of environmental support initiatives, Holt et al. (2000, p.44-47) identify eight key requirements needed in order for SMEs to be better targeted, to develop more effective environmental business support services, and to build a more coherent, effective service:

- Increased communication between different environmental business support services, especially on a regional basis;
- A multilayered approach;
- A focus on sector specific and local provision;
- The identification of opportunities for the creation of new small businesses;
- A focus on projects that deliver immediate benefits to participating businesses;
- More realistic funding assessment criteria;
- Monitoring of projects and a means of determining their effectiveness;

- Integrated environmental business support services.

External drivers and incentives, such as regulatory, market, supply chain and other stakeholder pressures, have an important role to play in increasing the demand for environment-related support and training and, as has been previously suggested, such external drivers ought to assume greater importance as concern and policy action around global climate change increases. Related to the issue of support is the need to develop and disseminate appropriate tools and techniques to SMEs (Palmer & van der Vorst, 1996; Merrit, 1998; Le Pochat et al., 2007) (see discussion in section 4.3 regarding product standards and ecodesign tools).

Some more recent insight into the experience of encouraging sustainability amongst SMEs is provided by the guide produced for Defra (NCBS, 2006) which involved a review of existing approaches and considered the key attributes of a **successful enabler**. The study examined three types of enabling organisations:

- **intermediary organisations** – providing basic information and advice, and/or a signposting service to more specialist organisations (e.g. Business Link);
- **delivery organisations** – delivering specific support or services to SMEs such as training and audits; and
- **programmes of activities or initiatives** – set up as a separate programme of activity within an umbrella organisation or government department, or established as a short/medium-term initiative under a particular funding stream (e.g. Envirowise, WRAP or Enworks). These can act as intermediaries and/or delivery bodies.

The case studies showed that SMEs were influenced by a combination of factors in their choice of enabler, including local factors (knowledge, credibility and delivery) and national profile. The factors identified as most likely to help SMEs to adopt better (environmental) business practices were:

- receiving individual tailored support highlighting manageable steps;
- peer influence, i.e. the importance of business mentoring, networks and industry leadership;
- being able to see that business change would result in marketing opportunities;
- funding to support the implementation of improvements.

Other factors important to the successful influencing of SMEs identified by enablers were:

- long-term relationships;
- provision of accessible information using appropriate language;
- flexibility in the support being offered (NCBS, 2006).

There also needs to be a better understanding on the part of key referral agencies of the sources and types of support available to allow for effective referral to the appropriate service. Interestingly, the report suggests that the most successful organisations have been national ones such as Envirowise, although the support available from Envirowise has subsequently been reduced and they now no longer provide direct business support.

It is generally recognised that the current business support infrastructure is complex and fragmented, with both duplication and gaps in provision. The Business Support Simplification Programme intends for Business Link to be the main point of contact and referral for all businesses. So in addition to considering how environment related information and support can be better integrated, there is a need to consider whether there is a role for Business Link call centre operatives to be equipped to identify and suggest that businesses consider environmental options. Whilst the simplification process itself may streamline the offers available to business, there will still be an enhanced need for Business link to have the fullest knowledge possible about the range of services/providers and what is currently available. Many services are dependent on funding and can be for a limited period. For businesses to be referred to an organisation only to find out that the service is no longer available could lead to disappointment and inaction.

With regard to the lack of data regarding the longer term effects of support, it should be acknowledged that ongoing evaluation of the outcomes of programmes and initiatives has been limited, often for very practical financial reasons. Whilst many programmes now have a requirement to undertake evaluation throughout the lifetime of an initiative, there may be a role for a government department or other appointed organisation to take responsibility for periodic follow-up monitoring of businesses receiving assistance. This will obviously have resource implications but would provide the data required for the development of services and to support ongoing improvement.

5. Summary and conclusions

5.1 Introduction

The past five years have seen a dramatic shift in attitudes to climate change on the part of both policy makers and the general public, with environmental concerns now seen by many as being much more central to economic policy. This is as a result of the scientific near consensus view about the likely scale of climate change and the increasing evidence of its occurrence and impacts. Political leadership shown by the EU and its member states has resulted in the introduction of a raft of climate change mitigation policies including the EU Emissions Trading Scheme, renewables targets, targets to reduce vehicle CO₂ emissions intensities. The UK has argued strongly within the EU, G8 and UN for concerted international action. Notwithstanding this progress, it is clear that the need to make a rapid transition to a low carbon economy poses a huge challenge for policy makers, businesses and individuals. Important questions are raised relating to the nature of wealth creation and the need to re-examine prevailing conceptualisations of economic growth, competitiveness, productivity, consumption and lifestyles.

This report has identified and reviewed a wide range of literature relating to business sustainability, low carbon innovation and the challenges and opportunities facing SMEs, allowing us to draw a number of conclusions and identify some priority areas for further policy research.

5.2 The challenges and opportunities for SMEs

SMEs play a crucial role in the UK economy through their contribution to economic growth, job creation and the promotion of entrepreneurship, making them key players in the transition to a low carbon future. The main challenges facing SMEs have been identified as relating to four main categories of **low carbon drivers**:

1. The costs of understanding and responding to the Government's mitigation policies.
2. The increasing cost of energy (and potentially of other raw materials and natural inputs to production), with carbon pricing (or equivalent regulatory instruments) as Government seeks to internalise the environmental costs of climate change in the price of energy and goods.
3. Changes in patterns of market demand for goods and services as a result of changing attitudes to consumption, including changes in the purchasing and investment decisions of large organisations and of Government.
4. The impacts of climate change itself on businesses and their operations, given that the effects are occurring more rapidly than expected and that adaptation as well as mitigation will be needed to meet the challenges.

But there are opportunities too, which for SMEs potentially include:

1. Increasing demand for low carbon / more sustainable goods and services, with opportunities for the development of innovative solutions, and new markets, both domestic and international. There is particular potential for new start-ups and innovative SMEs in the areas of renewable energy technologies (e.g. solar photo-voltaics, wind, geothermal power, regional biomass, tidal/wave), energy storage, local/regional (including organic) food provisioning, pro-biodiversity activities and novel transport options.
2. Opportunities for many existing SMEs to modify their processes and product range or services to be more sustainable. This is particularly important in manufacturing (including product refurbishment/remanufacturing), construction, transport, farming and food production, and professional advice services on sustainable business practice and carbon markets. For many SMEs this could result in lower costs and better profit margins as a result of deploying energy efficiency and other resource conserving measures and being able to take advantage of pro-environmental consumer demand.
3. Other opportunities in sectors particularly associated with the development of a low carbon infrastructure and productive capacity and the increasing emphasis on employment and consumption needs being met locally to a greater extent than hitherto. The relocalisation agenda, involving the strengthening and diversification of local/regional economies, is of particular significance for the majority of SMEs which do not trade internationally.

The challenges and opportunities facing SMEs in a low carbon economy are to a large extent overlapping and intertwined – while many businesses will experience the low carbon drivers as threats, for others they represent significant opportunities, particularly those whose operations are already on a more sustainable basis and those in key sectors or who are able to respond more innovatively and opportunistically than their competitors. It is also clear that SMEs have more limited resources than do larger organisations, i.e. in terms of access to finance and organisational capacity/expertise etc, and that this, in combination with other characteristics, plays an important role in how they respond to challenges and opportunities.

There is a substantial body of research going back over a number of years which shows that most SMEs have been slow to adopt environment-related improvements, despite the alleged existence of pervasive ‘win-win’ opportunities. This is attributed to a number of internal and external barriers, but particularly a lack of market signals and doubt amongst owner-managers relating to the business case for sustainability. Many SME owner-managers are also seen as being constrained by their operational environment to adopt incremental changes that are compatible with existing technology and practices and/or as being inherently conservative. This may be beginning to change, however, as a result of the recent increase in concern about global climate change, climate-related policy activity and supply chain pressures, and concerns about energy supply and other inputs to production.

It is also important to note, however, the powerful influence of **existing practices and the interests of incumbent industries** which will act to constrain any transition to a low carbon economy, as well as uncertainties and complexities relating to the strength and consistency of the regulatory and market drivers identified. There is a danger that these and other factors may well combine to undermine investment in low carbon technologies, products and services, also jeopardising the viability of businesses that make real efforts to be low carbon / more sustainable.

The study has drawn on insights from the innovation literature, and particularly that which relates to the development of **learning capabilities** in SMEs. Smaller firms are commonly understood as being resource constrained, which can limit their ability to make significant innovations, but also as having certain behavioural advantages, notably that they can respond more rapidly, flexibly and efficiently to customer needs. Small / high-tech start-ups and SMEs have been shown to be playing a key role in the development of novel low carbon technologies. It can be misleading, however, to conceptualise innovation as a discrete activity occurring within isolated firms since R&D and innovative activity often spans organisation boundaries and entails co-operative links between large and small firms. Particularly important here has been the role of 'advocacy coalitions', involving extensive partnering arrangements and forms of support, including venture capital and from public programmes and ideas originating in research intensive universities.

For many other SMEs there is a need to increase the application of existing knowledge and affordable technologies for improving their sustainability. An influential way of explaining and categorising different business responses to environmental pressures has been to develop typologies and segmentation models of (pro) environmental behaviour, often in terms of a spectrum, ranging from resistant to proactive and/or from unsustainable to sustainable. In order to explain why opportunities are or are not taken by SMEs in particular sectoral/market contexts, there is a need to better understand the learning dynamics and competing pressures involved when firms seek to incorporate environmental concerns into their general business strategy. Studies draw particular attention to the importance of appropriate incentives and an institutional context that is supportive of the greening of SMEs.

5.3 Implications for policy

An important starting point is the need to build on the understanding of the diverse nature of the SME sector and the particular problems involved in formulating and implementing effective policy in this area. Not only is a very large and heterogeneous business population involved, but there are also widespread information failures and deficits in absorptive capacity which can limit businesses' ability to effectively plan and manage change. It is also clear that there can be no 'one size fits all' small business policy and that effective policy making needs to be based on a good understanding of small businesses and the varied contexts in which they operate.

Most of the recent literature and debate sees government as having a central role to play in driving the transition to a low carbon economy including with respect to its *spending decisions*, as well as through establishing an appropriate *regulatory and fiscal environment*. The nature of the regulatory and market environment (or 'selection environment' in the

terminology of evolutionary economics) is clearly fundamental to how SMEs respond to the challenges and opportunities. There has also been volatility in relation to energy prices and it remains uncertain as to how the market for carbon and related schemes will impact on the behaviour of most SMEs. Consumer demand for low carbon / ethical products is relatively fragile and could be particularly so in the context of deepening economic recession. There is a need for SMEs to build on existing knowledge of this demand and also for government to support individual low carbon / pro-environmental behaviour and lifestyles through education and further raising the profile of climate change policy through its policies and in the media.

Better regulation (including market mechanisms) has an important role to play – driving forward the demand for new low carbon technologies, creating common standards to aid uptake and understanding of low carbon products and appliances, and assuring a level-playing-field to so that that:

- risk-taking early adopters of cleaner technologies are rewarded;
- adopters of good practice in environment, health and safety management are not disadvantaged.

There is a need here for clarity and consistency, including in terms of enforcement, in order to ensure a level playing field for SMEs. Smaller firms in particular tend to prefer this to voluntary / self-regulation measures.

A number of barriers have been identified in relation to the extension of **sustainable sourcing** from SMEs. It has been argued by a number of studies that the more consistent application and extension of **whole life costing** in the public sector is particularly crucial. Although recent studies refer to examples of good practice (i.e. in relation to food and health services procurement), a knowledge deficit in the public sector around whole life costing is identified, which clearly needs to be addressed as a key aspect of the low carbon policy agenda towards SMEs.

Government has a key role to play in relation to supporting **innovation and R&D**, with a number of studies pointing to the need to increase both business and government expenditure on low carbon technology. There may also be potential to redirect existing UK policies to prioritise the support of low carbon innovation and to avoid supporting developments which may go against the low carbon imperative.

A number of contributions have emphasised the need to **speed up the deployment of existing technologies**, given the availability of such technologies and that new technologies may be slow to develop and diffuse. Other forms of change that could be supported include the implementation of new business models and forms of social enterprise. The technologies and business models which will contribute most to the achievement of a low carbon economy are seen as essentially 'disruptive', involving step changes in both business practice and consumption/lifestyles. Government must take a leading role in facilitating such change.

The low carbon agenda can also be furthered through **business support and capacity building** in SMEs, although there is a need to consider how the take-up and delivery of

sustainability-related support can be improved, given that previous studies have identified the limited impact of such support to date. Recommendation that have been made in order for SMEs to be better targeted and to develop more coherent and effective environmental business support services include the need for:

- clear understanding on the part of the key referral agencies of the sources and types of support available to allow for effective referral to the appropriate service;
- increased integration and communication between different environmental business support services, especially on a regional basis;
- a focus on sector specific and local provision;
- the identification of opportunities for the creation of new low carbon enterprises;
- influencing all start-ups to take on board sustainability considerations at the business inception stage;
- a focus on projects that deliver immediate benefits to participating businesses;
- a focus on developing and disseminating tools and techniques which are appropriate to SMEs;
- more realistic funding assessment criteria;
- better monitoring of projects as a means of determining their ongoing effectiveness.

Tightening external drivers - such as regulatory, market, supply chain and other stakeholder pressures - have an important role to play in increasing the demand for sustainability-related support and training.

5.4 Current state of research and future directions

Much of the pre-existing literature on environmental management and green innovation presents a somewhat a negative picture of limited responsiveness to environmental issues on the part of most SMEs, including with respect to the take up of 'win-win' / 'low hanging fruit' opportunities and the available environmental business support. However, given the retrospective nature of many of the studies cited here and the rapidly changing nature of the policy and economic environment, further research is clearly needed:

- There is a need to *map and assess the current provision of and various sources of information and advice about sustainability and its impact on SMEs*. The research would need to be sensitive to the different types of SMEs, given that they constitute a highly diverse and heterogeneous group of businesses (e.g. in terms of sector, size, owner manager characteristics etc), including with respect to their environmental impacts and the differential impacts and opportunities involved. Issues to be addressed include:
 - recent data and insight into the extent to which actions are being taken and what factors are motivating different types of SMEs to seek advice and support;
 - what has been the impact of the credit crunch / economic recession on the take-up of support and attitudes to the environment;

- what are the limitations of existing sources and also the barriers to the greater uptake of information and advice by SMEs;
 - what are the views of expert practitioners on what further actions need to be taken in order to further catalyse pro-environmental behaviour amongst SMEs;
 - how can sustainability be better embedded at the business inception / start-up stage;
 - the relationship of different kinds of SMEs to the state and the facilitating role of business representative bodies and other non-governmental organisations.
- There is also a need for *recent evidence and case study examples of SMEs that have attempted to implement transitions to more low carbon / sustainable business practices* (and preferably with a longitudinal/retrospective element), including with respect to:
 - what have been the relative roles of different factors driving sustainability (internal and external);
 - what have been the outcomes, both in terms of business performance and environmental improvement.

A key consideration for any future research is the extent to which the *changing market structures and new policy interventions* are combining to enable full environmental, social and economic sustainability. This could be further explored in relation to the following issues:

- The role of *innovation and R&D support for low carbon innovation in SMEs*, including with respect to:
 - the influence of the changing market conditions and economic downturn on investment in low carbon innovation;
 - the relative roles of venture capital and public sector support;
 - existing public innovation support programmes and the extent to which sustainability considerations are or need to be further addressed as an aspect of their assessment criteria.
- The recent influence of *clusters and supply chains* on SMEs, including the potential for greater local sourcing and adoption of co-operative solutions involving the application of industrial-ecology / eco-industrial development principles.
- The contribution of *social enterprise models* to enable communities to address climate change issues while also contributing to local employment and the development of new community assets. What are their support needs and how can they become more financially sustainable?
- The role of sustainable public procurement, including the potential of 'green new deal' type programmes in combining social/economic and environmental objectives,

and how to further the involvement of SMEs and social enterprise in such programmes.

- Issues of scale and locality - the dynamics of 'green competitiveness' between large and small enterprises within local / regional economies.
- Changes in ethical purchasing / green consumerism, including the role of closer customer/provider relationships.

References

- Allenby, B. R. (1998) *Industrial Ecology: Policy Framework and Implementation*, Prentice Hall.
- Allen, S.R., Hammond, G.P. and McManus, M.C. (2008) 'Prospects for and barriers to domestic micro-generation: A United Kingdom perspective', *Applied Energy*, 85, 528-544.
- Ayres, I. & Braithwaite, J. (1992) *Responsive Regulation. Transcending the Deregulation Debate*, Oxford University Press.
- Baker, S, Kousis M, Richardson, D. & Young, S. (1997) *The Politics of Sustainable Development*, Routledge, London.
- Battisti, D & Naylor, R. (2009) 'Historical Warnings of Future Food Insecurity with Unprecedented Seasonal Heat', *Science*, 323(5911), 240 – 244.
- Baylis, R., Connel, L., & Flynn, A. (1998) 'Company size, environmental regulation and ecological modernisation: further analysis at the level of the firm', *Business Strategy and the Environment*, 7,285-296.
- Beder, S. (2002) *Global spin: The corporate assault on environmentalism*, Green Books: Devon, UK.
- Berger, G., Flynn A. & Hines F. 2001. 'Ecological Modernisation as a Basis for Environmental Policy: Current Environmental Discourse and Policy and the Implications on Environmental Supply Chain Management', *Innovation* 14 (1), 55-72.
- BERR, DEFRA & DIUS (2008) *UK Environmental Transformation Fund Strategy*, available at: <http://www.berr.gov.uk/files/file47575.pdf>
- BERR (2008) *Emerging Evidence: SMEs and Energy Efficient*, Department for Business, Enterprise & Regulatory Reform, London: unpublished document.
- Bianchi, R. and Noci, G. (1998), 'Greening SMEs' Competitiveness', *Small Business Economics*, 11, 269-281.
- Bessant, J., Phelps, B. and Adams, R. (2005) *A review of the literature addressing the role of knowledge and expertise at key stages of business growth and development. Final Report*, Cranfield Collection of E-Research, Cranfield University: <https://dspace.lib.cranfield.ac.uk/bitstream/1826/1036/1/Bessant-Phelps-Adams-Rev%20of%20Lit%20Business%20Growth%20and%20Development-Final%20Report.pdf>
- Bessant, J. & Tidd, J. (2007) *Innovation and Entrepreneurship*, John Wiley, Chichester.
- Bianchi, R. & Noci, G. (1998) 'Greening SMEs' Competitiveness', *Small Business Economics*, 11, 269-281.
- Bichard, E. (2000) 'Time to reassess the small business environmental advisory system in the UK', in *Small and medium-sized enterprises and the environment: business imperatives*, Hillary, R. (ed). Greenleaf Publishing Ltd: Sheffield.
- Biondi, V. Frei, M. and Iraldo, F. (1998) *Environmental Management System Implementation by SMEs: EU experiences and perspectives*. Paper presented at the 7th Greening of Industry Conference, Rome.
- Blackburn, R. A. & Smallbone, D. (2008) 'Researching small firms and entrepreneurship in the U.K.: developments and distinctiveness', *Entrepreneurship Theory: Theory and Practice*, 32(2), 267-288.

- Boardman, B. (2007) *Home Truths: A low-carbon strategy to reduce UK housing emissions by 80% by 2050*, Environmental Change Institute, Oxford University – available at: <http://www.eci.ox.ac.uk/research/energy/downloads/boardman07-hometruths.pdf>
- Bowen, F. E. (2002), 'Does Size Matter?', *Business and Society*, 41(1), 118-124.
- Bower, J. & Christensen, C. M. (1995) 'Disruptive Technologies: Catching the Wave', *Harvard Business Review*, January-February.
- Braithwaite, J. (2008) *Regulatory Capitalism: How it Works, Ideas for Making it Work Better*, Edward Elgar, Cheltenham UK.
- Brock, W. A. & Taylor, M.S. (2005) Economic growth and the environment: a Review of theory and empirics. In: Aghion, P., Durlauf, S. (Eds.) *Handbook of Economic Growth*, vol 1, Elsevier, pp. 1749-1821, Ch. 28.
- Brown, J. Hendry, C. & Harborne, P. (2007) 'Developing Radical Technology for Sustainable Energy Markets: The Role of New Small Firms', *International Small Business Journal*, 25(6), 603-629.
- BRTF, (2005) *Regulation – Less is More*, Better Regulation Task Force, London: Cabinet Office.
- Buller, H. et al (2007). Eating Biodiversity: An Investigation of the Links between Quality Food Production and Biodiversity Protection: Full Research Report ESRC End of Award Report, RES-224-25-0041. Swindon: ESRC.
- Business Link (2006) *Survey of Business Owners and Senior Decision Makers Hot Topic Spotlight – Sustainability*, South East Business Monitor, available at: http://www.businesslink.gov.uk/SouthEast_files/HotTopicSpotlight7Sustainability.pdf
- Carson, R., (1964) *Silent Spring*, Houghton Mifflin, New York.
- CCC (Committee on Climate Change) (2008a) *Workplan* May 2008, Committee on Climate Change.
- CCC (Committee on Climate Change) (2008b) *Building a low-carbon economy – the UK's Contribution to Tackling Climate Change*, December 2008, TSO, The Stationary Office, London.
- Christensen, C. M. (1997) *The Innovator's Dilemma*, Harvard Business School Press, Watertown, MA.
- Christensen, C. M. & Raynor, M. E. (2003) *The Innovator's Solution*, Harvard Business School Press, Watertown MA.
- Cohen, W.M. & Levinthal, D. A. (1990) 'A new perspective on learning and innovation' *Administrative Science Quarterly*, 35,128-152.
- Cohen, M. & Murphy J. (2001) *Exploring Sustainable Consumption: Environmental Policy and the Social Sciences*, Pergamon Elsevier Science Ltd, Oxford.
- Costantini, V. & Crespi, F. (2008) 'Environmental policies and the trade of energy technologies in Europe', *International Journal of Global Environmental Issues*, 8 (4), 445-460.
- Cowe, R. & Williams, S. *Who are the Ethical Consumers?*, Co-Operative Bank, London.
- CBI (2007) *Climate change: Everyone's business*, Confederation of British Industry, London: <http://www.cbi.org.uk/pdf/climatereport2007summary.pdf>
- CBI (2008) *Low-carbon innovation: developing technology for the future*, Confederation of British Industry, London: <http://climatechange.cbi.org.uk/uploaded/CBI-LowCarbonInnovation.pdf>.

- CEMEP (2007) *Commission on Environmental Markets and Economic Performance: Report*, BERR, IUS and Defra: <http://www.defra.gov.uk/environment/business/commission/index.htm>.
- Cerin, P. & Carlson, L. (2002) 'Business incentives for sustainability: a property rights approach' *Ecological Economics*, 40: 13-22.
- Clark, G. (2000) 'Developing better systems for communications: environmental best practice in small business', in *Small and medium-sized enterprises and the environment: business imperatives*, Hillary, R. (ed). Greenleaf Publishing Ltd: Sheffield.
- Daly, H. E. (1973) *Towards a Steady State Economy*, Freeman San Francisco.
- Daly, H. (1987) 'The economic growth debate: What some economists have learned but many have not', *Journal of Environmental Economics and Management* , 14(4), 323-336.
- Darby, S. (2007) 'Enough is as good as a feast – sufficiency as policy', in Proceedings, European Council for an Energy-Efficient Economy 2007 Summer Study, France: <http://www.eci.ox.ac.uk/research/energy/downloads/eceee07/darby.pdf>
- Dauvergne, P. (2008) *The Shadows of Consumption: Consequences for the Global Environment*, The MIT Press, Cambridge, MA, USA.
- Defra (2002) *The Strategy for Sustainable Farming and Food: Facing the Future*, Defra, London.
- Defra (2005) *One Future – Different Paths: The UK's Shared Framework for Sustainable Development*, Stationary Office, London.
- Defra (2006a) *Climate Change – the UK Programme 2006*, Defra, London.
- Defra (2006b) *Food Industry Sustainability Strategy*, Defra, London - available at: <http://www.defra.gov.uk/farm/policy/sustain/fiss/pdf/fiss2006.pdf>.
- Defra (2007) Survey of Attitudes and Behaviour towards the Environment, Department for Environment, Food and Rural Affairs, London – Statistical Release available at: <http://www.defra.gov.uk/environment/statistics/pubatt/download/pubattsum2007.pdf>
- Defra (2008) *A Framework for Pro-environmental Behaviours*, Department for Environment, Food and Rural Affairs, London - available at: <http://www.defra.gov.uk/evidence/social/behaviour/index.htm>
- de Groot H.L.F., Verhoef E. T. and Nijkamp P. (2001) 'Energy savings by firms: decision-making, barriers and policies, *Energy Economics*, 23, 717-740.
- DETR (1999) *A better quality of life: A strategy for sustainable development for the United Kingdom*, Department of the Environment, Transport and the Regions, HMSO, London.
- Dickson, B., Watkins, D. & Foxall, J. (2007) 'The Working Partnership: SMEs and Biodiversity', *Fauna & Flora International*, Cambridge UK.
- Dietz, S., Hope, C., Stern, N. and Zenghelis, D. (2007) 'Reflections on the Stern Review (1) A Robust Case for Strong Action to Reduce the Risks of Climate Change' 8(1), *World Economic*, 121 – 168.
- DoE (Department of Environment) (1994) *Sustainable Development: The UK Strategy*, HMSO, London.
- Donald, B. (2008) 'Food Systems Planning and Sustainable Cities and Regions: The Role of the Firm in Sustainable Food Capitalism' *.Regional Studies*, 2008, 42 (9),1251-1262.

Drake, F., Purvis, M and Hunt, J (2004) 'Meeting the Environmental Challenge: a Case of Win-Win or Lose-Win? A Study of the UK Baking and Refrigeration Industries', *Business Strategy and the Environment*, 13,172-185.

DTI (2002) *Foresight Futures 2020: Revised Scenarios and Guidance*, Department of Trade and Industry, London.

DTI (2003) *Public Procurement: A toolkit for social enterprises*, Department of Trade and Industry, London.

DTI (2005) *Energy Flow Chart 2004*, Department of Trade and Industry, London – cited in Allen et al. (2008).

Eames, M. and Skea, J. (2002) 'The Development and Use of the UK Environmental Futures Scenarios: Perspectives from Cultural Theory', *Greener Management International*, 37, pp.

ECOTEC Research and Consulting, (2000) *Report on SMEs and the Environment*, European Commission, Directorate General Environment, Brussels, www.europa.eu.int/comm/environment/sme/index.htm

Ekins, P. (ed.) (1986) *The Living Economy: a New Economics in the Making*, Routledge & Kegan Paul, London.

Ekins, P. and Newby, L. (1998) 'Sustainable Wealth Creation at the Local Level in an Age of Globalisation', *Regional Studies*, 32(9), 863-877.

Elkington J. (1999) *Cannibals with Forks: the Triple Bottom Line of 21st Century Business*, Capstone Publishing, Oxford.

Environment Agency (2005) 'NetRegs SM-Environment 2005', <http://www.netregs.gov.uk/netregs/1169119>.

Environment Agency (2006) *Spotlight on business environmental performance in 2006*, Environment Agency: <http://publications.environment-agency.gov.uk/pdf/GEHO0707BMMX-e-e.pdf>.

Environment Agency (2007) *SME-Environment 2007: UK Summary*, NetRegs: http://www.netregs.gov.uk/static/documents/Utility/smenvironment07uk_1856733.pdf

Environment Agency (2008) *Spotlight on business: 10 years of improving the environment*, Environment Agency, Bristol – available at: <http://publications.environment-agency.gov.uk/pdf/GEHO0708BOFX-E-E.pdf?lang=e>.

Epstein, M. J. and Roy, M. J. (2000), 'Strategic Evaluation of Environmental Projects in SMEs', *Environmental Quality Management*, 9(3), 37-47.

Ericksen, P.J., (2007) *Conceptualizing food systems for global environmental change research*, *Global Environmental Change*, doi:10.1016/j.gloenvcha. 2007.09.002

Ernst and Young, (2008) *Comparative advantage and green business*, Report for BERR: <http://www.berr.gov.uk/files/file46793.pdf>

Fanshawe, T. (2000) 'The interrelationship between environmental regulators, small and medium sized enterprises and environmental help organisations', in *Small and Medium-Sized Enterprises and the Environment: business imperatives*, Hillary, R. (ed), Greenleaf Publishing, Sheffield.

Fischer, P. (2003) *How to advance pollution prevention in small and medium-sized organizations*, HazMat Magazine, June/July

Fleming, D. (1996) 'Beyond the Technical Fix' in R. Welford and R. Starkey (eds.), *Business and the Environment*, Earthscan: Guildford.

- Foley, T. (2004) 'Using a responsive regulatory pyramid in environmental regulation', Queensland Environmental Law Association 2004 Conference – Carrots, Sticks & Toolkits, available at <http://www.qela.com.au/dbase/upl/1.foley.pdf>
- Friedman, A., Miles, S. and Adams, C. (2000) 'Small and Medium-sized Enterprises and the Environment: Evaluation of a Specific Initiative Aimed at all Small and Medium-Sized Enterprises', *Journal of Small Business and Enterprise Development* 7(4), 325-42
- Gabel, H. L. and Sinclair-Desgagné, B. (2001) *The firm, its procedures and win-win environmental regulations*. In: H. Folmer et al. (Editors), *Frontiers of Environmental Economics*, Edward Elgar, Cheltenham/Northampton
- Gardiner, P. (1994) 'Review article of Mastering the Dynamics of Innovation', *Research and Development*, 24(4).
- Garnett, T. (2003) 'Wise Moves: exploring the relationship between food, transport and CO2' (2003) for Transport 2000.
- Geels, F. W. (2002) 'Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-level Perspective and a Case-Study', *Research Policy*, 31(8-9), 1257-74.
- Gerstenfeld, A. and Roberts H. (2000) 'Size matters: barriers and prospects for environmental management in small and medium-sized enterprises'. In *Small and Medium-Sized Enterprises and the Environment: business imperatives*, Hillary, R. (ed). Greenleaf Publishing Ltd, Sheffield.
- Gibb, A. (2006) 'Social Responsibility and the Owner-Managed firm', unpublished briefing note - cited by Grayson and Dodd (2007).
- Gladwell, M. (2000) *The tipping point: how little things can make a big difference*, Little Brown.
- GNDG (2008) *A Green New Deal*, The Green New Deal Group, New Economics Foundation, available at: http://www.neweconomics.org/gen/z_sys_publicationdetail.aspx?pid=258.
- Gonzalez-Benito, J. and Gonzalez-Benito, O. (2006) 'A review of determinant factors of environmental proactivity', *Business Strategy and the Environment*, 15(2), 87-102.
- Grayson, D. and Dodd, T. (2007) 'Small is sustainable (and beautiful) – encouraging European smaller enterprises to be sustainable', Doughty Centre for Corporate Responsibility, Cranfield University – available at: http://www.som.cranfield.ac.uk/som/research/centres/ccr/downloads/Small_is_%20Sustainable.pdf
- Greening, L.A., Greene, D. L., Difiglio, C. (2000) 'Energy efficiency and consumption – the rebound effect – a survey', *Energy Policy*, 28(6-7), 391-401. 2001?
- Gunningham, N. and Grabowsky, P. with Sinclair, D. (1998) *Smart Regulation: Designing Environmental Policy*, Clarendon Press.
- Gunningham, N. and Sinclair, D. (2002) 'Leaders and Laggards: Next Generation', *Environmental Policy*, Greenleaf Publishing, Sheffield.
- Hamid, L., Stern, N. and Taylor, C. (2007) 'Reflections on the Stern Review (2) A Growing International Opportunity to Move Strongly on Climate Change,' *World Economics*, 8(1), 169 – 186.
- Hampton, P. (2005) 'Reducing administrative burdens: effective inspection and enforcement', London: HM Treasury, March 2005.
- Hansen, O.E., Sondergard, B., Meredith, S. (2002) 'Environmental Innovations in Small and Medium Sized Enterprises', *Technology Analysis & Strategic Management*, 14(1), 37-56.

Hart, S. L. (2007) *Capitalism at the Crossroads: Aligning Business, Earth, and Humanity*, Wharton School Publishing, Upper Saddle River, NJ, USA.

Haughton, G. (1998) 'Principles and Practice of Community Economic Development', *Regional Studies*, 32(9), 872-877.

Hawken, P., Lovins, A. and Lovins, H. (1999) *Natural Capitalism: Creating the Next Industrial Revolution*, Little, Brown, & Co, New York.

Hillary, R. (2000), '*Small and Medium-Sized Enterprises and the Environment: business imperatives*', Greenleaf Publishing Ltd, Sheffield.

Hillary, R. (1999), *Evaluation of Study Reports on the Barriers, Opportunities and Drivers for Small and Medium Sized Enterprises in the Adoption of Environmental Management Systems*, Department of Trade and Industry - Environment Directorate, London.

Hillary R. (1995), *Small Firms and the Environment: a groundwork status report*, Groundwork, Birmingham.

Hines, C. (2000) *Localisation: A Global Manifesto*, Earthscan, London.

HM Treasury / Cabinet Office (2006) 'Stern Review of the Economics of Climate Change', HM Treasury: London.

Holland, L. and Gibbon, J. (1997) 'SMEs in the metal manufacturing, construction and contracting service sectors: environmental awareness and actions', *Eco-management and Auditing* 4,7-14.

Holt, D., Anthony, S., Viney, H. (2000) 'Supporting Environmental Improvements in Small and Medium-Sized Enterprises in the UK', *Greener Management International*, 30, 29-49.

Hood, C., Rothstein, H. & Baldwin, R. (2001) *The Government of Risk*, Oxford: Oxford University Press.

House of Lords (2008) *Waste Reduction. Volume 1: Report*, Science and Technology Committee, House of Lords, The Stationary Office, London.

Huber, J. (2000) 'Towards Industrial Ecology: Sustainable Development as a concept of Ecological Modernisation', *Journal of Environmental Policy & Planning* 10, 2-11.

Hunt, J. (2000) 'Environment, information and networks: how does information reach small and medium-sized enterprises'? In *Small and Medium-Sized Enterprises and the Environment: business imperatives*, Hillary, R. (ed). Greenleaf Publishing Ltd: Sheffield.

Hutchinson, A. and Chaston, I. (1994) 'Environmental management in Devon and Cornwall's small and medium sized enterprise sector' *Business Strategy and the Environment*. 3(1), 15-22.

Hutter, B.M. (2005) 'The Attractions of Risk-based Regulation: accounting for the emergence of risk ideas in regulation', Centre for Analysis of Risk and Regulation, Discussion Paper No.33, London School of Economics.

Hutter, B.M. (2006) 'The Role of Non-State Actors in Regulation', Centre for Analysis of Risk and Regulation, Discussion Paper No.37, London School of Economics.

IPCC (2000) *Special Report Emissions Scenarios, Summary for Policy Makers*, Intergovernmental Panel on Climate Change, available at: <http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf>.

IPCC (2007) *Climate Change 2007: Synthesis Report, Summary for Policy Makers*, Intergovernmental Panel on Climate Change, available at: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

Ipsos MORI (2008) *Public attitudes to climate change 2008: concerned but still not convinced*, available at: <http://www.ipsos-mori.com/researchspecialisms/publicaffairs/socialresearchinstitute/envfoodruraff/understanding/attitudes.ashx>

Isaak, R. (2002) 'The making of the ecopreneur', *Greener Management International*, 38, 81-91.

IUCN (2006) *The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century*, Report of the IUCN Renowned Thinkers Meeting, 29-31 January, 2006 http://cmsdata.iucn.org/downloads/iucn_future_of_sustainability.pdf.

Jackson, T. (ed) (1994) *Clean Production Strategies - developing preventive environmental management in the industrial economy*, Stockholm Environmental Institute / Lewis Publishers, Boca Raton, FL.

Jones, P. and Greenwood, R. (2003) 'Construction Waste Minimisation in Housing', <http://www.cardiff.ac.uk/archi/programmes/cost8/case/waste/uk-waster.pdf> (accessed 06/08/07)

Kaplinsky, R. (1983) 'Firm Size and Technical Change in a Dynamic Context', *Journal of Industrial Economics*, 32(1), 39-59.

Kemp, R., Schot, J., & Hoogma, R. (1998) 'Regime Shifts to Sustainability through Processes of Niche Formation: The Approach of Strategic Niche Management', *Technology Analysis & Strategic Management*, 10(2), 175-95.

Killip, G. (2008) *Building a Greener Britain: Transforming the UK's Existing Housing Stock*, Environmental Change Institute, University of Oxford, A report for the Federation of Master Builders: http://www.fmb.org.uk/ea/pdf_ea/fmbbuildingagreenerbritain.pdf

Kitching, J. (2006) 'A burden on business? Reviewing the evidence base on regulation and small-business performance', *Environment and Planning C: Government and Policy*, 24, 799-814

Könnölä, T. & Unruh, G. C. (2007) Really changing the course: the limitations of environmental management systems for innovation, *Business Strategy & the Environment*, 16(8), 525-537.

Korunka, C., Frank, H. Luegar, M. and Muglar, J. (2003) 'The entrepreneurial personality in the context of resources, environment, and the startup process – a configurational approach', *Entrepreneurship Theory and Practice*, 28(1), 23-42.

Langhelle, O. (2000) 'Why Ecological Modernisation and Sustainable Development should not be Conflated', *Journal of Environmental Policy and Planning*, 2, 303-322.

Le Pochat, S., Bertolucci, G., and Froelich, (2007) 'Integrating ecodesign by conducting changes in SMEs', *Journal of Cleaner Production*, 15, 671-680.

Library House (2007) *Cleantech goes mainstream*, available at: <http://www.libraryhouse.net/cleantech/publications/>.

Lockwood, M., Bird, J. and Alvarez, R. (2007) *2050 Vision*, Institute for Public Policy Research, London.

Lyon, T. P. and Maxwell, J. W. (2004) *Corporate environmentalism and public policy*, Cambridge: Cambridge University Press, Cambridge.

Mahdi, S., Nightingale, P. and Berkhout, F. (2002) *A Review of the Impact of Regulation on the Chemical Industry*, Final Report to the Royal Commission on Environmental Pollution, SPRU, University of Sussex, available at: <http://www.rcep.org.uk/pdf/chin-txt.pdf>

MacCrory, R. (2006) *Regulatory Justice: Making Sanctions Effective*, Cabinet Office, London.

Masurel, E. (2007) 'Why SMEs Invest in Environmental Measures: Sustainability Evidence from Small and Medium-Sized Printing Firms', *Business Strategy and the Environment*, 16: 190-201.

McKeiver, C. and Gadenne, D. (2005), 'Environmental Management Systems in Small and Medium Businesses', *International Small Business Journal*, 23(5), 513-537.

Meadows, D., Meadows, D. L., Randers, J. and Behrens, W. (1971) *The Limits to Growth*, Universe Books, New York.

Merrit Q. (1998) 'EM into SME won't go? Attitudes, awareness and practices in the London Borough of Croydon', *Business Strategy and the Environment*, 7(2), 90-100.

Mol, A.P.J. (2001) *Globalisation and Environmental Reform: The Ecological Modernisation of the Global Economy*, Massachusetts Institute of Technology Press: Cambridge, Massachusetts.

Morgan, K. (2004) 'Sustainable Regions: Governance, Innovation and Scale', *European Planning Studies*, 12(6), 872-889.

Morgan, K. (2008) 'Sustainable Food Chains and the Public Plate', *Regional Studies*, 42(9), 1237-1250.

Mir, D. F. and Feitelson, E. (2007) 'Factors Affecting Environmental Behaviour in Micro-enterprises: Laundry and Motor Vehicle Repair Firms in Jerusalem', *International Small Business Journal*, 25(4), 383-415.

Mir, D. F. (2008) 'Environmental behaviour in Chicago automotive repair micro-enterprises (MEPs)', *Business Strategy & the Environment*, 17(3), 194-207.

Murray, R. (1999) *Creating wealth from waste*, Demos, London.

Murphy, J. (2001) *Ecological Modernisation: The Environment and Transformation of Society*, OCEES Research Paper No. 20.

National Audit Office (2007) *The climate change levy and climate change agreements*, National Audit Office, London.

NCBS (National Centre for Business & Sustainability) *Encouraging Sustainability Amongst Small Businesses*, Behaviour Change Guide for Defra, available at: http://randd.defra.gov.uk/Document.aspx?Document=SD14007_3807_INF.pdf.

Nelson, R. R. and Winter, S. G. (1982) *An Evolutionary Theory of Economic Change*, Harvard University Press, Cambridge MA.

NESTA (2007) Policy Briefing: New types of innovation for a low-carbon society, NESTA, London – available at: <http://www.nesta.org.uk/new-types-of-innovation-for-a-low-carbon-society-policy-briefing/>

NESTA (2008) Policy Briefing: Innovation against Climate Change, NESTA, London – available at: <http://www.nesta.org.uk/innovation-against-climate-change-policy-briefing/>

Observatory of European SMEs (2002) *European SMEs and Social and Environmental Responsibility*, Issue 4, European Commission - available at: http://ec.europa.eu/enterprise/enterprise_policy/analysis/doc/smes_observatory_2002_report4_en.pdf.

Observatory of European SMEs (2007) *Summary: Fieldwork of Survey November 2006-January 2007*. European Commission – available at: http://ec.europa.eu/enterprise/enterprise_policy/analysis/doc/2007/02_summary_en.pdf.

O’Riordan, T, Jordan, A. and Voisey, H. (1998) ‘The International Sustainable Development Agenda’, Environment and Sustainability Desk Study prepared for the ESRC April 1998.

OST (Office of Science and Technology) (1999) *Environmental Futures*, Department of Trade and Industry, London.

Palmer, J. and van der Vorst, R. (1996) ‘Are “Standard” Systems right for SMEs?’, *Eco-Management and Auditing*, 3, 91-96.

Patterson, W. (2007) *Keeping the lights on: towards sustainable electricity*, Earthscan, London.

Pearce, D., Markandya, A. and Barbier, E. (1989) *Blueprint for a Green Economy*, Earthscan, London.

Pedersen, C. (2000) Local authorities in dialogue with small and medium-sized enterprises. In *Small and Medium-Sized Enterprises and the Environment: business imperatives*, Hillary, R. (ed). Greenleaf Publishing Ltd: Sheffield.

Petts, J. (2000) ‘Smaller enterprises and the environment: organizational learning potential?’ in S. Fineman (ed.) *The Business of Greening*, Routledge, London.

Petts J. Herd A. Gerrard S. and Horne C. (1999) ‘The climate and culture of environmental compliance within SMEs’, *Business Strategy and the Environment*, 8(1), 14-30.

Perez-Sanchez, D., Barton, J. R. and Bower, D. (2003), ‘Implementing Environmental Management in SMEs’, *Corporate Social Responsibility and Environmental Management*, 10, 67-77

Pike A., Rodriguez-Pose, A. and Tomany, J. (2006) *Local and Regional Development*, Routledge, Abingdon: ch 2 and part IV.

Porritt, J. (2005) *Capitalism As If the World Matters*, Earthscan, London.

Porter, M.E. and van der Linde, C. (1995) ‘Green and Competitive: ending the stalemate’, *Harvard Business Review* Sept/Oct, 120-137

Price, L. & Worrell, E. (2000) *International Industrial Sector Energy Efficiency Policies*, Lawrence Berkeley National Laboratory, available from: <http://www-library.lbl.gov/docs/LBNL/462/74/PDF/LBNL-46274.pdf>

Primenova, P. and van der Vorst (2004) ‘The role of support programmes and policies in improving SMEs environmental performance in developed and transition economies’ *Journal of Cleaner Production* 12,549-559.

Revell, A. (2002) ‘The Ecological Modernisation of Small Firms in Japan’, *Environmental Economics and Policy Studies* 5,291-317.

Revell, A. (2007a) ‘The Ecological Modernisation of Small Firms in the UK’s Construction Industry’, *Geoforum* 38(1),114-126.

Revell, A. (2003) ‘Environmental Policy and the Small Firm: Comparisons between Japan and the Netherlands’, *Journal of Environmental Policy and Planning* 5(4), 397-413.

Revell, A. (2008) *The Business Case for Sustainability: A Small Firm Perspective*, unpublished PhD thesis, Kingston University.

Revell, A. and Blackburn, R. (2007) ‘The business case for sustainability? An examination of small firms in the UK’s construction and restaurant sectors’, *Business Strategy & the Environment*, 16(6), 404-420.

- Revell, A. (2007a) 'The Ecological Modernisation of Small Firms in the UK's Construction Industry', *Geoforum* 38(1), 114-126.
- Revell, A. (2007b) 'Sustainable Development: The Case of Japan', Singh, J. (ed) *Society, Sustainability and Environment*, Shivalik Prakashan, Delhi.
- Revell, A. (2005). 'Ecological Modernisation in the UK: rhetoric or reality?' *European Environment*, 15, 344-361
- Revell, A. (2003a) 'Environmental Policy and the Small Firm: Comparisons between Japan and the Netherlands', *Journal of Environmental Policy and Planning* 5(4), 397-413
- Revell, A. (2003b) 'Is Japan an Ecological Frontrunner Nation?' *Environmental Politics*, 12(4), 24-48.
- Revell, A. and Blackburn, R. (2007) 'The business case for sustainability? An examination of small firms in the UK's construction and restaurant sectors', *Business Strategy and the Environment* 16(6), 404-420
- Revell, A., Stokes, D. and Chen, H. (2007) 'UK SMEs and the Environment: Turning Over a New Leaf?' Presented to the World Conference on Sustainable Entrepreneurship, Leeds, July 15-17th, 2007.
- Roome, N. (1994) 'Business Strategy, R & D Management and Environmental Imperatives' *R&D Management*, 24 (1), 065 – 082.
- Rothwell, R. (1983) 'Innovation and Firm Size: A Case for Dynamic Complementarity; or is Small Really Beautiful?' *Journal of General Management*, 8(3), 5-25.
- Rothwell, R. (1989) 'Small Firms, Innovation and Industrial Change', *Small Business Economics*, 1(1), 51-64.
- Rutherford, R. Blackburn, R. Spence, L. (2000) Environmental management in small firms: an international comparison. *International Journal of Entrepreneurial Behaviour and Research*, 6 (6), 310-326.
- SBRC (Small Business Research Centre, Kingston University) (2008) *The Impact of Regulation on Small Firm Performance*, report for the Enterprise Directorate of the Department for Business, Enterprise & Regulatory Reform.
- Schaefer, A. and Harvey, B. (1998) 'Stage models of corporate 'greening': a critical evaluation', *Business Strategy and the Environment*, 7 (3), 109-123.
- Schaper, M. (2002) 'The essence of ecopreneurship', *Greener Management International*, 38, 26-30.
- Schaper, M. (2002), 'Small Firms and Environmental Management', *International Small Business Journal*, 20(3), 235-251.
- Schumacher, E. F. (1973) *Small is Beautiful: a study of Economics as if People Mattered*, Blond & Briggs, London.
- Schumpeter, J. (1911) *The Theory of Economic Development*, Harvard University Press, Cambridge, MA.
- SDC (2006) *I will if you will – towards sustainable consumption*, Sustainable Development Commission – available at: www.sd-commission.org
- Shell (2008) *Shell Energy Scenarios to 2050*, available at: http://www.shell.com/home/content/aboutshell/our_strategy/shell_global_scenarios/shell_energy_scenarios_2050/shell_energy_scenarios_02042008.html.

Simpson, M., Taylor, N. and Barker, K. (2004), 'Environmental Responsibility in SMEs: Does it Deliver Competitive Advantage?' *Business Strategy and the Environment*, 13, 156-171.

Smith, A. and Kemp, R. (1998) *Small Firms and the Environment 1998: A Groundwork report*. Groundwork Trust: Birmingham

Spence, L.J. & Rutherford, R. (2001) 'Social responsibility, profit maximisation and the small firm owner-manager', *Journal of Small Business and Enterprise Development*, 8(2), 126-139.

SPTF (Sustainable Procurement Task Force) (2006) *Procuring the Future: Sustainable Procurement National Action Plan*, Department for Environment, Food and Rural Affairs, London.

SQW (2006) *Exploring the relationship between environmental regulation and competitiveness*, Research report for Defra, London.

Søgaard, V. and Madsen, S. O. (2007) 'The Red Queen and the Environment: Reconciling Public Regulation and Business Strategy', *Business Strategy and the Environment*, 16, 430-441.

Suchard, R., Sapru, R. and Stewart, E. (2007) *Beyond Neutrality: Moving Your Company towards Climate Leadership*, Business for Social Responsibility, San Francisco, USA.

Suchard, R., Sapru, R., Stewart, E. and Sullivan, R. (2008) 'From good to best practice on emissions management', ch. 20 in Sullivan (ed) (2008).

Sullivan, R. (ed) (2008) *Corporate Responses to Climate Change: Achieving Emissions Reductions through Regulation, Self-regulation and economic incentives*, Greenleaf Publishing, Sheffield.

Sullivan, R., Crossley, R. and Kozak, J (2008) 'Corporate greenhouse gas emissions: the state of play', Ch. 2 in Sullivan, R. (ed.) (2008).

Tietenberg T., Button K. and Nijkamp P. (1999) *Environmental Instruments and Institutions*, Edward Elgar, Cheltenham.

Tilley, F., Hooper, P. and Walley, L. (2003) 'Sustainability and Competitiveness: Are there Mutual Advantages for SMEs?' in Jones, O. and Tilley, F. (eds) *Competitive Advantage in SMEs: Organising for Innovation and Change*, John Wiley & Sons Ltd., Chichester, 71-84.

Tilley, F. (1999a), 'The Gap between the Environmental Attitudes and the Environmental Behaviour of Small Firms', *Business Strategy and the Environment*, 8, 238-248.

Tilley, F. (1999b) 'Small-firm Environmental Strategy: The UK Experience', *Greener Management International*, 25, 67-80.

Tilley, F. (2000) 'Small firm environmental ethics: how deep do they go?' *Business Ethics: A European Review*, 9(1)

Tokar, B. (1997) *Earth for Sale: Reclaiming Ecology in the Age of Corporate Greenwash*, South End Press, Cambridge MA, USA.

UNEP (United Nations Environment Programme) (2008) *Green Jobs: Towards Decent work in a Sustainable, Low-Carbon World*, available at: http://www.unep.org/PDF/UNEPGreenJobs_report08.pdf

Van der Horst (2008) 'Social enterprise and renewable energy: emerging initiatives and communities of practice', *Social Enterprise Journal*, 4(3), 171-185.

Verheul, H. (1999), 'How Social Networks influence the Dissemination of Cleaner Technologies to SMEs', *Journal of Cleaner Production*, 7, 213-219.

- Vernon, J., Essex, S., Pinder, D. and Curry, K. (2003) 'The 'Greening' of Tourism Micro-Businesses: Outcomes of Focus Group Investigations in South East Cornwall', *Business Strategy and the Environment*, 12,49-69.
- Vickers, I. and Cordey-Hayes, M. (1999) 'Cleaner Production and Organisational Learning', *Technology Analysis and Strategic Management*, 11(1), 75-94.
- Vickers I, James P, Smallbone D, Baldock R (2005) 'Understanding Small Firm Responses to Regulation: The Case of Workplace Health and Safety', *Policy Studies*, (26)2, 149-169.
- Vivid Economics (2008) *The Race to Capture the Carbon Pound; The UKs place in the global market for low carbon innovation*, Shell Spring Board, available at: http://www.shellspringboard.org/downloads/R01515_Springboard_Report.pdf.
- Vos, J. (1998) 'Diagnosing Constraints in Knowledge of SMEs', *Technological Forecasting and Social Change* 58,227-239.
- Wagner, M. (2001) *A Review of Empirical Studies Concerning the Relationship between Environmental and Economic Performance*, Centre for Sustainability Management, University of Luneburg. Cited in Sogard & Madsen (2007).
- Wagner, M. (2008) 'Empirical influence of environmental management on innovation: Evidence from Europe', *Ecological Economics*, 66, 392-402.
- Walker, H. and Preuss, L. (2008) 'Fostering sustainability through sourcing from small businesses: public sector perspectives', *Journal of Cleaner Production*, 16(15), 1600-1609.
- Walley, N. and Whitehead, B. (1994) 'It's not easy being green', *Harvard Business Review*, May-June, 46-52.
- Walley, E. E. and Taylor, D. W. (2002) 'Opportunists, champions, mavericks...? Greener Management International', 38, 3-4.
- WCED (World Commission on Environment and Development) (1987) *Our Common Future*, Oxford University Press, Oxford.
- Weatherill, S. (ed.) (2007) *Better Regulation*, Hart Publishing, Oxford.
- Welford, R. & Starkey, R. (eds) (1996) *The Earthscan Reader in Business and the Environment*, Earthscan, London.
- Wheale, P. and Hinton, D. (2007) 'Ethical Consumers in Search of Market', *Business Strategy and the Environment*, 16, 302-315.
- White, R. (2007) *Carbon governance from a systems perspective: an investigation of food production and consumption in the UK*, ECEEE 2007 Summer Study, Saving Energy – Just do it
- Willis, R., Webb, M. and Wilsdon, J. (2007) *The Disruptors: lessons for low carbon innovation from the new wave of environmental pioneers*, NESTA, London.
- Winter, S. G. (1984) 'Schumpeterian Competition in Alternative Technological Regimes', *Journal of Economic Behaviour and Organisation*, 5(3-4) 287-320.
- Wycherley, I. (1999) Greening Supply Chains: the Case of the Body Shop International, *Business Strategy and the Environment*. 8(2),120-127.
- Young, C. and Tilley, F. (2006) 'Can businesses move beyond efficiency? The shift toward effectiveness and equity in the corporate sustainability debate', *Business Strategy and the Environment*, 15, 402-415.

Appendix 1: Policy in other countries

A1.1 Policies for energy efficiency

The examples of SME relevant energy efficiency policies in other countries given below are drawn from an initial internet search rather than being a comprehensive listing.

A database of all the energy efficiency policies in International Energy Agency member states is available at:

<http://www.iea.org/textbase/pm/Default.aspx?mode=pm>

Belgium

Since 2005, the Walloon Region has awarded an investment subsidy and an exemption from real estate taxes to companies which carry out an investment programme aiming at the sustainable use of energy (hydroelectric energy, wind energy, solar energy, geothermal energy, biogas, organic products and waste from agriculture and forestry arboriculture, biodegradable organic part of waste), and quality cogeneration and energy savings during the manufacturing process. The overall amount of the subsidy and the exemption from real estate taxes covers a percentage of eligible investments. The rates of the supports depend on the size of the enterprise and the objective of the investment programme. It ranges from 20 to 40%. The amount of the subsidy and the exemption from real estate taxes cannot exceed:

- EUR 1,000,000 per company over a 4-year period, in the case of a SME;
- EUR 2,000,000 per company over a 4-year period, in the case of a large enterprise.

The exemption can be awarded to:

- small-sized enterprise for a 5-year period;
- medium-sized enterprise for a 4-year period;
- large enterprise for a 3-year period.

In the case of business start-ups, the exemption can be awarded for a maximum period of 7 years as regards the equipment. The grant covers investments in all types of renewable energy, hydroelectric energy, wind energy, solar energy, geothermal energy, biogas, organic products and waste from agriculture and forestry arboriculture, biodegradable organic part of waste.

Source: IEA Database

<http://www.iea.org/textbase/pm/?mode=red&id=1563&action=detail>

France

Crediting System in Favour of Energy Management ((Fonds de Garantie des Investissements de Maîtrise de l'Énergie - FOGIME))

Launched in 2000, FOGIME has a budget of approximately € 17.8 million. These funds are provided by ADEME and SOFARIS, a branch of the development bank for SMEs (BDPME). The fund guarantees up to € 242 million for loans to the private sector in aiming to provide SMEs with the option to obtain loans for energy efficiency and renewable

energy investments. This guarantee is only available for SMEs created more than three years ago. Eligible for funding are investments in high performance production, use, recovery and energy storage equipment, energy efficient modifications of production processes and renewables that are incurred by SMEs.

Source:

http://www.sundasolar.com/services_france.html

http://www.thegreenpowergroup.org/pdf/renewable_policy_France.pdf

Energy efficiency program

The "Programme National d'Amélioration de l'Efficacité Energétique" (PNAEE) was announced by the French government in December 2000. It aims to mobilise all households, small businesses and local government to act on energy saving. It includes a number of measures to improve energy efficiency of transport, construction, industry and renewable energy.

Source: IEA Database

<http://www.iea.org/textbase/pm/?mode=pm&id=463&action=detail>

Germany

Special fund for energy efficiency in SMEs

The BMWi and KfW have established the Special Fund for Energy Efficiency in SMEs to tackle both the informational and cost barriers faced by SMEs. The programme has two components; the advice component and the financing component. The advice component provides grants for SMEs to obtain advice and consultation regarding energy efficiency. The advice can be initially designed to complete the lack of information regarding the energy savings an enterprise can achieve by examining its energy use, weak points and potentials. A grant amount can be provided to finance up to a EUR 800 daily fee. Up to 80% of the daily fee can be covered (to a maximum of EUR 640 per day), with a maximum grant amount of EUR 1 280.

Source: IEA Database

<http://www.iea.org/textbase/pm/?mode=pm&id=4150&action=detail>

Federal Ministry of Economics and Technology increased assistance of €1.4 billion for renovation work for SMEs, particularly in construction industry and craft sector to make buildings energy efficient. Assistance will be available until 2009.

Source: Federal Ministry of Economics and

Technology <http://www.bmwi.de/English/Redaktion/Pdf/the-federal-governments-initiative-for-small-and-medium-sized-businesses.property=pdf.bereich=bmwi.sprache=en.rwb=true.pdf>

Hungary

In 2004, the Hungarian Government established a new financial scheme to support energy efficiency and renewable energy project in municipalities and SME's. The minimum project size is 0,5 M€. The support is in the form of a grant, and is between 30-60%.

Source: IEA Database <http://www.iea.org/textbase/pm/?mode=cc&id=2111&action=detail>

The Netherlands

Dutch regulation provides opportunities for SMEs to receive bank loans in cases where they lack sufficient collateral. In such cases, the government steps in with an extra guarantee of up to EUR 1 million. In the past, the scheme's annual budget of over EUR 450 million has been used to cover loans by a number of European banks. The European Investment Fund contributes to the funding of the scheme.

Source: http://www.senternovem.nl/english/products_services/encouraging_innovation/sme_loan_guarantees.asp

Green Funds

Businesses that invest in 'green projects' can obtain lower interest rates from Green Funds which are created by savings of private persons exempted from paying income tax on the interest received.

Source: The Green Power Group

http://www.thegreenpowergroup.com/pdf/renewable_policy_Netherlands.pdf

Tax Credit

Since 1997 the Energy Investment Scheme (EIA) and the Environmental Investment Scheme (MIA) allowed investments in energy efficiency and renewable energies to be deducted from taxable profit up to a percentage of investment costs. In 2005, this was 44%. The maximum deduction is €107 million per year per fiscal entity and the minimum investment in the year of application is €2,000.

Source: SenterNovem

http://www.senternovem.nl/eia/eia_energy_investment_allowance.asp

http://www.thegreenpowergroup.com/pdf/renewable_policy_Netherlands.pdf

VAMIL Depreciation Scheme

The scheme allowed enterprises to decide when they want to depreciate investments in specific environmentally benign equipment, reducing income and company taxes. An interest and liquidity advantage was gained by shifting the payment of taxes to the future. Accelerated depreciation was only applicable to equipment which was included in the yearly updated VAMIL list "Milieulijst". The equipment must have been new and should have been available in the Netherlands, e.g., biomass reconditioning, biomass burning equipment, solar PV-systems. The incentive was applicable to all taxable Dutch enterprises. In 2000, tax expenditure under VAMIL amounted to NLG 250 million (113.45 million); in 1999 47% of the investments were related to energy. The objective was to stimulate investments in environmentally benign technologies, which included all renewable energy technologies. The VAMIL scheme allowed investors to decide when they offset their investments against taxable profits. Expenditures on the instrument including non-energy and energy efficiency measures grew from NLG 7.5 million (3.4 million) in 1991 to NLG 70 million (31 million) in 1999. Expenditures on renewable energy formed only a small part of this at approximately 5 million per year. Since 2003, the VAMIL scheme has no longer been applied to energy (including renewable) investments.

Source: IEA

<http://www.iea.org/Textbase/pm/?mode=re&id=100&action=detail>

Long Term Agreements (LTA) – aim to encourage companies to increase their energy efficiency through implementation of realistic energy saving measures. Agreements are based on energy management system (90% of companies complied with energy management system in 1996) and there has been an improvement by 20% in energy efficiency from 1996-2000.

Source: www.minInv.nl/cdlpub/servlet/CDLServlet?p_file_id=14935

Norway

The Norwegian Industrial Energy Efficiency Network (IEEN) was established in 1989 as a joint initiative between authorities and industry. It focuses on cooperation and networking of SMEs and integrates reporting/ benchmarking, assessments: sector and technology studies, design and implementation of EMS, information dissemination and demonstration: quarterly newsletter, annual report and demonstration programs. It was found that IEEN members experienced increased production and reductions in their energy consumption.

Source: <http://www.aid-ee.org/documents/013IndustrialEnergyEfficiencyNetwork-Norway.PDF>

Sweden

The Energy Gain – a local training programme for SMEs

The programme combining education and practical measures has been very successful and appreciated by the participating companies, resulting in energy savings and transition from fossil to renewable energy.

Source: EC

<http://www.managenergy.net/products/R2000.htm>

<http://www.managenergy.net/download/nr280.pdf>

Energy efficiency case study of SMEs in Norrbotten, Sweden:

<http://www.managenergy.net/download/nr274.pdf>

Switzerland

In 2008, the Swiss Climate Foundation was set up to support energy efficiency and climate protection measures in SMEs in Switzerland. The foundation is financed by the refunds of the carbon dioxide duties charged on the fuels of the partner companies.

Source: SwissLife

<http://www.swisslife.com/slcom/en/home/gruppe/commitment/environment.html>

<http://www.klimastiftung.ch/>

Swiss Federal Office of Energy (SFOE) and the Energy Agency for Industry work closely to reduce energy consumption and CO₂ emissions (Energy Act and CO₂ Act) among companies in the trade, industry and service sectors. SFOE carries out programme on

regional platforms to promote energy efficiency in SMEs and is developing information and support programmes in the area of process optimisation.

Source: SFOE

<http://www.bfe.admin.ch/energie/00572/index.html?lang=en>

European Union

Broad targets

The Climate Action package introduced in January 2008 by the European Commission proposes measures to fight climate change and promote renewable energy. It builds on the targets set in 2007 for 2020 as part of the Energy Policy for the European Union. These include 20% reduction in greenhouse gases; 20% increase in energy efficiency, and increase in renewable energy use to 20% of total energy consumption.

Source: EC : <http://www.managenergy.net/smes.html#legislation>

Initiatives specific to SMEs:

SMEs represent around 90% of GDP and two thirds of jobs in the EU.

The Intelligent Energy-Europe Programme (IEE) is the EU's programme of work to reduce energy use. It is a part of a seven-year framework programme (Competitiveness and Innovation Programme - CIP) which was adopted in June 2006 and is aimed at enhancing competitiveness and innovation among European businesses, especially SMEs. The funds available for IEE amount to €730 million and support actions in promotion of energy efficiency, increased investments and awareness-raising of renewable energy source.

Source: EC : http://ec.europa.eu/energy/intelligent/index_en.html

Eurostars is a European research and development project providing funding for SMEs in 31 European countries to encourage innovation. It has funds of €400 million available over a period of six years.

Source: Eurostars <http://www.eurostars-eureka.eu/>

The LIFE+ programme has available some €700 million for environmental projects in 2008-2013. SME's are eligible to seek project funding through annual competition – the standard grant rate is 50%.

Source: EC <http://ec.europa.eu/environment/life/funding/lifeplus.htm>

The EU Eco-Management and Audit Scheme (EMAS) is an energy efficiency toolkit for companies and other organizations to evaluate report and improve their environmental performance. The scheme was first launched in 1995 for companies in industrial sectors. Since 2001, it has been open to all sectors including public and private. In July 2008, the EC proposed revision of EMAS to boost participation of companies and reduce the administrative burden and costs, particularly for SMEs. The scheme has been more

successful and widespread in Germany, Austria and Nordic countries compared to other EU countries.

Source: EMAS http://ec.europa.eu/environment/emas/index_en.htm

Eurima - the leading trade association on energy efficiency in the EU, link to their report on EE in buildings (not specific to SMEs).

Source: Eurima – Better buildings through energy efficiency: a roadmap to Europe
http://www.eurima.org/uploads/Documents/documents/leaflet_building_cor4light.pdf
http://www.eurima.org/uploads/Documents/documents/EU_Roadmap_Fact_Sheets_020307.pdf

UEAPME - EU trade association for small businesses, asking for protection from monopoly energy providers.

Source: UEAPME
http://www.ueapme.com/docs/pos_papers/2007/071025_pp_EnergyPackage_final.pdf

Seventh Research Framework Programme FP7

With budget of over €50 billion, for the period 2007-2013, FP7 is a framework of research initiatives. It also sponsors research projects for the benefits of specific groups, in particular SMEs.

Source: EC – CORDIS http://cordis.europa.eu/fp7/home_en.html

ExBess

Benchmarking and Energy Management Schemes in SMEs (BESS project). This has been extended until May 2009 in the industrial SME sectors in and beyond the food and drink industry e.g. textile, machinery, crafts.

Source: Benchmarking and Energy Management Schemes in SMEs
<http://alpha.cres.gr/bess/servlets/bessStatic/en/index.html>

Regional Policy Commissioner Danuta Hübner announced the allocation of at least €27 billion (7.9% of total community investment) out of the bloc's 2007-13 cohesion fund to SMEs, with the lion's share (65% or €17.5 billion) going to technology and innovation. The remaining €10 billion or so will be allocated to ICT activities (14%), start-ups (12%) and eco-friendly projects (9%).

Source: EurActive.com

<http://www.euractiv.com/en/innovation/eu-wants-regional-policy-launch-pad-smes/article-174113>

Australia

The Energy Efficiency Opportunities program encourages large energy-using businesses to improve their energy efficiency. Also supports SMEs. There are approximately 210 corporations registered for the Energy Efficiency Opportunities program. Participation in

this program is mandatory for corporations that use more than 0.5 pet joules (PJ) of energy per year.

Source: Energy Efficiency Opportunities

<http://www.energyefficiencyopportunities.gov.au/index.cfm?event=object.showContent&objectID=1E2C7ADB-BCD6-81AC-1DD2BCE4E088C6FB>

USA

Energy star for small businesses

Energy star is a joint program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) aimed at helping SMEs save money and protect the environment through energy efficient products and practices. Offers free advice and technical support to SMEs on energy efficiency and annual awards for small businesses with outstanding record of EE.

Source: Energy Star

http://www.energystar.gov/index.cfm?c=small_business.sb_index

Small Business Innovation Research (SBIR) and Small Technology Transfer (STTR) Programs

U.S. Government programs in which federal agencies with large research and development (R&D) budgets set aside a small fraction of their funding for competitions among small businesses only. Small businesses that win awards in these programs keep the rights to any technology developed and are encouraged to commercialize the technology. In 2005, DOE set aside some \$102 million and \$12 million, respectively. The research areas include energy production (e.g. fossil, nuclear, and renewable), energy use, and environmental management.

Source: US DOE

<http://www.science.doe.gov/sbir/NEWWEB/Introduction.htm>

Bright Tomorrow Lighting Prize

The Bright Tomorrow Lighting Prize competition, or "L Prize", was authorised by the Energy Independence and Security Act of 2007. It challenges the lighting industry to develop LED (light-emitting diode) replacement technologies for current widely used inefficient lighting products. In May 2008, DOE announced plans to offer at least a USD 1 million prize for the development of energy efficient, solid-state lamps.

Source: IEA Database <http://www.iea.org/Textbase/pm/?mode=pm&id=4092&action=detail>

Builders challenge

DOE launched the Builders Challenge on February 14, 2008, calling on the U.S. homebuilding industry to build 220,000 high-performance, energy efficient homes by 2012. The voluntary programme also aims for 1.3 million of these high-performance homes to be built by 2030. DOE and its partners will offer technical information, resources, and marketing tools to support builders across the nation in meeting the challenge on their own or through a partner programme. Participating builders will also qualify for tax credits and utility benefits.

Source: IEA Database <http://www.iea.org/Textbase/pm/?mode=pm&id=3930&action=detail>

Low Carbon Fuel Standard (LCFS) - the first greenhouse gas standard for transportation fuels came into effect in January 2007 in California. LCFS will direct actions of a number of agencies in developing the protocols for measuring the "life-cycle carbon intensity" of transportation fuels. The standard aims to reduce carbon footprint of vehicles by 10% by 2020.

Source: The California Energy Commission
http://www.energy.ca.gov/low_carbon_fuel_standard/

The National Small Business Association's recent survey revealed that increasing energy costs of nearly 26 million small businesses in the U. S. have a negative impact on 77 per cent of business owners. As a result of rising costs, 37 per cent of businesses increased their prices besides reductions to their travel and workforce. The new Energy Independence and Security Act that was passed by the U.S. Senate at the end of 2007 includes a number of programmes designed to promote energy efficiency and encourage the use of renewable energy by small businesses. The deputy administrator of the Small Businesses Association, Jovita Carranza, who is responsible for implementing these programmes, was urged in an open letter by the members of the Senate Committee on Small Business and Entrepreneurship to carry out plans for meeting the requirements of small businesses as proposed in this law. One such programme is establishing an 'Energy Clearinghouse'. In conjunction with the EPA's 'Energy Star', the programme will educate small business owners and their employees on the benefits of energy efficiency. It will offer grants for pilot projects to reduce energy consumption and for R&D projects of renewable energy resources, all aimed at small businesses.

Source: <http://www.climatebiz.com/news/2008/08/01/senators-energy-efficiency-small-businesses>

<http://www.reuters.com/article/pressRelease/idUS258240+31-Jul-2008+PRN20080731>

A US study on international energy efficiency policies argues that the most effective way to improve industrial energy efficiency is by combining a number of programmes and policies (Price & Worrell, 2000). One example of 'integrated' energy efficient policies is the Danish Agreements on Industrial Energy Efficiency. The agreements last for three years and include mandatory EMS, targets, CO2 emission tax and subsidies of up to 30% of costs of investments in new energy efficient equipment. One analysis of the programme found that firms with an agreement saved on electricity as well as reducing their energy consumption.

A1.2 Other environment-related policies and programmes targeted at SMEs

European Union

Competitiveness and Innovation Framework Programme (CIP)

With a budget of €3.6 billion, programme running between 2007 and 2013 funds two programmes supporting environmental performance of SMEs:

1. Entrepreneurship and Innovation Programme (EIP) - Allocated €430 million for development of environmental technologies to protect the environment, while contributing to competitiveness and economic growth.
2. Intelligent Energy Europe Programme (IEE) – discussed in energy section.

Source: EC http://ec.europa.eu/cip/index_en.htm

Marco Polo is the EU's funding programme with a budget of €400 million for the period 2007-2013 supporting projects which shift freight transport from the road to sea, rail and inland waterways.

Source: http://ec.europa.eu/transport/marcopolo/home/home_en.htm

Germany

A New Impetus for Innovation and Growth programme is an investment of the Federal Government aimed at development in all fields of technology for SMEs. Funding will rise to €673 million by 2009 and will continue to grow with a rate of increase of over 10% p. a.

Source: Federal Ministry of Economics and Technology

<http://www.bmwi.de/English/Redaktion/Pdf/the-federal-governments-initiative-for-small-and-medium-sized-businesses,property=pdf,bereich=bmwi,sprache=en,rwb=true.pdf>

The German Blue Angel Scheme

In 1978, the then Federal Republic of Germany was the first country to introduce environmental labelling scheme. There are also schemes operating in other European countries including EU Ecolabelling Scheme which was launched in 1993. The schemes function on the similar principle; firstly a product group is defined, followed by the life cycle assessment of the product group and the setting of environmental criteria. Products that meet all criteria within their group can be awarded environmental label. Schemes are voluntary and open to all products in an existing product group. The scheme has two main aims: 1) to provide consumers with independent assessment of the environmental impact of products, and 2) to promote production and use of environmentally friendly products. Evidence from Germany suggests that the scheme is relevant to SMEs. There was a shift in the marketing shares for some product groups in favour of products bearing environmental label.

Source: European Environment Agency <http://reports.eea.europa.eu/GH-14-98-065-EN-C/en/enviissu10.pdf>

Japan

Environmental reform in Japan has been defined by decentralisation, the power of local authorities, voluntary agreements and industry participation in policy formation (Revell, 2002). Japanese SMEs, it has been argued, have little influence on national environmental policy which is mostly focused on large businesses. One study of SMEs in Tokyo shows that around 60% claim to be engaged in environmental measures mainly through compliance/regulation and voluntary action. Although Japan has the highest rate of ISO 14 001 registrations (Hillary, 2000, p.317), there is a lack of awareness about government loans and not much pressure to go green among SMEs. Japan is a world leader in environmental technology markets and has benefited from energy efficiency measures especially in automotive industry.

Source:

Hillary, R. (2000) *Small and Medium-Sized Enterprises and the Environment*, Sheffield, UK: Greenleaf Publishing

Revell, A (2002) 'The Ecological Modernisation of Small Firms in Japan', *Environmental Economics and Policy Studies* 5:291-317

Vinger, E., *Japanese Environmental Policy – and approach to environmental technology*, Swedish Institute for Growth Policy Studies, available from:

http://www.itps.se/Archive/Documents/Swedish/Publikationer/Rapporter/PM-serien/2008/PM2008_006.pdf [02/09/2008]

JASME – Japan Finance Corporation for Small and Medium Enterprise – provides long term funding for SMEs. JASME offers a variety of Special-purpose Loans designed to facilitate the government policy guidance by channelling funds into targeted sectors, including environmental measures. Two thirds of loans have terms longer than five years, with fixed rates that make it easier to map out repayment schedules.

Source: Jasme <http://www.jasme.go.jp/indexe.html>

The Netherlands

Dutch have one of the most advanced policy frameworks for sustainable development among industrialised countries. The National Environmental Policy Plan (NEPP) was first adopted in 1989 and revised every four years into three progressive variations reflecting the growth, lessons learned, challenges, and new objectives. The success of this policy results from a target based approach to environmental management. Rather than adopting approach that looks at separate impacts on water, air or soil, the Dutch policy focuses on sources of pollution (e.g. industries, transport, and farming) achieving over 70% of their initial goals with an aim of sustainability by 2010. Environmental management in the Netherlands is incorporated in business practice with greater emphasis on inspection/regulation, tax, licensing and advisory services provided for small businesses. The policy mix of regulation, economic instruments and agreements is shown to have been particularly productive.

Sources:

Resource Renewal Institute http://www.rri.org/greenplans_netherlands.html

OECD <http://www.oecd.org/dataoecd/51/60/2958654.pdf>

http://greenplans.rri.org/resources/greenplanningarchives/netherlands/netherlands_1993_nepp_summ.html

Rutherford et al. (2000)

The Foundation Stimular - set up in 1990 in Rotterdam region to encourage reduction in waste and emissions, to save energy and to protect the environment through practical advice and assistance. Since 2000 Stimular has extended its activities to include sustainable management for the SME and half of its projects now operate at a national level with more than 500 companies involved.

Source: Stimular <http://www.stimular.nl/engels.php>

USA

Small Business Innovation Research (SBIR) Program

The US EPA offers funding to small businesses with technologically innovative ideas in Manufacturing; Nanotechnology; Green Buildings; Drinking Water and Water Monitoring; Water Infrastructure Rehabilitation; Monitoring and Control of Air Pollution; Biofuels and Vehicle Emissions Reduction; Waste Management and Monitoring and Homeland Security. In March 2008, phase 1 of the program, allocated \$1.75 million in SBIR contracts to 25 small businesses to research and develop new environmental technologies.

Source: US EPA <http://es.epa.gov/ncer/sbir/>

The Small Business Compliance Policy

The policy promoting environmental compliance among small businesses by providing incentives for voluntary discovery, prompt disclosure, and prompt correction of violations through reduction or waiving of penalties.

Source: US EPA

<http://www.epa.gov/compliance/resources/policies/incentives/smallbusiness/sbcomppolicy.pdf>

National Compliance Assistance Centres

National Centres providing access to information on environmental regulations for businesses.

Source: Compliance Assistance Centres <http://www.assistancecenters.net/>

Environmental agencies and small business environmental assistance programs in different US states can be found through the following link:

<http://www.smallbiz-enviroweb.org/sba/seasbapweb.html>

APPENDIX 2: Case study examples of innovative low carbon SMEs and related developments

The recent literature provides a number of case study examples of SMEs developing innovative approaches to cope with / capitalise on challenges and opportunities arising from an increasingly low carbon economy. A selection of these are briefly summarised below.

Ernst & Young (2008, 3.8) present a number of case studies of successful green business models, including:

CERES Power – innovative fuel cell technology, based on over 10 years' research at Imperial College, London and founded in 2001.

Comverge – a clean energy company providing innovative solutions that significantly reduce peak electricity costs and improve grid reliability.

US Clean tech – start-up companies funded with venture capital or private equity.

Sleswig-Holstein (North Germany) – investment in renewables (wind farms, biomass [co-financed by EU], solar PV) driven by high levels of concern about climate change at regional government level and stringent legislation.

CBI (2007, p.20) provides examples of UK SMEs that are at the forefront of low carbon products:

Zedfactory – an architectural firm that has pioneered new methods of designing and insulating buildings, and developed the BedZed site in Surrey. Has since been asked by the Chinese government to design 140 new zero-carbon homes outside Beijing.

Pelamis Wave Power – a Scottish company which is behind the first wave farm in the world, recently established in Portugal.

The **Shell Springboard** awards provide up to £40,000 to SMEs that have ideas for products and services with commercial potential that also contribute to greenhouse gas reductions. Case study examples are provided by Vivid Economics (2008):

Inspects – founded in 2006 to develop the Optimiser which enables diesel engines to combine different quantities of alternative fuels, typically reducing the CO₂ emissions of a diesel lorry by 12 per cent and fuel costs by up to 25 per cent.

Vykson (Turbine Developments Limited) – a novel design of turbine which utilises methane (a greenhouse gas) from landfill gas of poorer quality and in lower concentrations than was feasible with pre-existing technology.

Polysolar – founded to take advantage of a technology developed by researchers at Cambridge University's Cavendish Laboratory. Involves photovoltaics but rather

than the conventional silicon utilises polymer semiconductors similar to those used in flat screen TV sets and flexible electronics. This results in transparent solar cells that can replace glass in building construction, thus avoiding both the labour cost of installing separate solar panels (i.e. improving their commercial viability) as well as any unwanted aesthetic impact from commercial designs. The market for this technology is driven by both regulation and the increased competitiveness of the product itself. Regarding the former, the Merton rule in the UK requires that buildings above a certain size must produce 10 per cent of their energy requirements from renewable. Feed-in tariffs in countries such as Germany have also contributed to the stimulation of photovoltaic technology.

Green Energy Options – energy monitoring systems for homes, businesses and schools which aim to engage people (including children) in energy saving by making it easy to see where energy is being used and how it can be reduced. It is estimated that energy savings of about 23 per cent are representative for most buildings.

Hydro Venturi – the original concept of this company was to commercialise technology developed at Imperial College London for exploiting low head hydropower sites – sites where the height difference between source and outflow water is too small for cost effectively electricity generation with a conventional turbine. Building on this original concept, Hydro Venturi have developed a radical new approach, which involves creating a pressure drop in the water and sucking air into the water flow via an air turbine and turning a generator in the process. A spin-off application of the technology is in water remediation and treatment since, through oxygenating the water the decomposition of organic wastes is accelerated. This latter application is likely to be as or more important than hydropower, given the increasingly stringent regulatory environment in the EU since the introduction of the Water Framework Directive. Low head hydropower technology is seen to have potential in a number of countries, including the United States.

Examples of the co-operative application of wind technology are reported by NESTA (2008):

Baywind – established in 1997 Harlock Hill, Cumbria and the UK's first community-owned windfarm, subsequently expanded to a further site at Haverigg. The planning process for this was enabled to run more smoothly due to the co-operative structure, with locally-held shares, with local residents able to see tangible benefits from the scheme. Also crucial has been government support in guaranteeing a market for the co-operative's output and ensuring the economic viability of the operation.

Danish wind sector - wind farm co-operatives are well established here, with half of the country's 'privately-owned' wind farms being owned by community co-ops. In this context, the success of co-operative ownership has been attributed to three main ingredients: a stable pricing mechanism for wind power, credibly guaranteeing a high price for wind energy fed into the national grid; a planning

system that actively encouraged the development of wind farms; a strong tradition of co-operative ownership.

Others case studies recently reported in the media include:

Novacem – ‘green cement’ – The 2 billion tonnes of cement used globally every year is a huge source of CO₂, emitting 5 per cent of the world’s CO₂ emissions – more than the entire aviation industry. Novacem was founded by chief scientist Nikolaos Vlasopoulos and colleagues at Imperial College London to commercialise a new formulation of cement based on magnesium silicate, which requires less heating than raw materials such as limestone and also absorbs large amounts of CO₂ as it hardens, making it carbon negative. Novacem claim that its product can absorb about 0.6 tonnes of CO₂ per tonne of cement, as compared with carbon emissions of about 0.4 tonnes per tonne of standard cement. The company has attracted the attention of major construction companies such as Rio Tinto Minerals, WSP Group and Laing O’Rourke, investors such as the Carbon Trust and has just commenced a £2.5 million project funded by the government-backed Technology Strategy Board to build a pilot plant. Assuming the development goes according to plan, Vlasopoulos expects Novacem products to be on the market within five years (source: *The Guardian*, 1 January 2009).

Geothermal International Ltd – founded in Coventry in 2000 by Brian Davidson, an electrical engineer. The company has grown to become the UK’s main provider of ground source heat pump systems. Such systems can lead to overall savings in heating and cooling costs of up to 70 per cent and reduce CO₂ emissions by an average of 45 – 50 per cent. Geothermal International has been involved with the design and implementation of well over 100 such installations, ranging from small, single homes with a 6kW heating requirement, to large scale commercial ventures requiring Megawatts of Heating and Cooling (source: <http://www.geoheat.co.uk/>; *The Guardian*, 3 December, 2003).