Innovation in Environmental Services

Final Report, December 19 2007

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Prepared for:

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Acknowledgements

The authors wish to thank the project managers, Chris Tollady of BERR, and Michael Harris of NESTA, and members of the Service Innovation Steering Group for Environmental Services (especially its chairman, Peter Jones of Biffa) for their assistance with this report. Professor Fred Steward of Brunel University also provided helpful feedback on drafts. The report has been discussed by the Steering Group, and its broad conclusions accepted by it. Any remaining errors in the document are the sole responsibility of the authors.

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Contents

Executive Summary

The environmental services sector makes a substantial contribution to UK economic and social life by helping to achieve Government targets for environmental improvement, and sustainable consumption and production; helping to ensure that these are met as cost-effectively as possible; providing high quality and secure employment; and contributing to greater awareness of sustainable development amongst business, the public sector, and consumers.

This report - prepared for BERR, DIUS and NESTA (in consultation with an Industry Steering Group) as part of their Innovation in Services initiative – examines innovation in the sector, with a particular focus on consultancy and waste management. However, one key point which has emerged is the existence of a broader, very large, but as yet little known, 'resource efficiency' sub-sector encompassing activities such as remanufacturing.

The sector has performed well in recent years, enjoying fast growth and a high share of international markets. However, it faces unprecedented challenges, including the need to develop new know-how and service solutions; to create large-scale physical infrastructures (especially for handling and processing waste); to scale-up and deploy many physical technologies; to develop and deploy new ICT-based methods; and to create new kinds of economic arrangements. In one area, alone – that of responses to climate change – the sector can significantly influence where costs fall within the range of -2% to +5% of GDP which was identified by the Stern Review.

There are currently a number of market failures which are impeding the sector's development, especially:

- A lack of investment 'bankability' created by uncertainty about medium-long term Government commitment and policies;

- Fragmented, short-term and overly prescriptive approaches to public sector procurement;

- Constraints in skills and technical capacity;

- A lack of risk capital for the demonstration and near market stages of new technologies and services; and

- Insufficient awareness of, and incentives to adopt, innovative environmental technologies and services in business and the broader economy.

Two other areas of concern are:

- Insufficient 'weight' given to resource, and especially materials, efficiency issues within Government; and

- A poor information base on environmental services and resource efficiency.

Table 1 summarises the recommended policy measures to overcome these barriers which have emerged from our research. Many of these recommendations repeat or parallel those made by other studies of innovation for environmental goods and services, e.g. those by the Environmental Innovations Advisory Group and the Commission on Environmental Markets and Economic Performance.

The individual measures suggested by this report will certainly assist innovation. However, the Steering Group discussions, and other consultations, also suggest that they are associated with more strategic messages that:

- Government needs to address resource efficiency innovation with the same vigour that it has low carbon (not least because the two are closely connected);

- Stimulating greater action on both these issues in the service sector generally – e.g. through a standardised carbon and resource accounting framework – is equally as important as a narrow focus on environmental services per se (as this will help achieve Governmental sustainability goals more directly, and also stimulate new markets for environmental services); and

- A key element in a more vigorous resource efficiency agenda, especially with regard to innovation, will be recognising that associated activities go well beyond those of conventionally defined environmental services, and certainly far beyond 'waste management'.

Table 1 Policy Recommendations and their Targets

Theme	All Services	All Environmental Services	Environmental Service Sub-Sectors
Create greater long-term certainty about policy implementation, and levels of financial incentive to stimulate greater interest and investment in innovation.		Explore methods of increasing the 'bankability' of projected returns from carbon, landfill, renewable energy and other credits arising from incentive-based regulation. Examine the relationship between taxation and resource efficiency, and make recommendations for changes to encourage use of recovered materials and 'servicising' innovations.	Examine the feasibility, and implications, of banning all recoverable materials from landfill.
Modify procurement mechanisms to provide greater encouragement for innovation.		Explicitly address innovation issues in public procurement programmes, learning from the successful experience of the Forward Looking Procurement pilots.	Ensure that municipal waste contracts are optimised for innovation (e.g. by outcomes based approaches, enabling commercial wastes to be treated in municipal facilities).
Improve the skill and management capacity, of the sector, and particular sub-sectors such as waste		Expand current initiatives to upskill supervisory and technical skills within the sector to encompass middle and higher management skills, in order to build the capacity for strategic change and	

management.		innovation. Support the development of networks and other measures to better connect different resource efficiency activities, and create a 'critical mass' as a basis for changing external perceptions.	
Enable greater support for the demonstration and near market stages of innovative environmental services.		Provide greater assistance for demonstration and early stage environmental service innovations, including new sources of risk capital. Help strengthen, and achieve more sharing of best practice between, regional support schemes for environmental goods and services (in ways which provide incentives for individual RDAs to co-operate).	Expand current regional/national schemes to support environmental technology and resource efficiency through more focused measures to support waste sector SMEs.
Establish new drivers for environmental service innovation.	Achieve substantial take-up of a standardised, business-level, carbon and resource accounting framework (e.g. PAS 2050) which can be used for both external	Examine the scope for greater support of 'servicising' approaches, including the creation of lead markets.	Support the development of more effective commodity markets for recovered materials.

	reporting, and internal decision-making, purposes. Review the current operation of producer responsibility legislation, and take measures to make it more effective.		
Create a higher profile for resource, and especially materials, efficiency issues within Government activities.		Establish a high level mandate for resource efficiency. Enhance co-ordination between Government policies and investments at regional and local level.	Quicken the pace of current work on the development of waste protocols, and expand it to cover all major recovered materials.
Improve the information base on environmental services and resource efficiency.		Gain better data on the size and composition of the environmental services sector (including upstream resource efficiency activities).	Develop a more detailed knowledge of waste stream volumes and carbon impacts, and use these to shape policy options.

Introduction

This report has been prepared as part of the UK Government's Innovation in Services initiative. The initiative involves a partnership of the Department of Business, Enterprise and Regulatory Reform (BERR), the Department of Innovation, Universities and Skills (DIUS), and the National Endowment for Science, Technology and the Arts (NESTA), with the objective of generating "recommendations to Government on how to stimulate and support innovation in and across service sectors to enable them to meet the global challenges of the future".

The partnership selected five service sectors for research as part of the study, with environmental services being one of these. It also established five Service Innovation Steering Groups of business representatives to advise on the work and make recommendations.

The brief for the report was to prepare a brief scoping study in a very short time period (about four weeks) in order to inform – and ultimately to reflect – the discussions of the Industry Steering Group, and those of relevant Government agencies. Because of this constraint, UK CEED was asked to analyse only two current sub-sectors of environmental services, with contrasting characteristics (see Appendices 2 and 3). Environmental consulting services often operate across national boundaries, are primarily about the provision of expertise and advice, and are therefore people-based. Waste management services operate primarily within national markets, involve physical activities such as collection, storage, sorting and disposal, and are becoming increasingly capital-intensive.

The lessons from these sub-sectors have been synthesised with desk research, and with interviews of sector experts, to draw more general conclusions. As the report does not consider carbon and energy issues in detail it is inevitably focused on the topics of resource efficiency, and environmental assessment and protection.

Two further aspects of the brief were a requirement that the study focus on service innovation (rather than technological innovation, which has been the subject of most previous work on environmental goods and services), and on practical measures which might be adopted by Government.

The analysis and set of policy recommendations which have resulted have been validated by the Steering Group, and by feedback from industry experts. Hence, we are confident that they provide a robust platform for further consultation about the role of environmental services within the Government's broader service innovation initiative.

1. What are Environmental Services?

Defining and analysing environmental services is not easy, for three reasons:

- They are often closely related to environmental goods, either in reality (e.g. a manufacturer provides free advice to customers), or in economic analysis (e.g. another supplier provides the same advice as a charged service, but the revenues are nonetheless treated as a sale of goods);

- A substantial amount of service-like activity that is aimed at environmental mitigation is undertaken by suppliers from other sectors as part of a broader offering (e.g. the boxed examples of remanufacturing services at Caterpillar, and solvent management services at Safechem);

- Many environmental services that are provided by external suppliers can also be undertaken in-house (e.g. one firm employs a consultancy to undertake a strategic review, whereas another uses internal staff).

A further complication is that, in environmental debates, the term has an additional meaning of the provision of a final 'service' or function to customers. The term 'servicising' is therefore used to describe approaches aimed at supplying the same or enhanced functionality as ownership of a physical good through alternative means which have greater resource efficiency, and other environmental benefits (James and Hopkinson, 2002; Rothwell, 2007). An example is replacing the 'mobility' service provided by ownership of a car with participation in a car sharing scheme, or the 'virtual mobility' of videoconferencing. Only some of the additional value created by these changes may be captured through marketable services (which may or may not be logged as environmental by statisticians).

One useful distinction when discussing environmental services is their differing relationship to physical processes or products:

- 'Heavyweight' environmental services are very physical in nature, and have similarities to manufacturing or mining in their throughputs of materials, processing technologies and skill requirements, e.g. contaminated land remediation or waste management;

- 'Lightweight' services such as environmental consultancy form part of a broader category of what service innovation economists call 'knowledge intensive business services' (KIBS), such as engineering or management consultancy;

- 'Middleweight' services have a significant physical aspect, but also a high level of knowledge intensity, e.g. pollution monitoring (involving management of, and analysing results from, specialist equipment), or many 'servicising' approaches (see box on chemical management services).

Table 2 Examples of Environmental Service Innovation

Product-related
'Add-on' services by suppliers, e.g. advice, management of inventory.
'End of life' value recovery, e.g. remanufacturing, surplus inventory disposal.
New products optimised for service use, e.g. instrumentation, sharing.
Process-related
New separation technologies for contaminated soils or wastes.
Collection and analysis of information.
Substitution of electronic for physical processes.
Marketing-related
New distribution channels for recycled/reused goods and materials.
'Servicing' solutions involving changes in customer behaviour.
Organisation-related
New forms of contractual arrangement (e.g. leasing rather than sale).
New kinds of partnership between service providers, customers and others.

Metamorphosis at Caterpillar as Remanufacturing Takes Off

Caterpillar's $1 billion turnover remanufacturing division is growing at 12-15% a year and is more profitable than many of its conventional manufacturing operations. The main reason is that remanufactured products, such as diesel engines, can have 85% lower energy costs, and 60% lower materials costs, than new equivalents. Caterpillar's Shrewsbury plant now processes 15,000 'end of first life' car, truck, plant, rail and marine engines and parts a month. 40% of these were originally built by other companies (CRR, 2007). Achieving this scale has involved customer incentives for returning worn-out products, and many advanced – and in some cases patented – technologies, including software systems to detect metal tolerance, blasters to remove dirt and paint, and metal sprayers to provide millimetre thick coatings of chrome and nickel.

Caterpillar sees particularly attractive growth prospects in Europe. Although remanufacturing is already substantial (remanufactured car parts alone were worth over £2.5 billion in 2005), the industry is more fragmented than in the US (Time, 2007). New regulations – such as the requirement of the End of Life Directive, which requires 95% recovery of car parts by 2015 – will also increase the supply of raw materials. In addition to in-house remanufacturing, Caterpillar anticipates more work providing advice on – and in some cases management of (as it already does for Land Rover) – remanufacturing services in other companies. This will include redesigning 'first life' products to enable remanufacturing, as Caterpillar already has done by making its cylinder heads slightly larger to allow for repeated remilling. Experts also foresee a lucrative business in 'refreshing' cars after initial leases so that they can be sold as 'good as new' (Time, 2007).

2. Why Does Environmental Service Innovation Matter?

Environmental services have four key contributions to make to UK economic and social life:

- Helping to achieve Government targets for environmental improvement, and sustainable consumption and production;

- Helping to ensure that these targets are met as cost-effectively as possible so that they do not become a burden on economic development;

- Providing high quality and secure employment; and

- Contributing to greater awareness of the imperatives of sustainable development amongst business, the public sector, and consumers.

All of these require innovation to achieve them.

As Appendix 1 shows, the scale of environmental challenges are growing, and the UK Government has set ambitious targets, many of which are a long way from being achieved. In some cases such as waste, the targets can only be delivered through the environmental services sector. In others, the sector plays a supporting role in assisting other parties to take action, for example, through consultancy support. The environmental services sector also has a vital role in supporting the Government's Sustainable Consumption and Production (SCP) objectives. The 2005 Sustainable Development Strategy document, *Securing the Future* (DEFRA, 2005), set out three key measures to achieve this:

- Better products and services, which reduce the environmental impacts from the use of energy, resources, or hazardous substances;

- Cleaner, more efficient production processes, which strengthen competitiveness; and

- Shifts in consumption towards goods and services with lower impacts.

The scale of investment required to meet these targets and objectives is enormous, and growing, as two examples indicate:

- The Stern Review (2006) on climate change stated that the costs of meeting its target for global carbon levels would be 1% of annual global GDP by 2050, with a range of -2% to +5% of GDP. It commented that "the range reflects uncertainties over the scale of mitigation required, the pace of technological innovation and the degree of policy flexibility".

- The Environment Agency (2007) have estimated that the average cost of environmental infrastructure (water quality, water supply, flood risk management and waste) in a South East house is already £20,200, and predict that it will be much higher in future.

Although this investment will be offset by many benefits, it is clearly important that it is undertaken cost-effectively, and used to its maximum potential. Environmental service innovation can help to achieve this.

As section 4, and appendices 2 and 3 discuss, environmental services are also major employers, and account for a significant share of the 400,000 total employment of the (conventionally defined) environmental goods and services (EGS) sector. Many of its jobs are high quality and well paid (and more are becoming so), and they are also evenly distributed around the UK. Several sub-sectors such as environmental consultancy are internationally successful and therefore assist UK exports.

Environmental services can also play a vital role in the development of greater awareness amongst business and consumers which is the key foundation of environmental improvement (CBI, 2007). In the case of business, innovations which enable consultancy services to have greater strategic impact can help environmental issues become part of 'corporate DNA' (CBI, 2007). In the case of both business and consumers, 'servicising' approaches can provide new alternatives which encourage behavioural change in ways that do not involve economic or psychological sacrifice.

3. Research on Environmental Service Innovation

Environmental services lie within two separate fields of innovation research – that into service innovation in general, and that focused on environmental innovation *per se*.

Most relevant work on general service innovation has focused on 'knowledge intensive business services', and a few studies have examined environmental consultancy within this framework (Miles, 2000). A recent review of the field for the European Commission identified a "growing consensus that acknowledges the increasing complex and multidimensional character of innovation not only in services but also in manufacturing. This includes the increasing 'encapsulation' or bundling of services and manufactured goods into 'solutions'. This also recognises the major changes that have occurred in managerial practice, and the shift away from 'manufacturing' versus 'service' companies, towards organizations focused on the realisation of value. This has moved the focus of research away from technologies to knowledge, and away from individual firms towards understanding value chains or networks, locating service and manufacturing in a set of interrelated activities" (Expert Group, 2007, p. 15).

These twin themes are echoed in research on environmental innovation, e.g. that resulting from the ESRC's Sustainable Technology programme (Monaghan and Steward, 2006). Much of the work undertaken under it – and a number of other studies – have defined innovation as an expansion of the scale and connectedness of supportive 'socio-technical' networks, with the associated creation of market opportunities (Conway and Steward, 1998). As noted in section 1, a sub-strand of environmental innovation research (which has mainly focused on products, processes and consumers) has also examined the potential for 'solutions' or 'servicising' approaches.

Miles (2007) has identified four broad facets of service innovation – type, management, context and agents – which provide a useful framework for more detailed discussion of recent research.

Varying Innovation Agendas in Environmental Services

Different areas of environmental services have different innovation features. For example:

In 'heavyweight' services such as waste management, innovation is focused on technical processes (which are often linked with new products created by suppliers), and organisation, in the form of new contracting arrangements (e.g. to achieve economies of scale or scope, better risk management of complex activities, or incentives for customers to change behaviour).

In 'middleweight' services, the main foci are on new products (e.g. more effective instrumentation, or designed to facilitate servicising approaches), and marketing and organisational innovation (e.g. new kinds of contract to facilitate shared use or 'end of first life' recovery).

In 'lightweight' services such as environmental consultancy, the main foci are new ICT-based processes to capture and analyse information, and marketing and organisational innovation (e.g. to achieve economies of scale or scope, or better access to key decision-making processes).

3.1 Types of Innovation

The OECD (2005) definition of service innovation distinguishes four main forms – in products, processes, marketing and organisation. With regard to the first two, a key distinction in the sustainable technology literature is that between 'end of pipe' and 'cleantech' approaches. The former accepts the creation of wastes, and treats them with the safest and most economic technologies. It involves some recovery of materials for recycling or reuse (enabled by some limited redesign of products), but only in relatively low value ways. Cleantech approaches aim to change industrial processes and the design of products so that much less waste is produced, and higher value recovery options are feasible (e.g. remanufacturing of products for a second use after their first use is completed). Achieving this requires reshaping consumption as well as production. Many studies have concluded that the scale of environmental challenges requires a much faster move towards clean technologies than has occurred to date. They also argue that a key part of achieving it is a 'servicising approach' which restructures product-service systems to achieve greater sustainability.

Most current (conventionally defined) environmental services have been developed in an 'end of pipe' context. Hence, their offerings have been focused on clean-up and disposal, and their relationships with clients have been typically limited and relatively short-term – often summarised as a 'contracting culture'. This is now changing, partly because the scale of the challenge in some areas such as municipal waste requires longer term relationships, and

partly because of the greater demands of 'cleantech' approaches. As a result, the potential for marketing and organisational innovation is increasing.

3.2 Agents of Innovation

The last decade has seen increasing interest in green business opportunities – many of them around environmental services - amongst entrepreneurs, financiers, academics and others. Several studies have noted that this is a feature of the UK when compared to other countries such as Germany which have more stringent and wide-ranging regulations, leading to an emphasis on compliance rather than proactivity (James, Prenn and Steger, 1997; Conway and Steward, 1998).

However, start-up and early stage businesses in all areas of environmental goods and services have had considerable difficulty in progressing to commercial success, due in part to difficulties in raising financing, and establishing credibility with customers (EIAG, 2006). Appendices 2 and 3 also demonstrate a mixed picture of innovation by established players. In waste management, for example, there has been considerable organisational innovation – especially through the emergence of long-term contracts covering a variety of wastes – which is connected with the increased risk arising from larger capital commitments, and the introduction of new processes for separation and treatment. However, many of these processes are innovative only within the UK, having been used for some time in other countries. Environmental consultancy has also seen organisational innovation, in the form of more integrated service offerings, and many new ICT-based products and processes. However, Appendix 2 notes evidence that R&D is focused on relatively short-term topics.

Much recent work on environmental innovation has argued that the large-scale and dense networks which are characteristic of mature technologies can effectively block emerging ones. A key policy implication of this research is the need to guard against this by creating and supporting innovation 'niches' – or 'lead markets' (CEMEP, 2007) - to provide opportunity spaces for the development of embryonic technologies and approaches.

Early Stage Funding Barriers Impede Recycling

Ecovonate, Ltd. was founded by architect Jose Pelli, and building project manager, Marga Pelli, in 2006 to develop 'Papercrete' - a mix of waste paper (up to 70%) and a base material (cement, sand or recycled glass) which has similar properties to plasterboard. Their business strategy sees the company's core business as a Papercrete brand, and as a supplier of expertise in its application, with production being licensed. However, to achieve credibility, and to strengthen its bargaining position, Econovate wanted a patent, and fully tested prototype products, before approaching investors or licensees.

Initial inquiries about funding support to Business Link, and (via WRAP) the Recycling Commercialisation Centre at Imperial College were unsuccessful, as the idea was deemed to be too early stage. The company then obtained a £3525 Small Business Grant from Remade East to cover UK patent fees, and expert advice. The latter led to a successful £230,000 application to the East of England Development Agency's Research and Development Fund, but the company was asked to find 65% (rather than the 50% it applied for). It could only raise half and so forfeited the loan. This resulted in a new strategy of seeking smaller amounts from multiple sources. A new approach to WRAP through Remade East resulted in a £20,000 grant for further patenting and IPR work, and the company is optimistic about similar sums from EEDA's Proof of Concept scheme, and the HE-based Carbon Connections Development Fund. Jose Pelli feels that "we have struggled for funding not because we have a poor concept – most potential funders believe that Papercrete has great commercial potential – but because of the lack of funding for prototyping and testing".

3.3 Management of Innovation

A key question is whether environmental service companies have an 'innovation culture' which leads them to be delivering successful new solutions to client needs, or increasing their efficiency and effectiveness of existing solutions. Whilst hard to answer in a limited study, a number of interviewees feel that the answer is mixed for the conventionally defined environmental services sector (Anon, 2007). They identify many positives, but also negatives such as:

- The way that burgeoning demand for existing services can reduce the urgency of innovating to find new ones;

- 'Contracting' cultures in many organisations which militate against longer-term investment, e.g. in R&D, and which can foster 'zero sum' approaches to customers that make it difficult to create longer-term partnerships based on mutual interest.

This mixed picture is borne out by the analysis in Appendices 2 and 3.

3.4 The Innovation Context

The innovation context includes financial systems, higher education and many other areas. In practice, however, for environmental services the role of Government is overwhelmingly important and so we focus on that for the remainder of the report. As a prelude Table 3 summarises the ways in which direct and indirect Government actions can influence innovation in environmental services.

Table 3 Government Influence on the Innovation Context

Measures	**Effect**
Direct	
Policy targets	Signal long-term business opportunities.
Environmental regulations	Drive reactive and proactive business investment to ensure compliance; Influence innovation pathways.
Environmental financial instruments (e.g. carbon credits)	Create economic incentives through new sources of revenue/new penalties.
Taxation (e.g. landfill tax)	Create economic incentives through higher costs.
Procurement	Signal medium-term business opportunities and quicken the achievement of economies of scale.
Indirect	
Resource costs	Ensure full economic pricing of resources and resource-consuming activities.
Skills	Provides capacity so that opportunities are taken, and performance is good.
R&D	Identifies potential innovation opportunities.
Commercial Financing	Overcomes market failures in providing initial or early stage capital.
Business Support	Provides advice and other assistance to assist entrepreneurship.

4. Sectoral Features of Environmental Services

As noted above, environmental services are difficult to distinguish from environmental goods, and most economic analyses focus on the totality of environmental goods and services (EGS). The global market for these was estimated to be worth $548 billion in 2004, and is expected to grow by 45% by 2015 (EBI, 2004). The broadly synonymous European 'eco-industry' sector has also been estimated at 227 billion euros (Ernst & Young, 2006). The UK currently represents around 6-8% of the global total, with an actual value of £25 billion in 2005, when approximately 400,000 people were employed in

17,000 companies (DTI, 2006a). Forecast growth to £46 billion by 2015 would increase this share to near 10%.

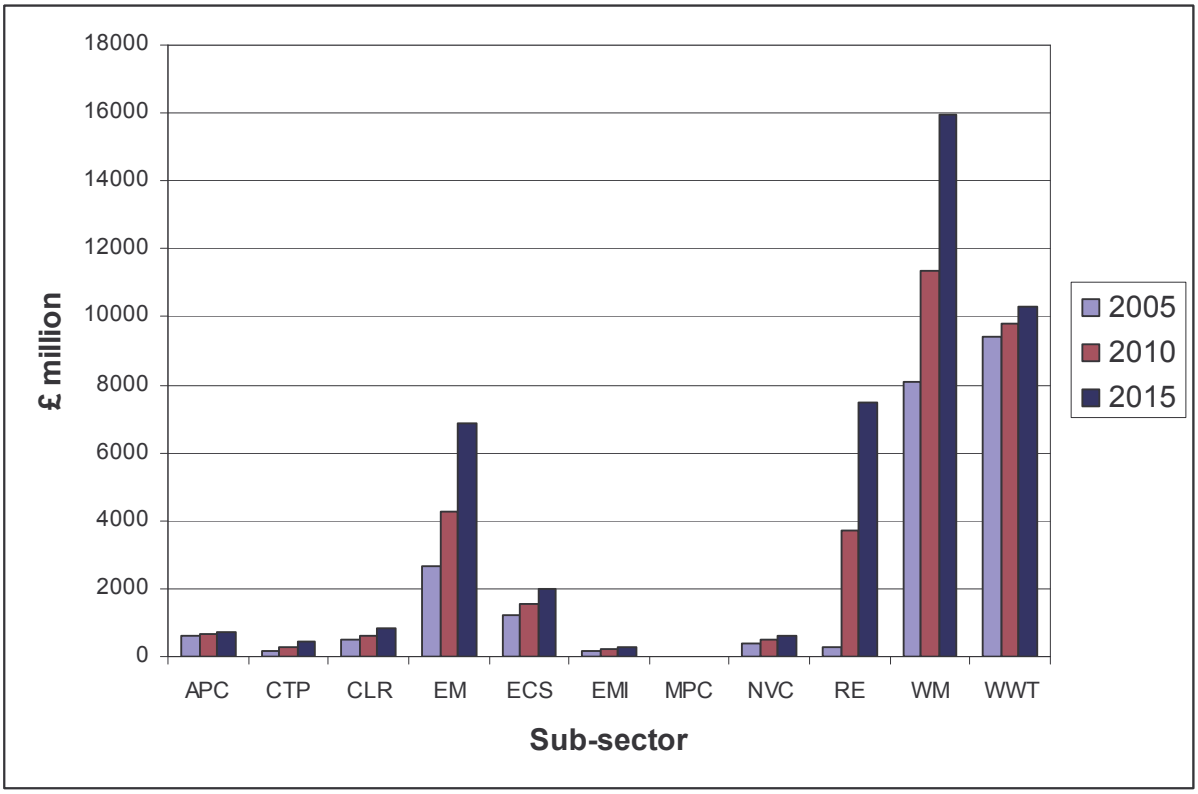
This growth seems likely to persist into the very long term. The Stern Review (2006), for example, argued that the markets for low-carbon, high-efficiency goods and services are likely to be worth at least $500bn per year by 2050, and perhaps much more.

As chart 1 demonstrates, even a broad differentiation of sub-sectors demonstrates that environmental services are an important part of UK EGS activities. The chart shows too that environmental consulting services and waste management are both sizeable sub-sectors, and have grown at double digit rates since 2000, and that this seems likely to continue. Appendices 2 and 3 analyse their market features in greater detail. Some salient points which emerge from this detailed analysis are:

- The environmental services market is very fragmented - although consolidation is occurring, there are only a handful of large–scale enterprises and these specialise in particular sub-sectors;

- There is a 'hidden' sub-sector positioned between products at the end of their first life, and their ultimate disposal as waste – remanufacturing alone has a UK turnover of £5 billion; and other activities focused on materials efficiency and waste minimisation within business (e.g. closed loop systems for solvents such as that described in the Safechem box) are also growing substantially.

Chart 1: UK EGS Growth by Sub-sector 2005-2015 (DTI, 2006a)



Key: *APC: air pollution control; CTP: cleaner technology and processes; CLR: contaminated land remediation; EM: energy management; ECS: environmental consulting services; EMI: environmental monitoring and instrumentation; MPC: marine pollution control; NVC: noise vibration control; RE: renewable energy; WM: waste management; WWT: water/wastewater treatment*

Business Reacts to Chemical Networks

Chemical management services (CMS) involve suppliers taking over some or all of the responsibility, and management tasks, of chemical storage, use and disposal within customer's facilities. Their expertise can then achieve resource efficiency through better inventory management to use all chemicals before their 'best before dates', improved quality and efficiency of application methods, and increased recycling and reuse. The incentives to reduce waste are highest when CMS providers are paid for performance – e.g. number of car bodies painted to an acceptable standard – rather than on an activity or volume basis.

CMS are used in 50-80% of the US auto industry, and 35% of the US electronics industry, and create well-documented environmental and financial benefits (CSP, 2007). At the Spring Hill plant of General Motor's Saturn division, for example, a CMS programme reduced chemical purchases by 30%, with similar reductions in waste volumes. One reason for a slower take-up in the UK is a less onerous financial liability and regulatory regime. Another is a lack of supportive networks such as the Chemical Strategies Partnership, which brings industry together with NGOs to build credibility and share experience (James and Hopkinson, 2002; Mont, Singhal and Fadeeva, 2006).

Proactive Responses to Regulation Drive Recycling Success

Five years ago, perhaps as many as a third of the UK's car dismantlers were unlicensed, or inappropriately licensed (ERM, 2002). The implementation of the End of Life Vehicles (ELV) Directive has forced many of these to shut down or lift their standards. A large percentage of the remaining dismantlers have joined the 'CarTakeBack' scheme, which offers them training, insurance and other services to help them comply with the regulations. Part of this package is automotive depolluting equipment supplied by Seda, an Austrian company that has been producing such equipment for a decade. It is in this position because Austria not only implemented the Directive early, but anticipated it through a 1996 industry initiative (European Commission, 1997). This enabled Seda to develop the innovative solutions which it is now exporting.

5. Drivers of Change and Competition in Environmental Services

As Appendix 1 shows, the scale of environmental challenges are growing, and so therefore are the demands of environmental regulation, which is the dominant factor in shaping environmental services markets.

Almost all discussion of the relationship between environmental regulation and innovation focuses on EGS generally. Some key issues within this debate are the:

- Extent to which innovation, and associated competitive advantage, can be gained through proactive regulation, e.g. the House of Commons Environmental Audit Committee has argued "that adopting more stringent domestic regulations, in particular aimed at cutting carbon emissions, could strengthen the long-term prospects of the UK economy by encouraging the development of new industries — industries which will be in ever-greater demand as oil prices rise and the world moves towards a low-carbon future" (EAC, 2006);

- Optimal balance for innovation between 'command and control' legislation and market-based approaches such as taxation and emission trading schemes;

- Value of adopting long-term targets to signal desired innovation pathways;

- Best means of implementing the European Directives which drive much UK national legislation (with a common argument being that these are implemented in 'gold plated' ways which stifle innovation as well as creating unreasonable cost and time burdens upon industry);

- Extent to which 'market pull' factors (of which regulation is the main kind) can drive innovation by themselves, or whether supplementary or alternative 'supply push' actions are also necessary.

During 2007 a series of business-influenced reports (especially CBI, 2007; and CEMEP, 2007) appear to have created a consensus around some of these issues, summed up in the desire for regulation that is "long, loud, and legal', i.e. applied over a significant timescale, building confidence that it will be maintained, and given credibility through legal requirements. This consensus was certainly shared by the Steering Group.

The specific relationship between Government policies and regulations, and innovation, varies by sector. For example:

- In waste management, key issues include the nature of long-term contracts for municipal waste, and regulatory and taxation impacts on the markets for recovered materials;

- In environmental consultancy, key issues are the general credibility of all regulation, and the need for underpinning with standardised carbon and resource accounting frameworks.

Other drivers identified in appendices 2 and 3 include:

- Development of 'cleantech' approaches to environmental mitigation;

- Rising resource prices, and concerns about resource security (especially important to the 'hidden' resources efficiency sector, such as remanufacturing);

- Growing integration of environmental issues into strategic agendas.

6. Key Innovations in Environmental Services

The environmental services sector faces unprecedented challenges in helping to deliver the ambitious environmental targets of the Government, which in turn reflect the broader demands of sustainable development for business and society. As appendices 2 and 3 illustrate, these challenges require innovation with regard to the:

- Development of know-how and service solutions to meet emerging environmental requirements such as sustainable production and consumption, better waste minimisation in product design and production/manufacturing systems, and higher levels of resource recovery and renewable energy utilisation (ICE and IMechE, 2006);

- Creation of large-scale physical infrastructures – especially for handling and processing waste - across the UK;

- Scale-up and widespread deployment of many physical technologies (in some cases already proven, but in others still needing demonstration), for example, in materials separation and recovery, renewable energy and soil decontamination;

- Development and deployment of ICT-based methods such as carbon and resources accounting systems to measure and analyse usage within organisations and sectors, and new kinds of 'intermediary' activities involving collection, aggregation and analysis of data;

- Creation of new kinds of economic arrangements, including the provision of a range of integrated services, forging partnerships with other suppliers, customers and Governments, and developing new contractual arrangements for service-based solutions.

At the same time, the sector must:

- Achieve higher added value to finance much greater levels of investment, and development of, skills and technical capacity;

- Achieve higher levels of efficiency and effectiveness in order to minimise cost burdens on customers and the economy as a whole, and to maintain and improve international competitiveness;

- Drive the move towards clean technology and waste minimisation within the economy as a whole.

Key Technologies for Environmental Services

A study commissioned by EIAG considered which EGS technologies should be prioritised in Government support (EIAG, 2005). The study assessed 22 technologies, in 5 generic categories, in terms of their scope for technical innovation, their market potential, the existence of a competitive UK supply base, and their suitability (in terms of development stage) for Government support. It concluded that two of the generic categories – both of which are very relevant to environmental services - were priorities for Government support, for different reasons.

One - which scored highly on all criteria - was data capture and management (encompassing remote monitoring, sensing and controlling, real time monitoring/warning systems, and intelligent diagnostic and prognostics). The other was waste separation and recovery, where the UK was felt to have "fundamental weakness in how to re-claim, recycling or re-use resource material, including for energy production". The former was felt to merit Government support because of the potential business opportunities, the latter because its importance to national environmental objectives meant that its performance had to be improved. A subsequent analysis of key technologies for sustainable production and consumption for the DTI (2006b) also concluded that energy recovery and recycling were the areas where R&D was weakest.

7. Performance and Barriers

As noted above, most environmental services sectors – and certainly those analysed in appendixes 2 and 3 - are experiencing rapid growth.

There is growing availability of capital from private equity and other investment funds, banks and overseas companies for many areas of EGS, which are seen as having relatively high and often secure returns all (Forum for the Future, 2006). UK CEED's EnviroDaq index of UK-listed EGS sector companies (defined as those which derive at least 60% of their turnover from EGS activities) has also seen the number of companies double from 50 to 100 over the last 12 months. However, much of this investment is in market solutions, rather than demonstration and near market areas. It is also difficult to estimate the proportion of investment that is being devoted to environmental services, as opposed to environmental goods.

7.1 Research and Development

Although there is no specific data on R&D in environmental services, comparisons of R&D expenditure on all forms of environmental protection provide interesting background. A recent report (OSI, 2005) calculated that UK R&D spending in this area in relation to GDP (1.8% in 2004) is well below Germany (3.29%) and France (2.95%), but well above Japan (0.87%) and the US (0.48%).

Part of this research is publicly funded by funding councils and other bodies. A recent report by their co-ordinating organisation, the Environmental Research Funders Forum (2007), calculated that its members directly spent over £260 million on environmental research and £23 million on environmental research training in 2004-05. In addition they made well over a £200 million contribution to the additional costs of maintaining research infrastructure. However, only a small proportion of this was related to the key environmental service areas of waste (2.9% of research, and 0.7% of training) and energy (1.9% of research and 1.7% of training). In the case of energy, there is undoubtedly considerable research carried out by other funders, but this is unlikely to be the case with waste. However, programmes such as the DTI's Technology Programme have been giving increasing support to waste-related development and demonstration.

A study by Enviros (cited in DTI, 2006a) also found that 17% of environmental goods and services companies spent over 20% of their turnover on R&D, and another 30% spent 5-20% on R&D. However, this study was biased towards research oriented companies, and included biotechnology in the environmental industry. And again, waste management had one of the lowest research intensities of the EGS sub-sector.

7.2 Innovation Warnings

The Environmental Innovations Advisory Group (EIAG, 2006) has sounded a note of caution with regard to relative performance in EGS as a whole, noting that: "Recent comparative data with our international competitors is limited but during the 1990s the UK's export growth rate was half that of its US and European competitors … Moreover the market shares achieved by Germany and France, normalised to their GDP, are around 50% higher than the UK's share". It concluded that the EGS sector faces a stark challenge: "To enhance our market share we need a step change in our innovation performance - doing better will not be enough: we need to be better than the rest. This is especially so in the rapidly growing market for cleaner technologies where we are starting from a low base. But it is also important in areas of relative strength, such as the more mature markets for pollution control where we risk losing ground to more innovative competitors and lower-cost new entrants."

The Stern Review (2006) noted additionally that, at a global level, "public spending on research, development and demonstration (related to climate change and energy efficiency) has fallen significantly in the last two decades and is now low relative to other industries. There are likely to be high returns to a doubling of investments in this area to around $20 billion per annum globally, to support the development of a diverse portfolio of technologies".

7.3 Barriers to Innovation

The Environmental Innovations Advisory Group surveyed the views of over 100 environmental businesses on barriers to innovation in the EGS sector. It identified a "wide degree of consensus" that the four main barriers as being procurement procedures, access to finance, testing and certification procedures, and government regulations (EIAG, 2006). The main issues identified were:

- Procurement – which can lock public sector purchasers into conventional specifications, and so discourage more radical options which need scale-up to achieve commercial viability;

- Access to finance – the procurement constraints combined with unpredictable changes in government policies and regulations make it difficult to create robust business plans to attract investors for long-term investments, even though there is considerable potential funding;

- Testing and certification – purchasers of many EGS are risk averse as they are buying to meet regulatory requirements and so they prefer thoroughly tested and certified offerings, creating problems for companies (especially SMEs) bringing new products to market;

- Environmental regulations – with problems including delays in implementation and/or watering down of requirements (especially serious when they occur at the last minute), and specifying old technologies and weak performance requirements.

The EIAG also felt that skills shortages were an equally important barrier, despite the fact that respondents rated them less highly.

Its overall conclusion was that: "Innovation requires, first and foremost, information from the customers about what they need and to know that existing products do not meet that need …. If policy and regulations are backward looking and do not anticipate that the future can be better than the past then there is no reason to procure new (and by definition riskier) products as their better performance is not required (EIAG, 2006)".

The discussions of the Service Innovation Steering Group, and additional interviews, suggest that – although Government has made some responses - the EIAG analysis remains broadly accurate, and many of the recommendations remain to be implemented. The EIAG analysis is also underpinned by a number of other studies reaching similar conclusions about innovation potential, barriers and enablers, and possible Government actions for EGS (CEMEP, 2007; CBI, 2007). The main concerns of business are that some of these actions are not being taken quickly enough, or in a sufficiently integrated way, to make a difference in practice.

Support Activities for EGS Innovation

These include:

- Three Knowledge Transfer Networks on environmental technologies (Environmental (formerly Integrated Pollution Management), Low Carbon and Fuel Cell Technologies, and Resource Efficiency);

- The DTI/BERR Technology Programme, which amongst other activities has provided almost £50 million of funding for ECG-related Collaborative Research and Demonstration projects;

- The Technology Strategy Board - responsible for £1 billion of investment in collaborative R&D since 2004 – which has financed work on its priority themes of energy and resources efficiency, sustainable water technologies, and waste and pollution management;

- A WRAP-funded Recycling Commercialisation Centre at Imperial College.

The EU has also published an Environmental Technology Action Plan. Approximately €2.1 billion is allocated for environmental R&D under this and the 6th Framework Programme for Research.

Establishing a Long-term Innovation Vision

The Fourth Dutch National Environmental Policy Plan stated that its ambitious targets - such as a 40-60% cut in CO_2 emissions by 2030 from 1990 levels – required innovation 'forcing' to restructure existing socio-technical systems. It therefore established transition platforms, which brought together private and public sector actors to develop a vision and pathways, and to suggest 'experiments' to make them happen. However, a recent analysis of their impact on energy by the Science Policy Research Unit has concluded that, despite some achievements, "it seems unlikely that the energy transition in its current unbalanced form will achieve its original goal of system innovation", largely because the difficulties of avoiding 'capture' by established players (Kern and Smith, 2007)

The California Zero Emissions Vehicle (ZEV) programme, established in 1990, has set long-term targets – originally of ZEVs forming 10% of manufacturer's car sales within the state by 2003, although that was later downgraded. A recent analysis by the Public Policy Institute of California (Bedsworth and Taylor, 2007) has concluded that "overestimation of the potential of advanced technology led to significant changes in the program when the potential went unfilled. These changes resulted in an extremely complex program and a weakened demand signal for zero-emissions vehicles." In practice, most of the improvement in vehicle performance in California has come from "continued but unanticipated improvements in conventional vehicles. The report suggests that technology-neutral programmes are likely to be more effective in practice.

8. The Scope for Government Intervention

The previous discussion has identified a number of market failures which are impeding innovation in environmental services. They can be summarised as:

- Uncertainty about the reliability of medium-long term Government policy targets, and the future value of financial instruments such as carbon and renewable energy credits, which diminishes their 'bankability' in investment decision-making;

- Fragmented, short-term and overly prescriptive approaches to public sector procurement which prevent longer-term signalling to innovators about future purchasing requirements, thereby making it more difficult to achieve investment and the scale-up which could benefit both suppliers and purchasers through economies of scale;

- Current capacity and skills in some environmental service sub-sectors, especially waste management, is inadequate to develop and manage the more complex supply chains and technologies which are needed to meet Government targets and market demands;

- Difficulties for innovators in finding adequate commercial funding, and overcome other barriers, at the demonstration and near market stages of new technologies and services;

- Insufficient awareness of, and incentives to adopt, innovative environmental services in business and the broader economy, potentially damaging international competitiveness and making it difficult to achieve Government policy targets.

These are broadly in line with the conclusions of other recent reports such as those by the CBI (2007) and CEMEP (2007). The service innovation focus of this report has also identified two 'policy failures' which are particularly relevant to environmental services. These are:

- Insufficient profile of, and 'weight' given to, resource, and especially materials, efficiency issues within Government;

- A poor information base on environmental services and resource efficiency (which is a contributory factor to the previous point).

The following sections elaborate on these, and describe possible policy responses.

8.1 Creating Market 'Bankability'

The Government's 'signalling' of expectations about future targets, regulatory regimes, market circumstances and technical trends can have a powerful impact on innovators. If credible, it can motivate investment in the expectation of future rewards. On the other hand, a failure to act upon these projections can greatly undermine credibility. The importance of this issue for innovation has been highlighted by the Environmental Innovation Advisory Group (2006) and was perhaps the most important topic within the Steering Group discussions.

Government credibility is especially important in waste management, where an under-capitalised industry has to make huge investments to meet policy targets. The current feeling amongst many operators, and most of the largest ones, is that there is not sufficient 'bankability' to make these investments easy to achieve (Steering Group, 2007).

Several past reports have suggested that a desirable means of signalling is for Government to establish a long-term vision in key environmental innovation areas, identify innovation pathways towards it, and establish targets to monitor and drive progress (for example, Anderson *et al.*, 2000; EIAG, 2006). However, two recent studies of widely cited overseas initiatives - the Dutch 'transitions' policy and the Californian Zero Emissions Vehicle (ZEV) programme – suggest, at the very least, the need for caution, at least with regard to their ability to drive innovation in environmental services (see box).

An alternative suggestion for signalling commitment which emerged from the Steering Group discussions is guaranteed minimum prices for key financial instruments such as carbon certificates and credits from the Renewable Energy Commitment (ROC). In the case of carbon, for example, the CBI (2007) has estimated that a price of 40 euros per tonne of carbon dioxide equivalent is needed by 2030 to meet the Government's targets. Guaranteeing a price of even 20 euros for key innovative investments (with appropriate clawback if prices rose higher than this) would not only help them, but also send a strong signal about the Government's long-term commitment to an effective carbon market.

Additional measures which interviewees have suggested would increase the credibility and effectiveness of Government policies and measures are:

- Tax breaks for recovered materials;

- A more favourable tax regime for 'servicising' approaches;

- Enhancing co-ordination between Government policies and investments at regional and local level in order to achieve better optimisation of

energy and resource outcomes, e.g. with regard to current initiatives on 'zero carbon homes' and 'sustainable eco-cities';

- A ban on disposal of all recoverable materials to landfill.

8.2 Improving Procurement

The Environmental Innovations Advisory Group (EIAG, 2006) argued that: "It is the lack of credible articulated demand that is at the root of the relative failure of innovation in the UK environmental goods and services sector not any lack of research, invention or innovative aspirations. EIAG believes the solution lies in Government taking action to mobilise the supply chain to deliver environmental innovations. And this means moving from a focus on R&D and technology push to a focus on intelligent supply chain management".

One key action of this kind - which could also help to provide more bankability - would be greater support for Forward Commitment Procurement. This has been recommended by both EIAG and the Sustainable Procurement Task Force (2006), with the latter arguing that: "Government must lead the public sector in setting forward commitments to purchase innovative solutions and establish clear routes to public sector market for suppliers of innovative solutions". By focusing specifications on outcomes rather than specific products, and by earlier market engagement, Forward Commitment Procurement has the potential to provide greater market visibility for innovators and better and more sustainable solutions for buyers (in part because vendors are more willing to invest to achieve economies of scale).

The joint BERR/DEFRA Environment Industries Unit (EIU) has been working with procurement professionals and The Office of Government Commerce (OGC) on demonstration projects with HM Prison Service and the London Fire and Emergency Planning Authority. The former involves specifications for a zero waste mattress system, and the latter a sustainable disposal solution for non-recyclable waste arising from its fire stations. The trials appear to be going well, and there is therefore a strong case for a more rapid roll out of the approach. It could also be of great relevance to other areas where Government is procuring non-environmental services.

Additional proposed actions to support sustainable procurement which have emerged from Advisory Group discussions include:

- More Government persuasion - through mechanisms such as circulars and greater release of PFI credits of local authorities - to introduce more outcomes based municipal waste contracts (rather than reducing supplier flexibility to innovate by tight operating specifications);

- Easing the unlimited liability requirements of many waste tenders, possibly by introducing some kind of collective insurance scheme;

- Allowing municipal waste treatment centres to process commercial and industrial waste, subject to safeguard against unfair competition and stifling of innovation.

8.3 Improving Capacity and Skills

As discussed above, skills shortages are a considerable barrier to innovation. The shortages are of two kinds. One is technical skills such as software or waste technology. The other, especially important in waste management, is the business-related skills which are needed to transform a very traditional, contracting-based, sector into one which is proactive and creating higher added value.

The Energy and Utilities Skills Sector Council (EU Skills) has emerged as the lead body for most environmental services sectors, thereby neutralising previous criticisms that skills responsibilities were fragmented between 8 Sector Skills Councils. It has undertaken a number of initiatives, including proposals - in partnership with the Environmental Services Association (ESA) – to change the regulatory requirements for the operation of waste management facilities in order to reflect the changed nature of the industry (especially the emergence of large multi-site operators), and to provide greater operational flexibility. This would then create changes in training requirements, for which the partnership has made specific recommendations. The Chartered Institute of Waste Management (CIWM) and the Waste Management Industry Training and Advisory Board (WAMITAB) have suggested a slightly different approach, and the likely outcome will be a situation of different accreditation routes to meet more flexible regulatory standards.

However, these initiatives – and others addressing sector-specific technical and management skills - will not solve the broader issues of developing innovation-related skills. These skills are needed to assimilate external developments (especially with regard to broader energy efficiency and waste minimisation perspectives, and more application of advanced data management and other ICT applications) into the sector, and to contribute to the required cultural changes in the waste management sub-sector.

The increased emphasis on resource efficiency will also require the further development of relevant skills with regard to process engineering, product design and other areas.

Filling these skills gaps may be difficult in some sub-sectors, especially waste management, because of a poor image – 'Steptoe and Son' in the words of one interviewee - which hampers recruitment. Repositioning this and related activities as part of a broader 'materials efficiency' sector could help to

ameliorate this by creating a more positive brand, and providing a greater sense of positive long term career prospects.

8.4 Greater Support for Innovation Implementation

Research is typically only a small proportion of the total costs of innovation. The Environmental Innovation Advisory Group (EIAG, 2006) argued that the greatest need for Government support was at the demonstration and early market stage, and identified several ways in which Government could do more:

- Assist the development of low cost early stage innovation assessment approaches (covering financial and operational, as well as environmental, performance) which could provide some validated information to investors, customers and others without the often prohibitive costs of full scale certification and testing procedures;

- Help establish a business mentoring scheme specifically aimed at the EGS sector;

- Press for changes in European Union State Aid policies to make it easier to fund demonstration projects.

None of these suggestions have materialised to date (although in the case of State Aid the Government has been making the case through diplomatic channels), yet the Steering Group discussions suggest that all remain of potential value to environmental services innovation.

One area which has seen encouraging growth is initiatives to support EGS innovation by regional development agencies. These differ in the extent to which environmental services (as opposed to goods) are targeted, the way in which support is organised, and the type of support which is offered. In two cases this has involved financial and other support for wide-ranging independent organisations:

- The NorthWest Regional Development Agency has supported Envirolink, a not-for-profit company formed and directed by business leaders from the regional environmental sector, since its birth in 2000. Envirolink provides a wide range of support for innovation and business development, including a new Waste Sector Support initiative which, amongst other activities, provides financial support for demonstrator projects;

- The South East Economic Development Agency (SEEDA) assisted the development of Envirobusiness in 2005.

Two other development agencies have also provided considerable assistance to alone bodies, but with a more specific focus:

- The East of England Development Agency has supported the Centre for Sustainable Engineering, which focuses on environmental technologies;

- Yorkshire Forward has established Future Energy Yorkshire to support innovation in renewables and other energy sources.

The latter has also established 12 Centres for Industrial Collaboration, including one on Environmental Technology at the University of Hull, to create better links between business and academia. These were short-listed in summer 2007 for the 'Best European Innovation Programme' Award.

Although such diversity is inevitable, and probably positive for innovation by testing a variety of different approaches, there is scope for more cross-regional collaboration, knowledge transfer, and sharing of best practice so that the more successful approaches can assist a wider range of companies. This process has already begun through the activities of the UK Forum for Environmental Industries (UKFEI, 2007), and other means, but should be given even greater priority.

Despite these initiatives, our interviews suggest that it remains difficult for innovators to find risk capital for the demonstration and near market stages of new technologies and skills (KTN, 2007). This is particularly the case when the investments required are relatively small, and therefore below the thresholds – which can be as high as £5-10 million - of some clean technology capital providers.

8.5 New Drivers for Environmental Service Innovation

The Steering Group discussions focused on two of these – standardised accounting frameworks for carbon emissions, and the creation of 'lead markets'.

The Aldersgate Group (2007) has observed in a recent report that: "Carbon emissions are now a financially material commodity with an economic and financial value to business, investors and the city. They need to be properly defined, measured, accounted for, audited and reported in the same way as other physical commodities and financial instruments". This would help to achieve the accurate picture of the true financial position of companies which is the aim of financial accounting. Noting the current lack of comparable, standardised, measures of carbon emissions, the report proposes that the Government prioritise the development of a common standard, and use this for all activities within its control, including procurement and financial regulation.

Chipping Away at Composting Innovation

Family owned business Mytum & Selby is a long established Yorkshire metal recovery and recycling business. Government targets for greater diversion of green waste from landfill threaten some of its existing contracts, and also provided an opportunity to develop new, potentially high margin, business (Lawson, 2007). In 2006 the company therefore opened a composting facility – with the potential to produce over 150,000 tonnes a year of compost - at the disused Milford Maltings site (and also reusing some of the existing equipment). In addition to its main feedstock of kitchen waste, it processes 100 tonnes a week of chipboard, which contains the hazardous material formaldehyde and is therefore likely to be banned from general waste streams and so become more expensive to dispose of. This has been achieved with assistance from the Environmental Technologies Centre of Industrial Collaboration (CIC) at the University of Hull. The Centre provided initial advice, and helped Mytum & Selby prepare a successful application to the Resource Efficiency Knowledge Transfer Network (KTN) for specialist consultancy support in the microbial breakdown of waste from University of Hull scientists.

The company is now working with the same scientists on safe methods of composting liquid food waste, which is currently classified as hazardous and so cannot be landfilled. The innovations are helping Mytum & Selby to position itself as a 'solutions provider', with the result that it is being called in to advise companies on how to optimise production processes to produce more recoverable wastes and reduce their waste disposal costs.

In addition to the external financial reporting focus of the Aldersgate Group, detailed information about carbon flows and emissions can also be of benefit to internal decision-making and activities, including investment decisions, benchmarking and marketing of products. Indeed, some business observers see a future world in which carbon emissions are reported by producers, retailers and others as routinely as is the case with nutritional labelling of food today. Improvements in these areas would almost certainly increase the demand 'pull' for consultancy and other kinds of environmental services, and stimulate innovation to reduce anomalously high emissions.

The recent launch by the British Standards Institute (2007) of PAS 2050, a draft standard on the measurement of greenhouse gas emissions from products and services throughout their life cycle, marks a significant step towards this objective and the Steering Group (2007) believes that there should be strong Government support to finalise and implement it as quickly as possible.

One key aspect of such a standardised system would be achieving a better understanding of carbon emissions associated with resource flows and waste streams. This would then support greater integration of carbon and resource

policies at national, regional and local level, and also create the potential for a new form of carbon-based financial instrument.

A recent report (CEMEP, 2007) has highlighted the potential role of Government in helping to create 'lead markets' which can give suppliers more confidence in making investments, and thereby achieve economies of scale or scope more quickly than would otherwise be the case. A suite of instruments could be used to do this, ranging from more targeted regulations in areas such as waste, to more market driven ones in others. The latter might include greater assistance for the development of effective commodity markets for recovered materials.

One area where a lead market approach could be applied is to support 'servicising' innovation. Within the last year both Japan (METI, 2006) and the USA (Stoughton, 2007) have begun studies of the potential role of this in meeting environmental targets. A European Commission study has also highlighted the potential for further development of chemical management services (or chemical product services as it is sometimes known in Europe) (IPTS, 2006). Given the environmental and business potential of this route it would be sensible for the Government to review ways of assisting its development in the UK.

A final option which featured in the discussions of the Steering Group (2007) was the potential for strengthening current producer responsibility arrangements. Although these have been successful in part, they have not yet acted as a major driver to resource efficiency.

8.6 Raising the Profile of Resource Efficiency within Government

A report by two leading engineering institutions has argued that current Government arrangements are delivering sub-optimal resource efficiency within the economy, and therefore need to be improved (ICE and IMechE, 2007). The report advocates better collaboration between key agencies and the creation of a new 'agent role' to provide leadership, communication, data management, strategic direction, planning and capacity building. It also advocates the creation of a Resource Efficiency Implementation programme analogous to the Waste Implementation Programme.

One move towards this has been the creation of a Products and Materials Unit within DEFRA as part of the 2007 Waste Strategy (DEFRA, 2007a). CEMEP (2007) has recommended that it produce a Products and Materials Strategy, with consensus based targets for resource efficiency, as soon as possible. Whilst welcome, many of those consulted feel that the Unit by itself will not raise the profile of resources and waste issues within Government sufficiently, or to achieve the political 'clout' which is needed to ensure that other actions are taken (Anon, 2007; Steering Group, 2007). The need for change is evidenced by the relatively slow progress of the

current Environment Agency-led initiative to develop waste quality protocols (see box).

One radical suggestion for change is the creation of a National Resources Agency, of equivalent status and scope to the Environment Agency. (It is also possible that such an agency could provide a high level focus for low carbon activities – including responsibility for the Carbon Trust - as well as resource efficiency ones). Others believe that a simpler solution would be to extend the Environment Agency's mandate to encompass resource issues as well as environmental protection.

Advocates of these changes believe that the possible benefits include:

- Increasing the credibility of policy initiatives in this field by demonstrating that there is a powerful voice within Government that is committed to their long-term implementation;

- Providing an alternative perspective to those with mandates for environmental protection;

- Helping to develop more 'joined up' support for resource efficiency related innovation;

- Helping to develop the supportive socio-technical networks which are required to support the radical innovations that appear to be possible within the overall resource efficiency sector;

- Making a potentially important contribution to the Government's climate change targets by highlighting the connections between waste minimisation and resource recovery on the one hand, and reductions in greenhouse gas emissions on the other.

Transmuting Waste into Useful Materials

Two key requirements for an effective recycling industry are as simple as possible processing (which can be hampered if raw materials are considering as wastes requiring special treatment), and product standards which enable waste-derived materials to be easily sold. WRAP has recognised the importance of these and devoted considerable resources to their development in various waste streams. This is helping to build confidence in customer industries – both the direct purchasers of recovered materials and the customers who buy the finished products, both of which in turn increase the market pull for recycled materials. However, progress is still being hampered by a lack of clarity and timeliness in advice and guidance from the Environment Agency about classification of materials (into waste and non-waste, and hazardous versus non-hazardous waste). Although a joint Environment Agency/WRAP initiative, under Agency leadership, was established in 2006 only one Protocol (on compost) had been published by November 2007. The Steering Group (2007) felt that this is too slow, and also that too few additional Protocols are under development.

8.7 Better Information on Resources and Waste

One reason for the relatively low profile of environmental services in debates about environmental policies and technologies is lack of information about their size and characteristics. Current SIC data makes it impossible to determine its size and composition of the sector, and its sub-sectors, even though they are almost certainly much larger than many others which have distinct SIC codings. In some cases – such as environmental consultancy services – remedying this could be straightforward. In other cases – upstream waste minimisation activities – it is more difficult but some estimate would be useful for policy purposes.

More data would also be useful on materials and waste flows within the economy. Some data already exists – such as that developed by the Mass Balance Movement (2007) – but more is needed, both at macro level and that of specific resource chains and waste streams. As one report has observed: "information on material flows is currently very poor. What is known comes from the EA's waste data compilations, of which the commercial and industrial data is far weaker in accuracy than the much smaller municipal stream" (ICE and IMechE, 2007).

Even in the case of municipal waste, a recent Friends of the Earth (2007) study has described the limitations of current knowledge about the composition of waste streams, especially from households, and how this influences policy options and associated innovation opportunities. All of the report's recommendations – for a review of waste compositional analysis work, the commissioning of a representative national survey of the full range of household waste arisings (household collected, civic amenity site and bulky wastes), integration of waste/product/material classification systems and a review of capture rates research to date – would be of benefit to innovation by providing better information on problems and opportunities.

Better information on the innovation performance of environmental services would also be useful for monitoring, and problem identification. This could draw on the definitions developed for European innovation tracking purposes - which are enshrined in the 'Oslo Manual' (OECD, 2005) – but these will almost certainly need to be 'tweaked' to reflect the sector's special features.

9. Conclusions and Recommendations

The environmental services sector is clearly healthy, and of great economic potential, but also in transition. It remains heavily dependent on Government intervention so that, unlike most other service sectors, the key question is not whether there is scope for Government intervention to support innovation, but whether the inevitable intervention which is occurring is as conducive to innovation as it might be.

Our answer to this question is – like that of several previous studies – a definite 'no'. And our analysis suggests that, unless this is addressed, the nation will find it difficult to meet environmental challenges as cheaply and effectively as it could, with consequent negative effects on the competitiveness of many sectors, and the tax burden of the public. The potentially bright prospects of the UK environmental services sector will also be much dimmer, and their share of a fast growing international market will fall.

The main answer to this situation, according to the Steering Group (2007) is less for new initiatives and ideas specifically focused on environmental services, but more the committed implementation of the general suggestions on moving to a low carbon, resource efficient, economy for which have been made by the bodies cited in this report, especially the Environmental Innovation Advisory Group and the Commission on Environmental Markets and Environmental Performance.

At a more specific level, the main ways in which Government can help to foster innovation in both the environmental services sector, and service industries in general, is to:

- Create greater long-term certainty about policy implementation, and levels of financial incentive to stimulate greater interest and investment in innovation;

- Modify procurement mechanisms to provide greater encouragement for innovation;

- Improve the skill and management capacity, and image, of the sector, and particular sub-sectors such as waste management;

- Enable greater support for the demonstration and near market stages of innovative environmental services;

- Establish new drivers for environmental service innovation, especially an effective carbon and resource accounting framework at business level, and the creation of lead markets;

- Create a higher profile for resource, and especially materials, efficiency issues within its activities;

- Improve the information base on environmental services and resource efficiency.

Many of these aims, and especially that of establishing new drivers, are also of relevance to the broader Innovation in Services initiative. As the motor of the economy, it is vital that the service sector as a whole pays greater attention to the issues of sustainable development. A clearer picture of carbon and risk impacts can help to achieve this. The potential for streamlined innovation assessments to assist in the development and early market stages of innovation which has been identified as important for environmental services is also of relevance to other service sectors.

Table 1 (which follows the Executive Summary) summarises possible policy measures which have emerged from our consultations and research, and the areas they would be targeted at. The recommendations are drawn from an initial 'shopping list' which has been the subject of a feedback process by the Steering Group and other experts. All the items on this list are mentioned in the previous discussion, but not all appear in this table as we have sought to group them for simplicity, to focus on those which appear to have the greatest relevance to service (as opposed to environmental technology) innovation, and to focus on the ones which appear to have the greatest amount of support.

One important point when considering the recommendations is their effect on the 'market for innovation'. As some areas of environmental services are heavily concentrated, some of our interviewees believe that there is a danger of Government policies to support innovation being biased towards the wishes of larger players, and/or too sectorally focused. with the danger that potentially more radical approaches from smaller scale and/or external organisations may be effectively disadvantaged (Anon, 2007). Many innovations around materials efficiency, for example, may come from manufacturers moving 'downstream'.

A further point is the two different aims of innovation in environmental services. One is the generic aim of all service sectors of greater economic success by developing new markets, increasing efficiency etc. The other is the 'environmental' aim of delivering the public policy objectives which underpin legislation – such as lowering emissions of greenhouse gases, or reducing public exposure to pollutants – more effectively. In many cases, these will coincide, but in others they may not. The following list has been prepared within the context of a Government business support initiative to stimulate greater service innovation. It is therefore focused on measures which are likely to help with these business focused objectives. If the context was environmental policy, a different mix of recommendations might have been produced.

Appendix 1 – Some Environmental Challenges for the UK

Issue	Policy	UK Target	Progress
Climate Change	Energy White Paper	60% reduction in CO_2 (from 1990 levels) by 2050 with significant progress by 2020.	In 2005, emissions of carbon dioxide were provisionally estimated at some 153 million tonnes (carbon equivalent), about 5.5% lower than in 1990 (DEFRA, 2006a).
Landfilled waste	The EU Landfill Directive and 2000 and 2007 Waste Strategies	Requires the amount of biodegradable municipal waste (BMW) sent to landfill in England to be reduced to 11.2 million tonnes in 2010, 7.5 million tonnes in 2013 and 5.2 million tonnes in 2020.	In 2006/7 11.5 million tonnes of BMW went to landfill in England, having fallen steadily from 13.9 million in 2004/5.
River water quality			In 2006 only 54% of rivers in Northern Ireland, 71% in England and 82% in Wales were of good biological quality (DEFRA, 2007b).
Air pollution	EU Air Quality Framework Directive and Air Quality Strategies 2000, 2003 and 2007	Sets health-based air quality objectives (AQOs) for nine key air pollutants and target dates for their achievement across the UK between 2003 and 2010	National AQOs for NO2, PM10 and ozone will very likely not be achieved by 2010 (DEFRA, 2006b).

Appendix 2 - Environmental Consulting Services

The environmental consulting services (ECS) sub-sector is difficult to define because it overlaps considerably with other sectors. However, its core activities are environmental audits, assistance with environmental management systems and training, life cycle assessment, environmental impact assessment, advice on environmental regulations and environmental institution building (JEMU, 2002).

A2.1 ECS Market Features

Many environmental consultancy companies form part of larger groups so that exact estimates of market size are difficult to achieve, and vary between sources. Plimsoll (2007) reports that the turnover of companies active in the sector totalled £4.3 billion in 2006. However, this figure includes all their principal activities, and overseas business. The DTI (2006a) has estimated the actual UK market at £1.23bn for 2005, and forecast growth to £1.57bn in 2010 and on to £2bn by 2015. The market has grown by around 10% annually since 2000 (ENDS, 2006) and was exceptionally buoyant in 2007 (ENDS, 2007).

The integration of environmental consultancy with other activities in many players makes it difficult to produce exact turnover figures, but it is clear that the sector is fragmented. ENDS (2007) calculates that 6 consultancies (in alphabetical order, AEA, Atkins, Jacobs, MWH, RPS and RSK) have a UK turnover of over £50 million, and another 13 have turnovers between £20-50 million. The largest player is probably RPS Group, which had a total turnover from all activities of £297 million in 2006 – a 36% increase over 2005. This growth enabled it to achieve entry to the FTSE 250 Index.

There is a high level of consolidation, driven by the demands of clients for integrated services – both with other consultancy activities such as engineering, and covering the range of environment-tasks required over the life of developments or policies – and because of the development of global consulting 'brands' (an area where UK consultancies are in the lead) (ENDS, 2007). The Plimsoll (2007) report also found that, on average, the turnover of smaller consultancies declined in 2006 – a trend which it attributed to reduced outsourcing from larger consultancies as they developed their in-house expertise, and a focus on profitability rather than revenue growth in a buoyant market.

The environmental consultancy market is linked to, and dependent on activity in, all of the sub-sectors of environmental goods and services. In 2006, the main consultancy segments were contaminated land (with a £217 million value), environmental impact assessments/strategic environmental assessments (£170 million), water/wastewater and waste management advice (ENDS, 2006). However, the balance of activities is shifting, with sustainable

energy and climate change-related activities expected to be the fast growing areas in the next few years (ENDS, 2007).

Standardised Evaluation of Contaminated Land Gases

The presence of methane and carbon dioxide in brownfield sites requires careful investigation and risk assessment. The National House Building Council (NHBC) therefore commissioned consultants RSK to develop guidelines for its internal use. The result was a manual containing practical guidelines, and an innovative colour-coded system to highlight the most scientifically sound investigation techniques for different types of site. This proved so useful that the Council made it publically available, and the Construction Industry Research and Information Association (CIRIA) adopted the concept in its own guidance. The document has since proved to be the most popular download from the NHBC's site, and won RSK the Best Conceptual Design category at the 2007 Brownfield Briefing Awards. The guidance has also been used by partner consultants ERM, and helped them to win Best Verification Project category in the same Awards. George Fordyce, Head of Engineering Policy, NHBC, believes that "there was a lot of advice out there but it wasn't in a simple, straightforward and digestible form … People don't just want to know all the background and good science, they want to know 'what do I actually do on my site', and that's what the document sets out to do (RSK, 2007)".

A2.2 Drivers of Change and Competition

The drivers of change and competition in environmental services are summarised in Table A2.1, using the widely used PESTLE (Political, Economic, Social, Technological, Legal and Environmental) framework. However, although many specific factors can be identified, surveys of consultancies suggest that they see legislation and enforcement, and to a lesser extent new developments and infrastructure, as the key drivers of their business growth (see chart A1).

Legislation and its enforcement drives the markets for environmental consultancy because it typically requires specialist advice on how to meet it, and in some cases – such as contaminated land – operational and project management support.

A second driver is the emergence of environment as a strategic issue for business, and as a potential 'dealbreaker' for many developments or projects. This both creates new markets for strategic consultancy services (such as involvement in the early stages of building design), and also increases the importance of consistent and properly co-ordinated response to multiple legislative, stakeholder and other external demands. One consequence is the desire of customers for more integrated, and wider ranging, services, which then drives consolidation amongst suppliers.

Chart A1 Growth Drivers for Environmental Consultancy Services (ENDS, 2007)

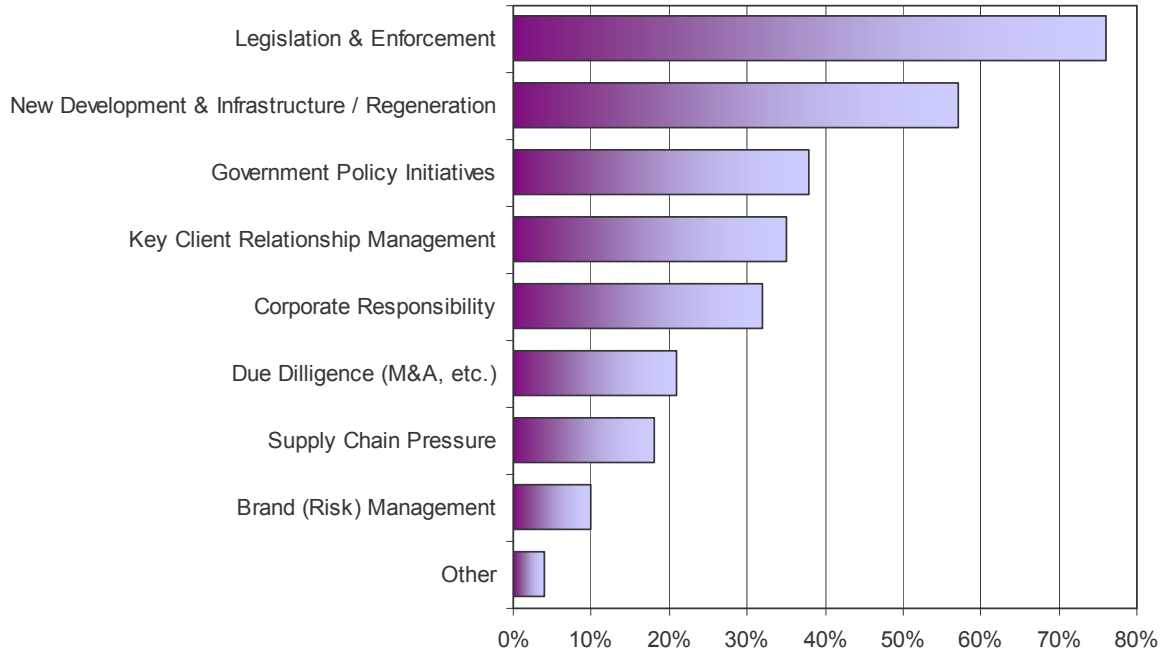


Chart A2: Environmental Consultancy Growth Prospects (based on selection of up to three disciplines offering the strongest growth prospects in their opinion) (ENDS, 2007)

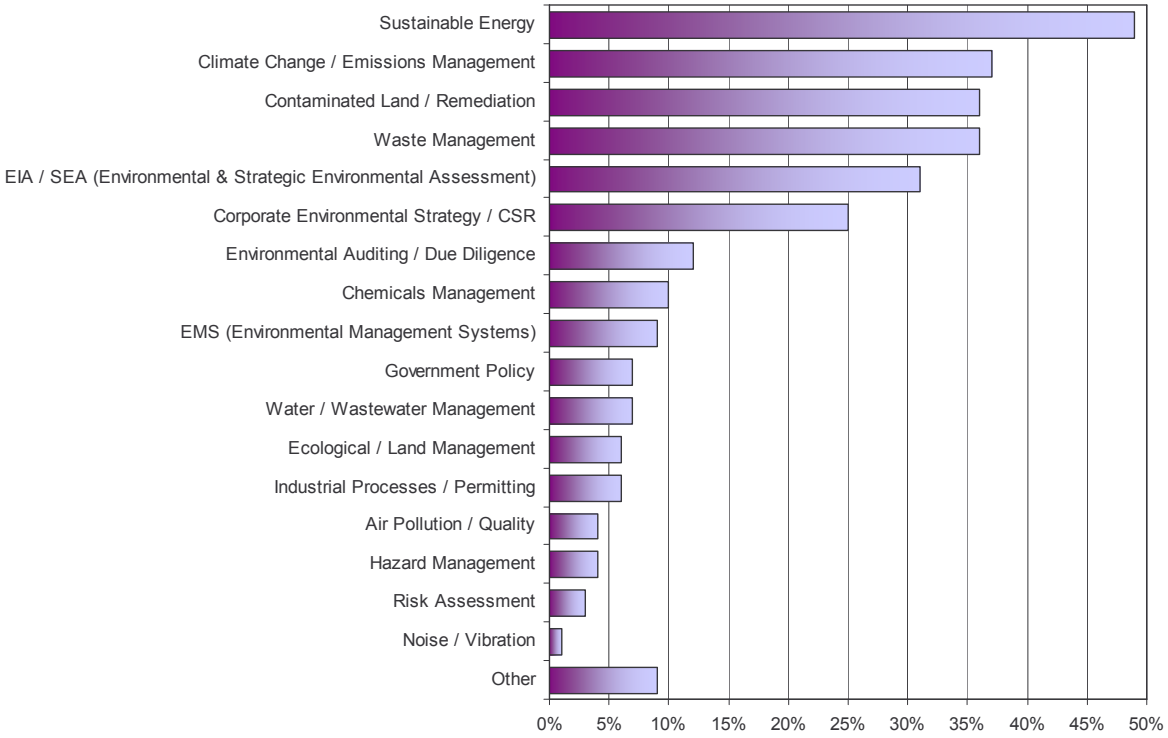


Table A2.1: Environmental Consultancy Services PESTLE analysis

Political	• Many controversial initiatives requiring detailed assessment to assuage opposition, e.g. new nuclear build, large scale infrastructure projects. • Greater incorporation of sustainability into all public sector policies and activities, including land use planning. • Drive to place UK at the forefront of moves towards a low carbon economy, e.g. carbon markets, green construction. • Security and affordability of resource supply.
Economic	• Continuous growth resulting in many large-scale development projects requiring assessment and design inputs. • Rising energy and resource prices creating demand for efficiency measures. • 'G-commerce' – greening as a key feature of corporate brands and market offerings. • Green procurement – growing importance of environmental criteria in purchasing decisions. • Move to incentive-based regulations, e.g. creation of markets in carbon emissions. • Outsourcing of environment-related activities as part of corporate rationalisation. • Increased competition, including from abroad. • Customer demand and other factors creating need for integrated consultancy offerings, both in environmental areas, and to interface with others such as finance, facilitating entry and stimulating concentration. • A 'people business' making individual firms vulnerable to movement of key staff. • Relatively low barriers to entry.
Social	• Social expectations of corporate social responsibility and good environmental performance. • Increased power of NGOs and third sector, creating need for intermediation with business. • Rising expectations of young professional staff and growing competition for the most talented. • Increased public awareness of climate change

	and carbon footprints. • Increasing number of environmental university courses leading to greater scientific understanding of environmental problems, and increasing pool of graduates.
Technological	• Intensive application of ICT for modelling, data collection and analysis, optimisation and other activities creating increased need for know-how. • Increased interest in, and adoption of, clean technology approaches. • New techniques for contaminated land clean-up. • Development of renewable energy and other green technologies.
Legal	• Deepening of environmental regulations and extension in areas, e.g. Carbon Reduction Commitment, increasing demand for specialist advice. • Increase in liability risks, creating business market for risk management but also a driver of increased concentration of environmental consultancy. • Growing demand for environmental due diligence studies in corporate finance.
Environmental	• Worsening environmental problems creating increased demand for preventative and remedial work. • Cyclical patterns of attention, creating 'boom and bust' pattern in some areas. • Increased take-up of Environmental Management Systems (EMS), and development of new variants, e.g. BS8555. • Increased pressure to build on brownfield sites, leading to increasing demand for contaminated land remediation services.

A2.3 Key Innovations

Table A2.2 summarises some of the specific innovations which are occurring in ECS. However, there are arguably three underpinning 'key innovations':

- the move from traditional 'end of pipe' solutions to environmental problems to ones which involve 'cleantech' (clean technology);

- the development of low carbon technologies for energy generation and other activities;

- the development of ICT-based tools and related standards to create better understanding of environmental issues (e.g. by carbon accounting footprinting), better use of process and other data to drive environmental improvement, and closer interactions between consultancies and their clients (see boxes on Enviros and Responsible Solutions for examples).

Table A2.2: Current and Projected Innovations in Environmental Consulting Services

Specialised Technical Innovations
• New ways of dealing with remediated land, e.g. biological techniques. • 3D modelling techniques to assess acoustic, visual etc. impacts for planned projects. • Hardware development for data collection and environmental monitoring including portable analysis tools. • New software and data collection methods to assess soil quality for PAS 100 regulations. • Renewable energy – economics, siting, technologies etc. • Wireless sensing, and software, for integrated utilities management.
Generic Technical Innovations
• Software development for data collation, mining and analysis. • Carbon footprinting techniques and links to low carbon business strategies. • More sophisticated life cycle assessment techniques.
General Business Innovations
• Development of 'package' of services going beyond environmental consultancy, e.g. corporate social responsibility, product development, risk management, whole life costing. • Relationship brokering between companies and stakeholders to aid decision-making • Environmental marketing services and brand management. • Sustainability (as opposed to narrow environmental assessments) of operations, products and supply chains. • Validation of environmental schemes, e.g. carbon emissions.

A2.4 Environmental Consultancy Services Performance and Barriers

As noted in section 1, the ECS sub-sector is growing strongly. Its members are also internationally successful, with many of the top companies reporting significant overseas turnover, contracts, and staff (ENDS, 2005). One especially strong area of growth has been central and Eastern Europe, and the former Soviet republics (Trew, 2005). However, the UK industry is perceived as high value and high cost, and the overseas contracts are primarily in high value industries such as oil and gas, or on grant- and loan-funded projects (Fuller, 2006). Chart A2 indicates the areas where strongest growth is expected in future.

The buoyant markets were reflected in an increased average operating margin of 6.7% in 2006, compared to 5.6% in the previous year (Plimsoll, 2007).

Skills shortages are reported throughout the industry, especially in environmental impact assessment and contaminated land remediation (Trew, 2005). This is somewhat strange given that the UK is second only to the US in terms of environmental science graduates, publications and citations (EIAG, 2006). Retaining highly skilled staff is a particular problem, with the average annual staff turnover for some large consultancies believed to be in excess of 20% (ENDS, 2006).

The Resource Efficiency KTN (2007) also reports that an EPSRC-sponsored dialogue about R&D with the ECS sub-sector revealed that many consultancies were driven by short term project timescales and therefore had little time or incentive to be involved in R&D. This is not to say, of course, that longer term perspectives are not adopted in other aspects of innovation.

One important measure of innovation in environmental consultancy services is their impact on innovation within business generally. Consultancies can drive innovation in clients by providing information on, and justifications for, solutions to known or unknown problems, and how these can be addressed through internal changes, application of clean technologies etc. On the other hand, this drive may be weak – either through their own failure to connect with client's businesses or client's failure to take their advice seriously – or they may accept incremental 'end of pipe' approaches to problems which, from a longer term perspective, are less optimal than clean technology approaches. Judged by this criterion, performance is mixed as UK business has made only modest improvements in many areas of environmental impact.

As an example, a study of UK resource productivity by the Wuppertal Institute (DEFRA, 2002) found that, although it was one of the better performing European Union members for materials intensity, "UK resource use still places high demands on the environment, and increasingly so on the environment of trading partners. This study reinforces the need for policies that emphasise the necessity to:

- reduce the consumption of fossil fuels and increase the efficiency of energy use in industry, transport and households;

- increase resource productivity of the construction sector, by fostering dematerialised methods of construction, and limiting the expansion of transport (especially road) infrastructure and the sprawl of urban systems;

- implement a recycling economy in order to reduce the requirements for primary resources, foster the markets for secondary resources, and support recycling on different levels."

There has been no fundamental change in this picture since then.

Responsible Services for SMEs Reduce Carbon Footprints

Responsible Solutions, Ltd has developed two new offerings for SMEs. Its *Virtual Environmental Manager* provides all the activities undertaken by an internal environmental manager - such as procedure writing, internal audits, legislative updates, training, and meeting attendance. The service – which is based on an agreed list of tasks, and monthly billing – can be cheaper than making an internal appointment. The consultancy has also developed *Construction Footprinter*™, a tailored version of the generic carbon *Footprinter*™ software developed by Best Foot Forward. This is database-driven, as opposed to the more common Excel spreadsheet approach, and has over 100,000 data points. Ian Nicholson, MD at Responsible Solutions, believes that the Footprinter™ "provides users with a more accurate understanding of their carbon impacts, and also allows them to explore different scenarios, such as replacing steel with concrete, or road freight with rail".

Appendix 3 - Waste Management

This analysis is based on conventional definitions of waste management services (WMS), which include waste collection, treatment, disposal, waste minimisation and regulatory advice, recycling (metals, plastics, compostables, glass, demolition and construction wastes etc) and technologies such as bins, shredders, compactors and specialised vehicles (JEMU, 2002). However, a key point which emerges from the analysis is the growing connections between waste management and a broader set of activities which are focused on resource efficiency.

A3.1 Market Features of Conventional Waste Management

Waste industry data is notoriously sketchy. The EFRA Committee noted widespread industry agreement that the available data is "abysmal" and commented that: "This kind of information is important, in order to allow for effective forward planning by local and national government, and to inform investment decisions by private companies which may be contemplating building waste treatment facilities" (EFRA, 2005). The OGC (2006) report also found that there is a general lack of market intelligence and that this is hindering the sector's development.

A 2006 report for the then DTI (2006a) estimated the WMS market at £8.1bn in 2005, and forecast growth to £11.4bn in 2010 and on to £15.9bn by 2015 – a 7% per annum rate of increase.

There are varying estimates for the number of people employed in the sector, ranging from 69,000 (ONS, 2005d) to 160,000 (HSE, 2004). Both these estimates exclude the 36,000 or so staff employed in local authority waste activities. There are around 3,000 companies, mainly relatively small SMEs which focus on specific materials or localities within commercial and industrial waste.

There has been considerable consolidation and market concentration in recent years and the sector is now dominated by 6 large firms, each with over £300 million per annum turnover (Veolia, Biffa, WRG, Shanks, SITA and Viridor). Veolia and SITA are subsidiaries of French companies, and WRG of a Spanish one. All of these companies, and a few medium-sized competitors, offer a range of integrated services, from domestic and private collection, through treatment, recycling, composting, energy recovery, and landfill. Many also offer consulting and land remediation services. The increasing capital requirements, and the move to create 'one stop shops' handling a variety of waste streams for municipal and other customers, means that further consolidation may occur.

The larger players are especially dominant in the municipal waste market, which has been estimated to be worth approximately £2 billion (DTI, 2006a).

One major change over the last decade has been increased commercialisation, with private operators obtaining a larger share of contracts, and remaining local authority activities being carried out by 'arms length' direct labour organisations. As discussed below, the sector is now undergoing an even greater change because of regulations to increase rates of composting and recycling. A two tier system is emerging, with long-term contracts with 'tier one' suppliers providing an integrated offering capable of handling and disposing of all forms of waste. These suppliers undertake many activities themselves, but also sub-contract specialised activities such as recycling to 'tier two' suppliers.

The commercial and industrial waste sector is much larger than municipal, but much more fragmented. There are few contracts for integrated waste services, and almost all contracts are short term in nature.

One feature of all waste segments is the prevalence of third sector organisations, generally providing recycling and recovery services for particular materials such as IT equipment or plastics. This has been one of the most innovative areas of waste management in recent years, with third sector initiatives helping to demonstrate the feasibility of many recycling streams, and then deploy them on a large scale. Another area of innovation has been the development of waste broking services, which help to link supplies of waste material with potential users.

The WM sector overlaps with the metals recycling industry, which has a turnover of £3.5bn (Millington, 2006). Some, but not all, of this is included in the figures given above. This sector has a long history of exporting recovered materials for further separation and processing and the same expertise is now being applied in other areas, such as plastics.

A3.2 Market Features of the Resource Efficiency Sector

The physical inputs of manufacturing and other activities have always had a cost, and so there have been persistent pressures to use them more efficiently. These pressures have varied over time in response to price fluctuations, scarcity (e.g. in wartime) and other factors. The same pressures have also led to the recovery and reuse of some wastes that are derived from very expensive materials, or end of life products that were originally expensive and which can be repurposed. Very often, these activities have been conducted 'in house' by suppliers, and therefore not had high economic visibility. Yet one activity alone – remanufacturing of 'end of first life' products or components – is said to have a UK value of £5 billion, employ 50,000 people and create greater environmental benefits than recycling activities (CRR, 2007). Remanufacturing is currently focused on high value or high technology areas such as aerospace, military and power turbines. A recent survey also found that remanufacturing was associated with 'add on' services, as the Caterpillar case indicates.

Another growing area is that of 'solutions services', in which suppliers manage various aspects of resources sourcing, use and disposal for customers. As resource efficiency is typically only one aspect of these services – and often not a primary objective of the contracts – it is hard to place an economic value on it, but it is undoubtedly considerable. The best known example of such a solutions service is probably that of chemical management services (CMS).

Table A3.1 (below) provides further examples of activities which can be classed as part of a broader resource efficiency sector.

A Cheeky Environmental Service Moves Furniture Fast

Andover-based Testway Housing won a Neighbourhood Award (2006) for its Twice as Nice scheme. This offers a free collection service for furniture and then sells most of it, in part through classified ads with the strapline 'Twice as Nice for your pocket, Twice as Nice for the environment'. Prices are heavily discounted for those on low incomes, and people moving on from the local crisis centre can purchase a complete home 'starter pack' for £50. The scheme has achieved considerable local support by reducing flytipping, and through imaginative marketing. Its launch featured a Guinness-authenticated fastest piece of furniture (an 87 mph sofa!), and a tea party for all local twins – plus the pop star twins, the Cheeky Girls, as guests of honour.

Like around 400 other furniture and white goods re-use organisations around the UK, Twice as Nice has benefitted from advice and other support by the national charity FRN. FRN estimates that its members employ over 3,000 staff, have trained over 8,000 people, helped over 700,000 low income households, diverted over 90,000 tonnes of waste from landfill, and re-used over 2.5 million items including 300,000 electrical items and over 200,000 computers (FRN, 2007).

A Service Innovation Dissolves Chemical Waste Problems

SAFECHEM Europe, a Dow Chemical subsidiary, provides a management and disposal service for hazardous solvents, especially chlorinated ones. This utilises SAFE-TAINER™, a serviced container with airtight pumping systems which provides the platform for delivery, storage, recuperation, and end of life transport of solvents. Reduced leakage, and other benefits, can reduce solvent consumption by 25%, and waste by 33% - and by as much as 75% and 96% when combined with additional services, such as monitoring of solvent quality (IPTS, 2006). A recent pilot programme in metal cleaning within the Austrian automotive industry has extended the concept to leasing rather than selling solvents, so that SAFECHEM retains all legal responsibility for their use and disposal. According to the company, this – and the additional services and knowledge transfer it has led to – have increased the solvent lifespan by 4-8 times, and reduced overall consumption (and therefore ultimate waste disposal) by 40 to 80% (Dow, 2006).

The service was introduced in direct response to German regulations of the late 1980s, and as an indirect response to the 'Responsible Care' approaches which Dow was helping to develop in the US, and was partially intended to provide compensating revenues for their expected effect in reducing sales of solvents, then a key Dow product. Uncertainty about, and watering down of initial, regulatory requirements – combined with higher costs for users – restricted its growth over following decades but greater commercial success is expected as recent regulations such as the European REACH Directive create larger market opportunities.

A3.3 Drivers of Change and Competition

There are many drivers of change and competition in waste management (see Table 3). However, two stand out as especially important – regulation, and resource costs.

UK waste regulation is driven by European Union Directives – especially on Batteries, Energy-using Products, End of Life Vehicles (ELV), Landfill, and Waste Electrical and Electronic Equipment (WEEE). The Landfill Directive, for example, requires the percentage of biodegradable municipal waste sent to landfill to be reduced to 75 per cent of the 1995 level produced by 2010; 50 per cent by 2013; and 35 per cent by 2020. The Integrated Pollution Prevention and Control (IPPC) Directive also covers the largest waste management activities (including incineration, hazardous waste and landfill sites). At the UK level, landfill tax and domestic recycling targets have been the major factors influencing the WMS market over the last 5 years and this is likely to continue.

These new regulations are creating a fundamental shift in WMS, from a landfill business to a process technology sector. In 2006, the UK landfilled almost half of its solid waste, sent the second highest percentage of municipal waste to landfill of the EU-15, and had one of the lowest recycling rates in Europe. The main reason for this was a supply of cheap landfills, partly as a result of the void spaces left behind by the mining and quarrying industry. Unfortunately, this unique position means that many other European countries are far ahead of the UK in advanced waste processing technologies. The Institution of Civil Engineers (2004) has estimated that 1500-2300 new waste facilities - at a cost of £10-30bn – will be needed to meet the EU Landfill Directive's requirements for diversion of biodegradable municipal waste.

These changes have to be achieved with value for money. For example, DEFRA has identified the potential for around £300 million worth of efficiency gains in local authority waste services (OFT, 2006).

The rising costs of most resources is also transforming the economics of many materials recovery processes. In addition, concentration of supply for some key materials creates concern about security of supply, and consequent spikes in prices. The greatest impact is likely to be increased levels of remanufacturing which allow the embodied materials value of 'end of first life' products to be recovered.

Innovation in Municipal Waste Service Provision

An insight into the nature of the new materials processing sector that is emerging is provided by the PFI-financed scheme which Viridor/Laing are developing for the Greater Manchester Waste Authority. The largest scheme of its kind to date, it is intended to handle 1.4 million tonnes of waste a year and involves a 25 year contract, £3 billion revenue over the lifetime of the contract, and a £300 million capital investment in 30-40 new facilities. These include:

- Two Materials Recovery Facilities (MRFs) to separate 'dry' recyclable materials such as plastic bottles, glass and cans using advanced screening, optical sorting and other technologies;

- Up to four 'In-Vessel Composting' (IVC) plants for kitchen and garden waste, producing around 125,000 tonnes of compost per annum;

- A number of Mechanical Biological Treatment (MBT) plants for residual waste – these use anaerobic digestion technology to produce a) methane which powers turbines to generate electricity to the National Grid and b) a Solid Recovered Fuel (SRF) for sale.

The technology suppliers also provide insights into the changing nature of the industry. The Materials Recovery Facilities are being designed by Peterborough-based PPS, a specialist 'one stop' design, project management and equipment vendor whose roots lie in metals recycling, a traditionally strong area in the UK. The composting plant is supplied by a Preston-based AIM-listed green technology company, TEG, which provides a complete solution to customers by also offering sales contracts for compost through its Natural Organic Fertiliser Company subsidiary. The MBT plants are being supplied by two British based process engineering solutions, Enpure and Clarke Haase, but are utilising German technology developed as a result of that country's early move into large scale recycling.

It is also of interest that a new £160 million Energy from Waste facility being built by a Viridor/Grundon joint venture in Slough will probably use Japanese technology.

A key Government action to support the sector is the Waste Implementation Programme (WIP) initiative which is producing a comprehensive strategy for the construction of the estimated £10 billion of infrastructure needed to meet the obligations of diverting biodegradable waste away from landfill. Specific funding has been provided through:

- Support for Private Finance Initiative (PFI) projects to support investment in waste disposal facilities and divert waste from landfill (£255 million of PFI credits in 2006/07, and £280 million in 2007/08);

- The Business Resource Efficiency and Waste (BREW) programme which seeks to incentivise businesses to reduce the amount of waste they send to landfill, and also assist them in developing ways to achieve this (£284 million between 2005 and 2008);

- The Waste and Resources Action Programme (WRAP) which aims to accelerate resource efficiency by creating efficient markets for recycled materials and products and removing barriers to waste minimisation, re-use and recycling (around £80 million a year);

- Around £30 million of assistance to set up new waste treatment technology demonstration projects under the Waste Implementation Programme.

A number of specific initiatives have also been wholly or partly funded through these channels, such as the National Industrial Symbiosis Programme.

Table A3.1: Drivers in Change and Competition in Waste Management

Political	• Waste as a key European priority, reflected in Directives which cascade to national level and create many new demands. • Mismatch between highly activist policies for municipal waste, and more hands off ones for commercial and industrial waste. • Uncertainty created by controversial nature of some waste policies, e.g. differential charging of households.
Economic	• Rising costs of waste disposal, and increased (though volatile) prices for many recovered materials transforming the costs of waste. • Move to incentive-based regulations, e.g. landfill tax and landfill allowance trading scheme. • Rising cost base due to higher skill requirements, increased capital needs and increased operating costs. • Increased investment requirements and demand for integrated solutions by customers. • Decline in UK manufacturing base as source of commercial and industrial waste. • Large SME base with historic tradition of intense competition and suspicion. • Limited knowledge and understanding of waste related issues in the investment community. • 'Contracting' culture with little experience of partnership or solutions based approaches.

	• Limited waste market information including waste data. • Development of long-term contracts in municipal waste. • Low barriers to entry in many areas of commercial and industrial waste. • Rising costs of primary resources will stimulate the markets for secondary materials.
Social	• Increased and changing consumer demands for responsible waste disposal and end of life practices by business. • Public suspicion of, and resistance to, siting of many waste facilities (especially as many are 'importing' large waste volumes to achieve economies of scale), and some technologies used, e.g. incineration. • Increased public demand for responsible solutions but unwillingness to pay additional infrastructure costs. • Willingness of public to recycle substantially and responsibly.
Technological	• New technologies for waste separation and processing. • Increased sensitivity to contamination/quality of raw materials.
Legal	• Increase in amount of regulation and standards related to waste management. • Definitions and classification of waste and products influencing costs of processing and marketing. • Increase in liability risks, raising potential costs of unlimited liability in waste disposal contracts.
Environmental	• Growing burden of materials production increases advantages of recycling and reuse. • Development of landfill technology and practice, creating exportable know-how. • Demand on industry to improve environmental standards

A3.4 Key Innovations

Table A3.2 gives examples of some recent, or near term, innovations within waste management services.

One general point is that much of the investment taking place in the municipal waste sector involves relatively limited innovation. It is essentially a rolling out, and scaling up, of existing technologies and processes (e.g. kerbside collection systems, civic amenity sites, transfer stations, materials recycling facilities.) The technical innovation which is occurring is often based on inputs from other countries, generally in Northern Europe.

The 'key innovation' in waste management services, especially within the commercial waste area, is the strategic change of operators from a relatively reactive sector based on sub-contracting to a more proactive, strategic and higher added value 'materials and resource management' sector. A key emphasis will be on designing products and production processes in such a way that waste generation is minimised, and that which is produced can be more easily processed to extract high value components.

As discussed above, one aspect of this is the development of a clearer demarcation between 'tier 1' and 'tier 2' suppliers. As in the car industry, a key feature of tier 1 suppliers is their co-ordination of the more specialised activities of tier 2 suppliers to provide an integrated service to customers. One implication is different forms of innovation. For tier 1 suppliers the key innovations are likely to be around large scale separation processes, and new kinds of organisational structures (longer term and more wide ranging contracts, partnerships with customers and suppliers). For tier 2 suppliers – who include the growing not-for-profit sector which has been an important source in innovation in recycling (see box on FRN) - the innovations are likely to focus more on specialised processes, and new organisational and marketing arrangements to sell recovered materials.

The development of partnerships, both within the supply chain, and with customers, will therefore be crucial to provide the ability to process a wide variety of waste streams, and also to share investment costs. They are increasingly important to customers because the financial scale and longevity of contracts makes them of huge strategic importance. One possible trend in future, especially if materials prices continue to increase, is the development of revenue sharing arrangements for recovered materials between suppliers and local authorities.

A study of waste partnerships by the Open University (2006) identified many difficulties but also found that "successful partnership working can facilitate learning and understanding of different partners' perspectives. This shared learning together with pooled knowledge and resources has enabled authorities to improve their recycling and composting activities in ways that would have

been difficult or impossible to achieve in isolation." However, it noted that almost all partnerships were focused on achieving minimum Government targets or efficiency savings and that more flexible and innovative practices were only evident when the partnerships encompassed and prioritised wider aspects of sustainability.

Another long discussed innovation is the development of "resource recovery parks" which involve co-location not only of waste processing and recycling facilities but also downstream users of the recovered products. An example is the proposed South Kirby, Yorkshire project of Urban Mines Ltd, Commercial Development Projects Ltd, and Wakefield MBC, which recently gained planning permission for a 22 acre brownfield site. Developments of this kind can provide economies of both scale and scope, and also help create knowledge networks to stimulate further innovation. However, their complexity has made them difficult to get off the ground to date, and some observers believe that there are more fruitful innovation alternatives available (Anon, 2007). Certainly, the scope for new forms of remanufacturing, 'servicising' and the other 'materials efficiency' activities identified above is considerable.

Table A3.2 Innovations within Waste Management Services.

Waste Collection and Transport
• Weighing and calibration technologies enabling 'pay by volume or weight' approaches. • New kinds of collection vehicle. • Use of GPS and other technologies to optimise vehicle loading. • Waste tracking and monitoring software and devices. • More efficient volume reduction technologies (compactors/compressors/shredders).
Initial Waste Treatment and Separation
• Mechanical recovery system/treatment process automation (software and technology). • More sophisticated sensing, sorting and separation technologies. • Novel solvents. • Medium/micro sized facilities to serve local demand and avoid excessive transport costs.
Specialised Waste Processing, Materials Recovery and Disposal
• Composting techniques for hazardous materials. • Safer, more efficient, energy from waste technologies. • Second generation bio-fuels from waste technologies. • High temperature processing of hazardous wastes. • Handling biodegradable plastics without cross-contamination of non-biodegradables. • Systems engineering approaches to multiple treatment streams.
General Business Innovations
• Waste brokering to link waste generators with potential users. • Integrated waste management contracts to handle all waste streams. • Supporting waste minimisation and zero waste strategies in customers through service solutions and other means. • Electronic markets for recovered materials.

Based in part on inputs from David Boardman of the Resource Efficiency KTN (2007)

Table A3.3 Innovations in the Materials Efficiency Sector

Remanufacturing of components/products
'Servicising' contracts providing integrated solutions (including waste disposal)
Take-back schemes by retailers or suppliers
Recycling services within supply chains
New distribution channels for remanufactured/end of first life products
Reverse logistics

Based in part on inputs from Nick Morley of Oakdene Hollins

A3.5 Waste Management Performance and Barriers

As noted above, the waste management sub-sector is growing strongly. The associated and overlapping UK metals recycling sector is growing less strongly – largely due to the decline of UK manufacturing, which has provided many of its raw materials - but is still considered a major player in the EU and global markets. UK-based EMR and SIMS (ultimately Australian, but largely UK-based) are among the top ten metal recyclers in Europe.

However, the UK is not currently in a strong position to complete the secondary materials processing chain. Even when secondary materials are recovered from the treatment of by-products many of these are exported for processing because the treatment facilities are not available in the UK. This means that the UK economy does not recover the inherent value of these secondary materials (Resource Efficiency KTN, 2007).

The industry may be under-capitalised for the scale of investment which is needed to meet national and EU waste targets. One recent report has noted an increase in debt and a fall in the combined operating margin of the six majors from 5.7% in 2003 to 4.5% in 2005, commenting that: "The worrying implication of this is that there may be Balance Sheet constraints on the major companies in meeting the considerable funding requirement that is required in new waste treatment infrastructure, if the UK is to achieve the landfill diversion targets set for 2010 and 2013 (Caledonian Economics, 2006)".

One response to increased capital requirements is increased consolidation. However, several recent reports have expressed concerns about lack of competition in the municipal waste market, with 6 large players now responsible for over 70% of waste collection by weight (OGC 2006, OFT 2006). Most of these players tend to be strong in particular regions so that competition at regional level can be weak. As a number of recent innovations within the sector – such as the development of recycling chains by third sector organisations – have come from outside the established players there is also concern that consolidation will reduce innovation opportunities in future.

However, some industry representatives interviewed believe that they are handicapped by rules which prevent commercial and industrial waste from being treated in municipal waste facilities (Steering Group, 2007). They argue that this can help to achieve full utilisation of existing facilities, lower costs for all by allowing greater economies of scale, and provide sufficient critical mass for specialised material recovery streams. They also endorse the views of the Office of Fair Trading (2006) that local authorities are often too prescriptive about particular technologies in procurement contracts, and need to become more focused on outputs without specifying the means of achieving them. This, it is said, will enable incremental innovations to occur more easily within processing facilities.

One area of definitely poor performance is R&D which, as discussed above, is very limited. For some time this area was considered to be a 'poor relation' because the issues were seen to be commercial, practical or engineering based rather than pure science issues. However, with support from the Technology Strategy Board, EPSRC and others, the Environmental and Resource Efficiency KTNs (KTN, 2007) is now stimulating R&D in this area and expert groups are growing at a range of institutions (Birmingham, Brighton, Cardiff, Cambridge, Imperial College, Leeds, Northampton, Open University, Oxford, Oxford Brookes, Surrey, etc.).

The waste industry as a whole also suffers from a skills shortage, which is forecast to worsen should technology become increasingly sophisticated (Gower, 2005).

The main expertise of the UK WMS sector is in landfill, which is a declining market in Europe. However, there are opportunities to develop service contracts and knowledge transfer in developing countries, where rapid economic and population growth will require continued investment in landfill. For example, Brazil has some 100,000 tonnes of urban waste per day being inadequately disposed. Landfilling it properly would require an initial investment of $570 million, and annual costs of $420 million (USCS, 2005).

The UK has a wide range of SMEs developing and applying alternative technologies, although few of these have yet been able to break through as major players in the sector. Examples include TEG Environmental and Civic Environmental, with in-vessel aerobic treatment; Greenfinch Biogas and Sustainable Waste Systems, with anaerobic digestion; Dundee Energy Recycling, with incineration; Compact Power and Graveson Energy Management, with pyrolysis technologies; Comex, Estech Europe, and Sterecycle with autoclave treatment; and Fairport and Orchid Environmental with thermo treatment.

The UK is also leading EU policy development in certain areas. For example, PAS-100, a quality standard for composted organic waste, was developed in the UK.

The development of alternative treatment facilities has been held back by the planning process. Local opposition to facilities, particularly incineration, can be intense, adding costs, time, and uncertainty to investments in this sector.

Another perceived barrier which has emerged from Steering Group discussion is the requirement of many municipal waste tenders that suppliers have unlimited liability for any problems. Operators feel that this discourages innovation by making them more risk averse, and also reduces the number of bidders because few have the financial strength to make such commitments.

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