



Closing the Procurement Gap. The costly failure to mobilise sustainable procurement for innovation. A Provocation written as a background paper for the discussion forum at Business Innovation and Skills.

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Manchester, April 2011

Closing the Procurement Gap

THE COSTLY FAILURE TO MOBILISE SUSTAINABLE PROCUREMENT FOR INNOVATION

A Provocation written as a background paper for the discussion forum at Business Innovation and Skills (London), 7 April 2011, organised by the Sustainable Consumption Institute, The University of Manchester.

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THE MISSING LINK

Public procurement has been identified both as a major driver of innovation and as an instrument to achieve a more environmentally sustainable society and economy. We shall argue here that the innovation agenda in public procurement has come under pressure in the context of the current government focus on efficiency, and that public procurement has not supported the environmental sustainability agenda¹ as broadly as envisaged in past policy initiatives. In the private sector, achieving sustainable objectives through better managing of purchasing and supply chains has become a major feature for many companies. However, it has too often tended to maintain the technological status quo and only achieved incremental improvements.

Against this background, we set out the case for bringing together the innovation and sustainability agendas in public and private procurement. This is a link that has yet to be exploited systematically:

- Those focusing on innovation through procurement across government do not exploit the leverage of environmental sustainability to foster their cause through the widely shared appeal it has developed; sustainability can and should be a lever for radical innovation.

- Those focusing on procurement of sustainable products and services do not see the huge opportunities that lie in the next generation of technologies, but rather focus on the incremental improvement that bears no risk and promises rapid progress. At the same time, they do not fully understand the specific challenges to procuring innovation, and thus are not prepared to overcome them. This, it appears, is true both for public and for private buyers.

While there are some creditworthy initiatives at national level and in selected sectors, procurement of sustainable products and services needs to be much more ambitious and much more oriented towards eco-innovation across all public services (and indeed in private companies). Furthermore, there are as yet untapped opportunities for public purchasing of eco-innovations to become aligned with private procurement. Together, the two sectors can provide a critical inspiration for the development and diffusion of green technologies, and marshal public funds and private investments for the realisation of environmentally sustainable economic growth. **There is a strategic win-win situation that is neglected, both in the public and private sectors.**

¹ In this paper we limit ourselves to environmental sustainability if not otherwise stated.

THREE STRANDS OF PROCUREMENT

1. DRIVING INNOVATION BUT NEGLECTING SUSTAINABILITY

The use of public procurement of goods and services to drive innovation is based on two considerations.² Firstly, procurement of innovative products and services makes **public services more effective and more efficient**, and thus society more innovative and creative. This is, of course, compatible with achieving efficiency savings since, as with any investment, it is a combination of life-cycle costing and enhanced benefit (long term cost-benefit) that should be the basis of public purchasing decisions.

Secondly, public demand for innovation incentivises industry to invest in innovation, with potentially substantial spill over effects. It sends a signal to industry that the UK market is a location in which innovative goods and services can be introduced and diffused. It can also give suppliers in the UK a leading edge and – depending on the nature of the product or service – potentially initiate further private demand. As public needs are similar in many other countries, innovation procurement can also trigger export opportunities, taking advantage of the UK being a **lead market**. Furthermore, there is a particular benefit for **innovative start-ups**. Such firms often struggle to find the first customer to begin their ‘reference list’. A public purchase helps to overcome this credibility gap and is worth far more than a grant. In sum, beyond

improved social services the additional social benefits of public procurement for innovation stemming from the market creation potential of the initial purchase of innovation provides a further justification for the public buyer to invest in innovation. There is ample, though mostly anecdotal, evidence to support the active use of procurement as a tool to create innovation dynamics more broadly. In our own academic work, we have conducted³ and collected a broad range of national and international case studies demonstrating good practice of **how procurement processes can lead to innovative activities** within firms and shape or create new markets. Some earlier studies claim that the procurement of innovation through public bodies in the US after WWII triggered more innovation in the market place than did supply side measures, such as technology programmes and other kinds of subsidies⁴. It has been shown empirically that in satisfying new societal needs and providing infrastructure and public service, the state very often has been more demanding than private consumers. In achieving its mission, in improving its function, the state very often acts as a **lead user**⁵. As a result, procurement policy “is a far more efficient instrument to use in stimulating innovation than any of a wide range of frequently used R&D subsidies”⁶. In a survey of more than 1000 firms and



² Edler, J., Georghiou, L. “Public procurement and innovation—Resurrecting the demand side.” *Research Policy* 36, no. 7 (2007): 949-963.

³ Edler, J., Edquist, C., Georghiou, L., Hommen, L. Hafner, S., Papadakou, M., Rigby, J., Rolfstam, M., Ruhland, S., Tsipouri, L., 2005. *Innovation and Public Procurement. Review of Issues at Stake, final report*, Brussels [ftp://ftp.cordis.lu/pub/innovation-policy/studies/ full_study.pdf], Uyarra, E. (2010) *Opportunities for innovation through local government procurement A case study of Greater Manchester*. NESTA research report, May 2010. <http://www.nesta.org.uk/library/documents/opportunities-for-innovation18May2010.pdf>. Uyarra, E., Flanagan, K. (2010) “Understanding the innovation impacts of public procurement”, *European Planning Studies*, Vol.18 No.1 pp123-43.

⁴ E.g. Rothwell, R., Zegveld, W. 1981. *Government regulations and innovation - Industrial Innovation and Public Policy*, London: Rothwell, R./Zegveld, W. (Ed.), *Industrial Innovation and Public Policy*, 116-147. London.

⁵ Dalpé, R., DeBresson, C., Ciaoping, H., 1992. The public sector as first user of innovations. *Research Policy* 21(3), p 258.

⁶ Geroski, P.A. 1990. Procurement policy as a tool of industrial policy. In: *International Review of Applied Economics* 4(2), S. 182–198.

125 industry federations across Europe, over 50% of respondents indicated that new requirements and demands are the main sources of innovations, while new technological developments within companies are the major driver for innovations in only 12% of firms.⁷

Consequently, across the OECD world, **public procurement of innovation** is becoming a **cornerstone of innovation policy**. This is part of a move towards more demand based innovation policy to tackle the grand challenges being faced by societies all over the globe.⁸

A scan through **sustainability procurement studies** across Europe and the UK confirms a broad **lack of innovation orientation**.⁹ At EU level, sustainable procurement as such, is a hot topic, as illustrated by various tool kits, guidelines and EU networks. However, the activities oriented towards procurement of sustainable products and services do not feature innovation strongly, if at all; the term innovation is hardly mentioned. Interestingly though, EU schemes that support public procurement for innovation are focussed on sustainability-oriented areas. Four out of the six pilot Lead Markets of the EU* are oriented in this way: sustainable construction, renewable energies, bio-based products and recycling.

In the UK, the central Sustainable Development document does not consider the triggering of eco-innovation through procurement as a means to deliver on the agenda across the board of government.¹⁰ Rather, there are various special innovation procurement schemes that have been tried to explicitly trigger innovation in sustainable procurement. One example is the **Forward Commitment Procurement (FCP)**, supported by the Innovation for Sustainability Competition scheme and launched by BIS in 2009. In this scheme, potential buyers signal a clear, unmet need to the market and commit themselves to the purchase of an innovative solution by a certain date should it meet the defined requirements. Despite a set of encouraging cases, the FCP scheme and the lessons from the FCP pilot cases have not been taken up broadly across government so far. Within the **Small Business Research Innovation** scheme the Technology Strategy Board (TSB) procures the solution for clearly specified problems (e.g. achieving a certain sustainability goal), thus triggering the development of innovative prototypes. However, in this scheme public bodies do not commit themselves to actually buy the resulting product or service.

⁷ BDL 2003. The Power of Customers to Drive Innovation, Report to the European Commission, Brussels.

⁸ OECD (2011): Demand side innovation policies.; Paris, forthcoming (here referred to draft version DSTI/IND/STP(2010))

⁹ Steurer, R, Konrad, A. (2007): Sustainable Public Procurement in EU Member States – The survey results, Report to the EU High Level Group on CSR, May 7 2007.

¹⁰ DEFRA (2011): Mainstreaming sustainable development – The Government's vision and what this means in practice, February 2011, p. 3.

*For more details see <http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/>

2. DRIVING SUSTAINABILITY BUT NEGLECTING INNOVATION

THE PUBLIC SECTOR

The UK Government has in recent years pursued a sustainable development (SD) agenda, with the aim to mainstream SD across government ensuring that “government buys more sustainable and efficient products and engages with its suppliers to understand and reduce the impacts of supply chains”.¹¹ The strategy builds on leading “by example with the greenest ever operations and procurement which includes transparency on the carbon impact of our supply chain, and making procurement of goods and services more sustainable whilst continuing to deliver value for money”.¹²

Need for a step change

Meeting these ambitious targets requires a step change. A report by the National Audit Office in 2009 has found that progress towards better addressing the environmental impact of public procurement has been considerably behind official targets, and that four departments and the NHS (PASA) indicated very low scores in their procurement self-assessment.¹³

Public procurers in general do **not yet systematically consider sustainability issues** in their procedures. When they do, they rarely go beyond the so-called “quick wins”, that is minimum environmental standards for established products. Whole life-cycle costing with in-built sustainability considerations is not very common. Equally, a survey of UK public

bodies conducted in 2006 found that many public bodies do not engage in systematic sustainability considerations when purchasing,¹⁴ while a broad EU survey of public purchasers found that the actual practice of buying “green” is much less developed than the bodies themselves claim.¹⁵ But none of these studies discuss any systematic considerations by public bodies to demand innovative solutions in order to meet sustainability targets. The empirical studies have identified the most important barriers for sustainable procurement as being higher costs and a lack of dedicated budgets, as well as, lack of awareness.

THE PRIVATE SECTOR

“Greening the supply chain” has moved higher up the agenda and become more important in corporate presentation in recent years. Recent SCI funded research¹⁶ has classified company sustainable supply chain activities into two strategic approaches: compliance and competitive advantage. The majority of firms surveyed in this research are maintaining a compliance focus, either reacting to regulations or doing so with some additional efforts to exploit cost saving opportunities. Only a very small number of respondents claimed that they were pursuing sustainability as a value proposition for competitive advantage or differentiation, and integrating far reaching sustainability objectives into their supply chain management strategies. Furthermore, the research



¹¹ DEFRA 2011, op.cit., p. 3

¹² DEFRA 2011, op.cit., p. 7

¹³ National Audit Office (2009): Addressing the environmental impacts of government procurement, London, April 2009

¹⁴ Walker, H.; Brammer, S. (2009): Sustainable Procurement in the UK public sector, in: Supply Chain Management: 14 (2), pp. 127-138

¹⁵ Jonk, Jonk, M. (2005). GPP in the EU: Status & Recommendations, Take-5 Consortium. Accessed March 14 2009 from www.ec.europa.eu/environment/gpp/pdf/Stateofplaysurvey2005_en.pdf.

¹⁶ Led by Prof. Paul Cousins at Manchester Business School, publications forthcoming.

revealed that recent economic conditions have led some firms to retreat from more ambitious strategies back to a compliance-orientation. A compliance-oriented approach can also lead to competitive advantage, if a company successfully anticipates regulatory change and adapts ahead of the market.

There is evidence that not only firms with general strategic procurement strategies are more successful in the marketplace, but also those with sustainable supply chain management.¹⁷ However, companies – by and large – do not apply specific sustainability tools in their procurement processes. The barriers that have been identified in numerous studies include associated costs, short term profitability, lack of legitimacy (internally!) and general awareness about sustainability. One of the strongest enablers of sustainable procurement is collaboration with suppliers¹⁸.

Strikingly, just as in the public sector, the sustainable procurement debate and practice in the private sector tends to be oriented towards the low hanging fruit, the incremental improvement and the implementation of more sustainable but proven and tested practice. An analysis of approximately 300 reports and articles on corporate sustainable procurement¹⁹ does not feature innovation as an important dimension at all. The majority of companies are **not systematically responsive to eco-innovations** within or outside their supply chains. They are even **less concerned** with defining specifications that will **trigger** entirely novel solutions and **often fail** to see the merit in **co-constructing eco-innovation** with suppliers.



¹⁷ Walker, H. (2010): Successful business and procurement: what lessons for sustainable public procurement can be drawn from successful businesses? A rapid research and evidence review. Report to the SDRN, Warwick Business School.

¹⁸ Walker, H., diSisto, L., McBain (2008): Drivers and barriers of environmental supply chain practices: Lessons from the public and private sector; in: Journal of Purchasing and Supply Chain Management 14, pp. 69.85.

¹⁹ Walker, H., 2010, op. cit.

3. PROCUREMENT IN THE CURRENT EFFICIENCY AGENDA

According to the Efficiency Review by Sir Philip Green, total government spending in 2009/2010 was £670 billion,²⁰ roughly £220 billion of which are spent for procuring goods, services and works. Sir Philip Green's review has identified public procurement as a major source of savings. Meanwhile, the Office of Government Commerce (including Buying Solutions) has been moved to the Cabinet Office as part of the Efficiency Reform Group (ERG), which is about 'driving down the cost of government' (Francis Maude), 'securing value for money' (Sir Peter Gershon), and 'greater efficiency and effectiveness' in government (Martin Reid).²¹ Starting October 2011, nine commodities will be bought collaboratively and centrally, with a view to major efficiency and cost saving, standardisation, process streamlining and bigger market power of the public buyer. In parallel, procurement has been identified as a potential means to support SMEs by securing and simplifying their access to public contracts²², whereby the aim is to have 25% of contracts awarded to SMEs.²³ This may be in conflict with the up-scaling approach itself.

Sustainability should not be neglected in the efficiency agenda. The essence of sustainability is using fewer resources to achieve desired levels of activity and in many instances this can lead to a more efficient public sector. Similarly, as argued already, innovation provides a means to reduce whole life costs or to transform activity to a new platform which may provide a step change in efficiency if a wider perspective is taken.

However, the procurement agenda is currently, even more than previously, dominated by efficiency, volume, standardisation and SME access. Although in principle such moves can have positive effects, in contrast to the time before the current crisis, innovation as a goal and leverage of public procurement is much less in the spotlight – or even seen as going against the cost savings agenda.



²⁰ Sir Philip Green (2010): Efficiency Review. Key Findings and Recommendations. <http://download.cabinetoffice.gov.uk/efficiency/sirphilipgreenreview.pdf>

²¹ http://www.cabinetoffice.gov.uk/newsroom/news_releases/2010/100615-shakeup.aspx, accessed November 2010

²² See <http://www.cabinetoffice.gov.uk/content/sme-contracts>.

²³ David Cameron, March 6, at the Conservative Spring Forum, (The Guardian, March 7, p. 12).

JOINING UP THE STRANDS: TOWARDS STIMULATING SUSTAINABLE INNOVATION THROUGH STRATEGIC BUYING

There is an opportunity to join up the three strands of procurement we have discussed, bringing innovation into the sustainability agenda and creating a sound long term basis for efficiency. We observe the risk of a **lost opportunity**, and argue for a **step change**. Public and private procurement are not seizing the opportunities offered by an innovation-driven approach to the sustainability and economic growth agendas. The challenges are similar for sustainability and innovation procurement – in the public *and* the private sector: Risk aversion, high levels of uncertainty about environmental problems and innovative solutions, short term cost consideration, insufficient capabilities and skills, ‘siloes’ division of labour and misalignment of incentives within organisations, lack of clear leadership and awareness, and poor metrics to measure long term success.

BOX 1: PUBLIC SECTOR EXAMPLE

In 2010 HM Revenue & Customs (HMRC) and the office supplies company Banner developed an innovative solution for the handling of confidential paper through the use of a closed-loop system. This integrated service involves disposal, on-site shredding, traceability of confidential waste, recycling and final sale of the recycled paper back to HMRC. This shift from a routine purchasing of commodities to a service incorporating materials disposal and recovery, has resulted in overall cost reductions in paper purchasing, important environmental benefits, and improved confidentiality and accountability in the handling of confidential waste. Key enabling factors for this innovative and sustainable solution were a collaborative and transparent buyer-supplier relationship, close departmental coordination and strong support by senior managers.

Against this background, we argue that companies and public bodies alike have a **unique chance to meet their sustainability agenda by taking on the innovation challenge**. Production and distribution systems can be shifted towards new growth trajectories. There is a basic societal buy-in to demanding sustainable products and services. This is a sound basis for a step change, for an innovation driven lift-up of this sustainability agenda. Given the global challenge of climate change, **stimulation of eco-innovation** can create **lead markets** in the UK, and can give companies a leading competitive edge beyond the short term. In addition, they can **significantly lower the long term running costs** of investments, and thus link to the efficiency agenda.

Lessons from Good Practice in the Public and Private Sectors

The **lessons** from various activities in (and our own research on) the public sector to make procurement **more innovation friendly** must not be lost, but rather rolled out to those decision makers that are responsible **for the sustainable agenda**: output specification, market intelligence, risk management, political leadership, internal coordination of procurement and users. This is not about yet another goal on the back of procurers, rather, it is about understanding the long term societal and economic benefit of the next generation of eco-innovation in order to make eco-innovation procurement a regular feature.

Box 1 illustrates how procurement of a more sustainable solution was organised to trigger innovation and to overcome the specific challenges of innovation procurement.

BOX 2: PRIVATE SECTOR EXAMPLE

As a dietary staple and major contributor to greenhouse gas emissions, milk is high on the agenda for carbon reduction initiatives. Tesco is working with its milk supply chain in several ways to stimulate the development and adoption of innovations to meet carbon reduction targets. Going beyond first tier (processor) suppliers, Tesco has established direct contracts and relationships with over 700 dairy farmers through the Tesco Sustainable Dairy Group, through which Tesco can share knowledge of the best farming practices for emission reductions. But, more proactive still is Tesco's unique collaboration with the University of Liverpool through the Tesco Dairy Centre of Excellence, which has been researching innovations in dairy inputs to reduce on-farm emissions. Tesco is now pursuing collaboration with input suppliers, such as feed companies, to make innovations from this research available to farmers: their adoption can then be facilitated through the Tesco Sustainable Dairy Group.

BOX 3: MARKET TRANSFORMATION PROGRAMME SWEDEN

In the 1990s, the Swedish energy agency NUTEK/STEM implemented around 30 co-operative and catalytic Procurement Programmes at national, regional, local level. The basic idea was to detect latest energy efficient innovations and to build up combined demand for them from public agencies, industry and consumers. The programme created market transparency, applied the life cycle approach, and a range of awareness measures. This was partly supplemented with demand subsidies. In a revision of the approach, STEM created user groups and organised the articulation of demand and future needs to industry. The programmes have been evaluated, and by and large, the transformation of markets was successful. The programmes are an example of a successful, technology-specific mix of measures, supported by market intelligence, supplier interaction and demand articulation. Public procurement not only supported the uptake of innovations in public agencies, but was a catalyst for private buyers and scaled up private demand.

As research within the SCI Flagship Project has shown, large firms, with considerable market power as demanders of innovation, can create new, more sustainable trajectories for sustainable products and services. This more long term oriented, leapfrogging strategy is currently the exception rather than the rule but Box 2 shows an example that others can follow.

There are also cases where public action can stimulate private demand to create both private and social benefit. An example in Box 3 is that of Market Transformation approaches in Sweden, which were complemented with regulation and awareness measures of various kinds which have successfully driven markets towards eco-innovations.



EIGHT KEY ACTIONS

We conclude with eight key actions that would help to effect the transformation of the effectiveness of procurement as a policy instrument. These are addressed to government at both policy-making and operational levels, and to business.

1. For the step change needed across government and within firms, sustainability procurement must be open to innovative solutions. This means taking up existing innovations in the market place and actively searching for further innovation opportunities. The first of these allows capture of the low hanging fruit in the sustainability agenda and sends signals to the market about innovation adoption. The second and more important step is to understand the leverage for the green and the economic agenda that lies in **triggering** innovation, asking the market for new solutions based on outcome specifications. More often than not, this will mean new forms of **co-operation** between buyers and suppliers. Research has shown that the latter is often the basis for successful sustainable procurement and more radical innovation, as it allows for a joint understanding of the challenges and opportunities, as well as, for integrated risk management. Structures for pre-tender interaction with suppliers are of overriding importance.

2. A more strategic approach to efficiency should be taken to create a win-win situation. The current focus on efficiency and centralisation in public procurement potentially exacerbates the challenge. There is a danger that efficiency is translated into lowest costs (input), while for many types of products and services the efficiency gains of long term investments need to be taken into account. The business case for each

procurement project needs to include cost consideration *and* output efficiency. Further, cost efficiency is only one part of the equation. “More for less” does not only mean reduced costs, but better service provision – with all corresponding long term cost savings and welfare gains – *and* stimulus to firms. Public investments that link long term efficiency gains with the sustainability agenda are good candidates for being demanded in other markets as well, turning the UK into a lead market for green goods and services.

3. Centralised procurement needs to preserve and regain the intelligent customer characteristics found at lower levels of aggregation. The drive towards centralised procurement of commodities still holds opportunities for eco-innovation. Large scale demand, rising cross-government awareness and intelligent tender procedures can incentivise business to invest in next generation solutions in strategic areas. The challenge for procurement in centralised categories is to keep up and improve the capabilities and market intelligence within the public sector that allows eco-innovation orientation. This can be done through combining centralised and de-centralised expertise.

4. Business also needs to take on the eco-innovation agenda as it procures from the supply chain. Research has confirmed the link between sustainability procurement and economic performance in firms,



purchasing portfolios should include more systematically long term, eco-innovation strategies that actively search for next generation innovations and integrate supply chains as procurement partners. Large firms in particular can act as focal organisations for radical change.

5. Government should develop ways in which private procurement can be stimulated to demand more eco-innovation. There is a policy gap in terms of incentivising private procurement to demand more eco-innovation. Since the public and private sustainability agendas are highly complementary, in areas in which there is clear private demand, with the public buyer stimulating the market and triggering subsequent private demand, it is time to get serious with:

- a. **Catalytic procurement**, whereby an *initial* public purchase then spills over to private market demand; and
- b. **Cooperative procurement**, whereby public and private organisations identify similar needs; establish joint processes of market consultation; formulate joint demand *and* procure together, thus enabling critical mass even in areas of very advanced demand.

6. Government should consider radical new ways to support demand for innovation in the private sector including an insurance guarantee scheme for private buyers of socially desirable eco-

innovations. This measure would directly address the major barrier faced by innovative SMEs seeking a first customer for an innovation. Government already mitigates the risk for buyers from firms that have benefitted from grant funding as these have passed technological and financial audits. Support can go further by providing a guarantee which effectively insures the purchaser against all or part of the additional risk incurred by purchasing from an innovative SME.

7. There should be a much more systematic reflection on, as well as, sharing and roll out of good practice across the public and private sectors, such as interesting models of pre-commercial procurement and forward commitment procurement in the public sector or advanced eco-innovation approaches of firms.

8. To improve procurement of eco-innovation, the government should support awareness and clarity in the procurement and user community by outlining more clearly what is possible within the regulatory framework. This also extends to influencing the wider regulatory framework, e.g. by having clear position vis-à-vis the on-going EU Green Paper on Modernisation of Procurement.

This background paper draws on two major projects currently conducted within a set of related projects to better understand the role of public and private demand for innovation and sustainability at the Manchester University:

SUSTAINABLE CONSUMPTION INSTITUTE FLAGSHIP PROJECT

The Sustainable Consumption Institute Flagship Project, "Driving Eco-Innovation through Supply Chains" is led by Profs. Andrew McMeekin and Jakob Edler and Drs. Paul Dewick and Chris Foster. It is a two year research project looking at the potential for 'focal organisations' (large buyers with significant market share) to stimulate eco-innovation within and beyond their existing supply chains. The main empirical component of this work looks at eco-innovation in the food and drink sector, with cases on milk, beef, orange juice, bread and post consumer food and packaging waste.

Please visit <http://www.sci.manchester.ac.uk/research/production/>

UNDERSTANDING PUBLIC PROCUREMENT OF INNOVATION (UNDERPINN)

This two years project funded by the ESRC, TSB, BIS and NESTA in the context of the UK Innovation Research Centre initiative is led by Prof. Luke Georghiou and Prof. Jakob Edler. It analyses empirically, practices of innovation procurement in the UK on the basis of large scale surveys and in-depth case studies across various government departments and various policy levels. Results of this project are to be expected in late autumn 2011.

For further information see <http://underpin.portals.mbs.ac.uk/>

THE SUSTAINABLE CONSUMPTION INSTITUTE

The SCI is an interdisciplinary, academically independent research institute, established by The University of Manchester. It has a distinctive focus on innovative ways to harness the power of consumers to shape policy making in business, government and civil society, and to bring about a step change to more environmentally sustainable lifestyles. The SCI focuses on research and educational outreach across three research themes: Sustainable Consumption, Eco-Innovation and Emissions Futures.

For more information please visit <http://www.sci.manchester.ac.uk>

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