WWF

REPORT 2010

Green game-changing innovation

New business thinking from around the world

VERDANTIX
Helping You Change with the Climate

Commissioned by WWF-UK, researched by Verdantix

WORKING FOR BETTER BUSINESS

WWF is convinced that the business community offers one of the most effective routes to finding sustainable solutions to the world's pressing environmental challenges.

The credit crunch was a stark reminder that living beyond our means leads to unsustainable debt. But there's the ecological crunch, too – the use of more natural capital than we can afford. The implications of this are becoming more evident. Through our work with business, we seek to bring sustainability to both the ecological and economic systems.

There is much to gain for everyone in the pursuit of sustainable business solutions. We encourage innovation within the business community, smarter regulation from government and better informed consumers and investors. We are optimistic that these endeavours will help us all flourish within the ecological limits of the planet as we work towards a future in which people and nature thrive.

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FOREWORD

New business thinking is key to survival and success in a fast-changing world. In the face of escalating climate change and an ecological recession, businesses will need to think differently or fail.

"It will take green game-changing activities to ensure the private sector flourishes without harming, and better still, restoring the natural capital on which it depends."

Dax Lovegrove

The pressure on the private sector to play a major role in driving a low carbon economy with a 100% renewable energy future – which many believe to be feasible – presents major business opportunities to those that innovate in this direction. The increasing competition around the globe for natural resources and ecosystem services, which are already in steep decline, means that companies have to adapt fast to the declining availability of natural capital in order to become more resilient.

Leading businesses are starting to look beyond their operational impacts. They are now considering the overall carbon and ecological footprint of their suppliers and customers too. They understand that the production and consumption of goods must be manageable if a business is to cope with increasing environmental constraints.

For example, the food sector is beginning to grasp the threats that declining water availability will have on its industry. Therefore, they are starting to see that effective water stewardship will help to future-proof their business. Likewise in DIY and construction, which use large amounts of timber, are increasingly recognising the need for sustainable forest management. A recent study by The Economics of Ecosystems and Biodiversity (TEEB) lends further support to this by helping businesses to better comprehend their changing relationship with nature.

However, these moves to build business resilience need to go further – into real innovation. It will take green game-changing activities to ensure the private sector flourishes without harming, and better still, restoring the natural capital on which it depends. Such innovations are starting to emerge and many have the potential to be transferred and scaled up across global markets and sectors.

WE INVITE YOU TO SUBMIT CASE STUDIES OF YOUR OWN TO HELP US BUILD OUR BANK OF GREEN GAME-CHANGING STORIES.

The waterless washing machine, the move from products to dematerialised services, the development of non-petrochemical plant-based plastics, community-based renewable energy schemes, and the use of waste from one company as a resource for another and many other new green business solutions are rapidly changing the way in which business is done.

A number of these international innovations are captured in this bank of case studies commissioned by WWF-UK and researched by Verdantix. This bank is by no means exhaustive and the case studies are not necessarily endorsed by WWF-UK, but they demonstrate new thinking that is emerging within the private sector.

Through our green game-changing initiative, we're inviting readers, entrepreneurs and anyone working in business future-proofing to submit case studies of their own. Ones that you are involved in or are aware of. In this way, we'll build a rolling bank of green game-changing stories. It'll allow us to share innovative thinking and drive climate-safe and ecologically-sound business practices. To find out more and participate in a changing world – please visit wwf.org.uk/innovation

Dax Lovegrove
Head of Business & Industry Relations, WWF-UK

METHODOLOGY

The purpose of this study is to highlight commercially-interesting innovations in policy, products, process and strategy that illustrate how firms are benefiting from sustainable business opportunities.

Innovation can be simply defined as the introduction of something new. Many business theories have interpreted the role of innovation in business, through comparative advantage, the productivity of national economies, competitive advantage and creative destruction. All are united in concluding that innovation is crucial to the success of individual firms and economies.

This study includes familiar categories of innovation such as by process, product and business model. It also includes regulatory and partnership innovations (see Figure 1), which were considered relevant to developments in environmental sustainability. The review was open to innovations driven primarily by the commercial opportunities offered by mitigating environmental issues, and innovations where mitigation of environmental problems is secondary, but a recognised co-benefit.

The research is based on:

1. A market scan conducted using desktop research, phone interviews and existing Verdantix research on sustainable business innovations.
2. The application of screening criteria (see Figure 2) to select the 20 most relevant innovations.
3. Further desktop research and analysis to explore the potential of the 20 innovations selected.

The initial market scan resulted in a database of 120 sustainable business innovations. It listed the stage of evolution of the innovation, its environmental sustainability benefits, and its existing or potential commercial applications. Screening criteria were applied to identify the most relevant innovations (see Figure 1). Further research was then carried out on each of the shortlisted 20 innovations.

Each innovation case study contains a definition, details of the innovators, the adopters, the environmental sustainability benefits, and the potential commercial impact.

Figure 1: Scope of innovations included in the market scan

BUSINESS MODEL INNOVATION	Finds new markets in which to apply a firm's core competencies, or creates an entirely new form of business.
PRODUCT INNOVATION	Ranges from incremental enhancements to existing products, to entirely new products.
APPLICATION INNOVATION	Taking existing products and services into new or adjacent markets, where they can serve new purposes.
PROCESS INNOVATION	Ranges from enhancements to existing processes, to new processes across the entire value chain. It includes supply chain, manufacturing, logistics and marketing.
REGULATORY INNOVATION	Regulation and policies are reformed or developed to encourage innovation and generate commercial benefits.
PARTNERSHIP/ALLIANCE INNOVATION	Innovation that has come from a partnership or alliance between organisations.

Figure 2: Innovation screening criteria

KEY QUESTION	CRITERIA	DEFINITION
IS IT RELEVANT?	Genuine environmental sustainability benefits	Does the innovation provide significant benefits across one or more dimensions of environmental sustainability: energy efficiency, the decarbonisation of energy, water efficiency, ecosystem health (or services)?
	On or close to market	Has it achieved some adoption already, or is it close to reaching the market?
DOES IT HAVE THE POTENTIAL TO BE GAME-CHANGING?	Is it scalable?	The innovation should have the potential to achieve a high level of market adoption.
	Is it lasting?	The innovation should be likely to achieve lasting adoption.
	Is it different?	The innovation should be sufficiently different in nature from existing market offerings.
	Does it have the potential for a high commercial impact?	Could it change the competitive landscape? Could it alter existing markets and create new ones?

SUMMARY: 20 HIGH – POTENTIAL INNOVATIONS

Figure 3

NAME	INNOVATION CLASS	STAGE OF EVOLUTION	GEOGRAPHY	ENVIRONMENTAL SUSTAINABILITY BENEFIT	MAIN INDUSTRY AFFECTED
ADAPTIVE BUILDINGS	Product	Launch	US	Low-carbon energy generation	Construction and materials
CARBON NEGATIVE CEMENT	Product	Launch	US/UK	Carbon sequestration	Construction and materials
PLANT FEEDSTOCKS FOR POLYMERS	Product	Launch	US/UK	Reduce, reuse recycle	Chemicals and basic resources
TELEPRESENCE	Product	Growth	US	Decarbonising transport	Telecoms and technology
ENVIRONMENTAL SENSOR NETWORKS	Product	Development	US	Ecosystem health	Telecoms and technology
ELECTRIC VEHICLE VALUE CHAIN	Business Model	Growth	US	Decarbonising transport	Transportation/ mobility
MONITORING HOUSEHOLD ENERGY USE	Product	Launch	US/Europe	Energy efficiency	Consumer goods, services and healthcare
'CRADLE TO CRADLE' DESIGN FRAMEWORK	Process	Growth	US	Reduce, reuse recycle	Consumer goods, services and healthcare
AD-FUNDED SOLAR STREET LIGHTS	Business model	Launch	India	Low-carbon energy generation	Consumer goods, services and healthcare
'TOP RUNNER' PRODUCT STANDARDS RACE	Regulatory	Growth	Japan	Energy efficiency	Consumer goods, services and healthcare

NAME	INNOVATION CLASS	STAGE OF EVOLUTION	GEOGRAPHY	ENVIRONMENTAL SUSTAINABILITY BENEFIT	MAIN INDUSTRY AFFECTED
WATERLESS WASHING	Product	Development	UK	Water	Consumer goods, services and healthcare
CONSUMER PRODUCT SHARING	Business model	Growth	US/Europe	Reduce, reuse recycle	Consumer goods, services and healthcare
HIGH ALTITUDE WIND POWER	Product	Development	US	Low-carbon energy generation	Utilities
ONSITE FUEL CELL POWER GENERATION	Product	Launch	US	Energy efficiency	Utilities
COUPLING PROFITS TO ENERGY DEMAND REDUCTION	Regulatory	Growth	US	Energy efficiency	Utilities
ESCOS FOR HOUSEHOLD RENEWABLE ENERGY	Business model	Launch	US	Low-carbon energy generation	Utilities
BIOMASS POWER SUPPLY FOR THE DEVELOPING WORLD	Business model	Growth	India	Low-carbon energy generation	Utilities
PRINTED THIN FILM SOLAR PANELS	Product	Launch	US	Low-carbon energy generation	Utilities
CLOSED CYCLE WATER RECYCLING	Process	Growth	Singapore	Water	Utilities
INDUSTRIAL SYMBIOSIS FACILITATOR	Partnership	Growth	UK	Reduce, reuse recycle	All

ENVIRONMENTAL AND COMMERCIAL REWARDS

Sustainable business innovations are being developed across many sectors in response to current and expected transformation of markets. The innovations uncovered in this market scan promise significant commercial opportunities and contribute to fundamental issues of environmental sustainability – in areas such as resource scarcity, climate change and erosion of ecosystem health.

Our key conclusions are that:

- **Innovation is occurring across multiple levels.** The market scan uncovered innovations at all levels of business, from product and processes to business models. Firms are also shaping innovations that operate above the level of the individual corporation. These include partnerships for mutually beneficial re-purposing of waste streams (a process known as industrial symbiosis) and innovative regulatory frameworks (see Figure 3).
- **Sustainable business innovations are found worldwide.** Even though half of the innovations originated in the US, there were also several examples from the UK and Europe, and notable innovations from Singapore, India and Japan.
- **Innovations will generate both commercial and environmental benefits.** Each of the 20 innovations captured in the market scan promise significant commercial opportunities while mitigating problems of environmental sustainability. In many cases the innovations hold great commercial potential precisely because they mitigate environmental problems. In others, it may be a contributing factor to their commercial success.

New business thinking is not only key to survival and success, but crucial to finding a sustainable balance to both economic and ecological systems.

Green game-changing bank

CONSTRUCTION AND MATERIALS

ADAPTIVE, SELF-OPTIMISING BUILDINGS

Please see inside back cover for key of benefit icons.

DEFINITION	Adaptive buildings use sensor networks and motorised building components to respond to environmental changes such as wind, rain, solar radiation and conductive heat.
WHO ARE THE INNOVATORS?	**The Adaptive Building Initiative** was founded by Buro Happold and Hobermann Associates in 2008 to design and produce adaptive building facades and envelopes. Architecture firm **Skidmore, Owings & Merrill** has designed the Pearl River Tower. The structure directs wind to a pair of openings at its mechanical floors, where travelling winds push turbines which generate energy for the building.
WHO ARE THE ADOPTERS?	The **Campus of Justice**, in Madrid, utilises an intelligent shading system to minimise solar radiation. **POLA**, a Japanese cosmetics manufacturer, has implemented an adaptive shading system for its showroom in Tokyo.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	An adaptive, intelligent building system can respond to external and internal changes in temperature and weather. This helps to minimise operating costs from ventilation, heating, cooling and lighting, through the capture of greater levels of solar and wind power and water. This higher level of optimisation can significantly reduce the energy consumption of large buildings through intelligent shading and ventilation while also harvesting all available renewable energy and water. Recent advances in sensor technology and reduction of costs in motorised systems have now made this economically feasible.
WHY IS IT POTENTIALLY GAME-CHANGING?	The UK's building stock generates 27% of the country's total CO_2 emissions. The bulk of emissions from the built environment are created during the lifetime operation of a building. Technology to minimise the energy consumed in heating and cooling will be essential in reducing this footprint. The exterior of a building also offers large surfaces for renewable energy generation and water collection. In particular, this technology offers the potential of emissions reductions from large new buildings. This is a significant portion of the built environment in some regions, particularly given China's objective of building 400 new cities by 2020[1].

[1] In 2001, China's state minister of civil affairs, Doje Cering, stated the ambition to build 400 new cities by the year 2020.

Adaptive systems, such as the roof shading system above, respond in real time to changes in temperature and weather to optimise heating, cooling and lighting within buildings.

CONSTRUCTION AND MATERIALS

CARBON NEGATIVE CEMENT CO_2

DEFINITION	Cement that absorbs and sequesters carbon dioxide (CO_2) during the manufacturing process.
WHO ARE THE INNOVATORS?	**Calera** is a US-based firm that has designed a process which captures CO_2 and sulphur dioxide (SO_2) emissions from flue gas, using an aqueous mineralisation process similar to that used by coral. This results in the formation of metastable magnesium carbonate, calcium and bicarbonate minerals, which are extracted for cement or aggregate manufacture. **Novacem** was founded in 2007, based on technology developed by Imperial College London scientists. Novacem has developed a cement using magnesium silicate, which lowers the required processing temperature and absorbs CO_2 as it hardens. The result is that with every tonne of cement made, it absorbs up to 100kg more CO_2 than it emits during production.
WHO ARE THE ADOPTERS?	Bechtel Power is developing facilities utilising Calera's technology.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Net carbon sequestration from building materials. This produces a double CO_2 saving, replacing the emissions that would be associated with normal cement manufacturing, and capturing CO_2 either from the atmosphere or flue gas exiting a power station.
WHY IS IT POTENTIALLY GAME-CHANGING?	The potential to turn one of the world's most carbon-intensive industries (cement manufacturing is responsible for around 5% of global emissions – more than aviation) into a method of storing carbon. Sequestering CO_2 in the built environment has enormous potential, due to demand for carbon capture and storage technology and the global market for cement and aggregate. In particular, developing countries have enormous construction needs over the next five decades, while also being challenged to control their emissions.

CHEMICALS

PLANT FEEDSTOCKS FOR POLYMERS

DEFINITION	Plant-based substitutes for oil-based chemical feedstocks. Currently the majority of feedstocks used in plastics manufacturing are derived from oil.
WHO ARE THE INNOVATORS?	**Amyris** is a renewable chemical products manufacturer. The firm uses yeasts to transform plant sugars into the building block chemicals used by the food, cosmetics and automobile industries, replacing traditional fossil-fuel based feedstocks. **NatureWorks** is a wholly-owned subsidiary of **Cargill**, which is a firm with 138,000 employees. Cargill produces food, agricultural and industrial goods. NatureWorks produces Ingeo plastic using a process that converts plant starch into a polylactide polymer. **Reluceo** is a privately-owned green chemistry firm based in Minneapolis. It produces plant-based polymers using hemicelluloses and cellulose.
WHO ARE THE ADOPTERS?	Amyris' technology and processes are still at the development stage, but it has entered into commercial agreements with P&G to supply Biofene, a renewable feedstock chemical designed to replace petroleum-derived products.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Polymers sourced from renewable resources substitute fossil-fuel use. In addition, they can ultimately be composted by commercial facilities.
WHY IS IT POTENTIALLY GAME-CHANGING?	Over the medium term, the combination of policies to reduce demand of oil-based products (such as emissions regulations), and supply constraints will force a rethink of entire value chains in the petro-chemicals industry. Substitutes for crude-based chemical feedstocks will become increasingly necessary to break our dependency on oil. Biodegradable polymers open up more sustainable product life-cycles for containers, plastics and artificial fibres.

TELECOMS AND TECHNOLOGY

TELEPRESENCE  CO_2

DEFINITION	Substituting business travel with high-definition videoconferencing.
WHO ARE THE INNOVATORS?	**Cisco** offers TelePresence systems. **HP** has developed HP Halo Telepresence Solutions. **Polycom** sells Polycom Telepresence Solutions. AT&T markets the **AT&T** Telepresence Solution.
WHO ARE THE ADOPTERS?	Telepresence is a new technology, but there are early adopters across multiple industries, including Bayer AG, Aviva, PepsiCo, Novartis and Danske Bank.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Travel reduction through replacement with virtual meetings, which will reduce greenhouse gas emissions from transportation. Large firms in the US and UK could achieve CO_2 reductions of 5.5 million tonnes by 2020 by using just 10,000 telepresence units[2].
WHY IS IT POTENTIALLY GAME-CHANGING?	Substituting telepresence for business travel can create significant cost savings with a rapid return on investment, and substantially reduce carbon emissions. This combination makes a very appealing business case.

10,000

IF LARGE UK AND US BUSINESSES IMPLEMENTED 10,000 TELEPRESENCE UNITS - 5.5 MILLION METRIC TONNES OF CO_2 EMISSIONS WILL BE SAVED FROM REDUCED BUSINESS TRAVEL.

[2] Verdantix/ Carbon Disclosure Project Report, The Telepresence Revolution 2010.

TELECOMS AND TECHNOLOGY

ENVIRONMENTAL SENSOR NETWORKS

DEFINITION	Networks of cheap micro-sensors, which enable detailed monitoring of the health of ecosystems, improve resource management and adaptive buildings.
WHO ARE THE INNOVATORS?	**HP** is developing micro-sensor network technology for a project it describes as the Central Nervous System for the Earth (CeNSE).
WHO ARE THE ADOPTERS?	This technology is still under development, but HP has already announced a commercial application with Shell for use in optimising oil extraction from wells.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	There are many potential benefits of high resolution, real-time data from the environment. These benefits might include ecosystem health monitoring for critically-endangered habitats, more accurate resource management for fisheries, forest carbon, watersheds and aquifers, and adaptive buildings that respond and adapt to changes in temperature and weather to manage heating, cooling and lighting.
WHY IS IT POTENTIALLY GAME-CHANGING?	Sensor networks are regarded as potential game-changers in the environmental and earth sciences. Cheap and numerous micro-sensors, connected to data storage, analysis and end-user interfaces, have the potential to dramatically improve the manner in which we monitor and manage our impact on the Earth's ecosystems. They also enable a more adaptive built environment (see 'Adaptive, self-optimising buildings').

TRANSPORTATION/MOBILITY

ELECTRIC VEHICLE VALUE CHAIN

DEFINITION	Electric vehicle (EV) infrastructure and services, comprising a system of charging points, battery exchange facilities, driver and network software, and connections to renewable energy sources.
WHO ARE THE INNOVATORS?	**Better Place** was founded in 2007 by Shai Agassi in San Francsico with initial $200 million of funding. Since then the firm has raised total global investment of $700 million and established a separate business unit for each country where they are planning a commercial launch. These countries include Australia, Denmark, Israel and North America, with pilot projects in Japan.
WHO ARE THE ADOPTERS?	Better Place has formed partnerships to implement EV infrastructure with the government of Israel, the province of Ontario, the city of Copenhagen, and the states of California and Hawaii. In February 2010, Israel opened its first Better Place EV demonstration centre. The firm now has 150 corporate fleet owners signed up to participate in its Israel network. Better Place plan for investment of up to $1 billion over time for a complete roll out of a San Francisco Area network.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	The electricity for Better Place batteries will come from renewable energy sources including wind, solar, wave and geothermal. Better Place has partnerships with power generators like ActewAGL, DONG and the Hawaiian Electric Company to purchase electricity from renewable sources. Additional demand for renewable energy by Better Place users will be met through market purchases.
WHY IS IT POTENTIALLY GAME-CHANGING?	Better Place is accelerating the formation of an EV ecosystem based around their network of charging, battery exchange stations, and driver and network services. These services are critical to managing demand and integrating intermittent renewable energy sources. Better Place's partnership with early-adopting countries, states and cities has crystallised the demand for EVs from Better Place's partners, the Renault-Nissan Alliance and Chery Auto Ltd. The first Renault electric cars with switchable batteries will come to market in the second half of 2011, in time for the planned commercial launch of Better Place in Denmark and Israel in 2011. Nissan is currently not planning to build electric cars with switchable batteries but plan a roll out of their EV Leaf model later in 2010.

© BETTERPLACE.COM

Electric vehicle (EV) infrastructure providers, such as Better Place, can give access to a network of charge points, battery switch stations (above) and GPS journey planners to make EVs easier to use.

CONSUMER GOODS, SERVICES AND LIFESTYLE

MONITORING HOUSEHOLD ENERGY USE

DEFINITION	Interface media that encourages efficient energy management in the home. Data is translated from smart meters into easy-to-use interfaces that enable residents to see levels of energy use, set energy saving goals and track progress.
WHO ARE THE INNOVATORS?	**Onzo** is a London-based firm that provides utilities with customer insights through its 'smart energy' kit. **Google** is an internet search provider with US$22 billion revenue. It has its headquarters in San Francisco. Google offers a PowerMeter software tool for home energy management, in partnership with four utilities firms.
WHO ARE THE ADOPTERS?	The number of smart meter owners using Google PowerMeter does not seem to be publicly available. Google partners with utilities such as Yello Strom, San Diego Gas Electric, and firstutility. It also partners with energy-monitoring device manufacturers AlertMe, Current Cost and the Energy Detective.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Increasing awareness and energy efficiency, and ultimately minimising residential energy consumption.
WHY IS IT POTENTIALLY GAME-CHANGING?	As household energy prices increase and utilities are given incentives to improve the home energy efficiency of their customers, demand for energy management tools will increase. Well-designed interfaces will enable more sustainable energy-use behaviour. As the market develops, interfaces will get more sophisticated – moving beyond displaying energy data and analysis of energy use, to media products that reward good behaviour.

2020

THE UK GOVERNMENT PLANS TO ROLL OUT SMART METERS TO EVERY HOME BY 2020.

CONSUMER GOODS, SERVICES AND LIFESTYLE

'CRADLE TO CRADLE' DESIGN FRAMEWORK

DEFINITION	Comprehensive new sustainability certification, and an open database for sustainable product design, based on the 'cradle to cradle' philosophy. This moves beyond 'cradle to grave' by aiming to create products with recycling or reuse in mind.
WHO ARE THE INNOVATORS?	**McDonough Braunart Design Consultants** (MBDC) has been consulting with clients to implement its 'cradle to cradle' design framework since 1995. It has donated the data behind the methodology to the non-profit Green Products Innovation Institute, which will administer the Cradle to Cradle Certification and develop a public database facilitating sustainable design.
WHO ARE THE ADOPTERS?	MBDC currently lists 334 products that have achieved cradle to cradle certification. **Aveda** has achieved gold standard certification for some of its shampoo and conditioner products. **Shaw Industries** was awarded silver standard for its EcoFiberTouch carpet.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Designers are encouraged to create products that are suitable for future life-cycles, while also being safe for people and the environment. Certification requires the transparency and traceability of chemicals used. Other product standards in the certification include material health, material reutilisation, renewable energy use, water stewardship and social responsibility.
WHY IS IT POTENTIALLY GAME-CHANGING?	The resources behind this comprehensive sustainable design framework have been made publicly available through the Green Products Innovation Institute. The aim is to spur a rush of innovative sustainable designs by allowing free use of the design framework and data on alternative processes, material and chemicals.

CONSUMER GOODS, SERVICES AND LIFESTYLE

AD-FUNDED SOLAR STREET LIGHTS

DEFINITION	Solar-powered streetlights in India, funded entirely by revenues from attached advertising. Solar lighting is provided free of charge in exchange for the advertising space below the light.
WHO ARE THE INNOVATORS?	Shuchi Energy Ad Promotions is a joint venture formed by **Sunwatt** and **Shuchi**, based in Hyderabad, India. The firm offers lighting and advertising space in dozens of schools, universities and colleges across India.
WHO ARE THE ADOPTERS?	Advertising agencies such as Ogilvy and Mather Advertising, Portland and Madison.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Free solar-powered lighting for cities in the developing world.
WHY IS IT POTENTIALLY GAME-CHANGING?	This is an innovative business model which generates environmental benefits by funding the implementation of renewable energy micro-generation. There is likely to be greater scope for supporting the costs of renewable energy generation through advertising revenues. Installations such as solar panels are highly visible, and offer immediately positive brand associations for many consumers.

CONSUMER GOODS, SERVICES AND LIFESTYLE

‘TOP RUNNER’ PRODUCT STANDARDS RACE

DEFINITION	Product standards that require a certain level of efficiency to be met. Manufacturers strive to achieve the ‘Top Runner’ status in their product category and products that fail to meet the baseline are labelled negatively.
WHO ARE THE INNOVATORS?	**Japan’s Top Runner programme** sets minimum efficiency standards for 23 categories of machinery, equipment and vehicles under the Energy Conservation Law. The programme applies an efficiency baseline for each category, which is periodically raised, according to the speed of innovation. A baseline is set by the leading product within each category, labelled the Top Runner. A timeframe is then negotiated with manufacturers within which all other products must meet that level as a minimum standard. Products failing to meet the minimum standard within the timeframe are labelled negatively.
WHO ARE THE ADOPTERS?	Manufacturers of automobiles, consumer appliances, copiers, vending machines, heaters and transformers for the Japanese market are obliged to comply with the Top Runner programme.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Increase the environmental performance of products through a race to the top, where the leaders are rewarded and laggards are negatively labelled. Product energy efficiency is currently targeted, but other environmental metrics such as water efficiency are equally relevant.
WHY IS IT POTENTIALLY GAME-CHANGING?	This model applies a mix of regulation, which fosters industry collaboration, competitive dynamics and reputational risk. Though Japanese firms may be particularly sensitive to reputational risks, the applicability is universal.

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JAPAN’S TOP RUNNER PROGRAMME INCLUDES 18 PRODUCT CATEGORIES FROM VEHICLES, COMPUTERS, AIR CONDITIONERS, HEATERS AND ELECTRICAL APPLIANCES.

CONSUMER GOODS, SERVICES AND LIFESTYLE

WATERLESS WASHING

DEFINITION	Washing machine technology that uses absorbent polymers to achieve a 90% reduction in water consumption.
WHO ARE THE INNOVATORS?	**Xeros** is a UK start-up which emerged from the University of Leeds. It has patented the nylon polymer cleaning process.
WHO ARE THE ADOPTERS?	There are no current adopters, as Xeros' technology is still under development. The firm is aiming to produce a machine implementing its technology for the commercial laundry sector initially.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	The key benefit is the reduction in use of water. In addition, less electricity and smaller amounts of detergents are required than in conventional washing machines, reducing carbon emissions and water treatment costs.
WHY IS IT POTENTIALLY GAME-CHANGING?	Water conservation is an increasingly important issue as many regions of the world forecast water stress. This technology has not yet reached the market, but has the potential to make enormous improvements in household water efficiency, while also reducing energy consumption. Average UK domestic water consumption in 2007-08 was 148 litres per person per day[3]. In the UK, around 13% of household water consumption is used in clothes washing[4].

90%

THE WATERLESS WASHING MACHINE USES 90% LESS WATER THAN WHAT'S USUALLY REQUIRED.

[3] Defra, Sustainable Development Indicator 16: Domestic water consumption: www.defra.gov.uk/sustainable/government/progress/national/16.htm.

[4] Waterwise: www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/save_water_at_home.html.

CONSUMER GOODS, SERVICES AND LIFESTYLE

CONSUMER PRODUCT SHARING

DEFINITION	Firms supplying services such as web platforms that facilitate the sharing of consumer goods. This can take the form of peer-to-peer rental sites, car-sharing services or clothes hire services.
WHO ARE THE INNOVATORS?	**ZipCar** is a US-based firm offering a car-share service in the US and Europe (through StreetCar). **Zilok**, founded in 2007, offers an online rental marketplace for individuals to rent their goods to other users.
WHO ARE THE ADOPTERS?	The combined membership of ZipCar and its recent acquisition StreetCar is around 400,000.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	These services have the potential to lower material consumption – without reducing standards of living – through substituting ownership of under-used goods for rental or sharing.
WHY IS IT POTENTIALLY GAME-CHANGING?	Innovative web-platforms and business models like ZipCar could facilitate a shift from ownership to rental or sharing for many types of goods. The impact on consumer goods firms if a large segment of the population adopted these practices would be significant. However, the environmental benefits are dependent on an overall reduction in material consumption per capita, which is yet to be demonstrated. Consumers who rent rather than own may then spend the money they save on other energy-intensive or polluting goods. This is known as the 'rebound effect'.

UTILITIES

HARNESSING HIGH-ALTITUDE WIND

DEFINITION	Generating electricity from high-altitude winds, using floating turbines or kites. Currently at the prototype stage, with firms such as Magenn Power looking to begin commercial production in 2010-11.
WHO ARE THE INNOVATORS?	**Magenn Power**, founded by Fred Ferguson, is based in Ottawa and Washington. The firm is developing tethered helium-filled air rotors, which can transfer electricity through the tether to a battery for mobile deployment, or into the grid for fixed deployments. **Makani Power** is a start-up company based in Alameda, California. The firm is reported to have received US$20 million from Google. Makani Power is currently developing kite-powered turbines. The kite generates lift, pulling on a cable that tethers it to a ground-based turbine.
WHO ARE THE ADOPTERS?	No current adopters.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Like other forms of electricity generated from wind, it provides sustainable, long-term, zero-carbon energy. Initial studies of high-altitude wind power densities indicate levels far in excess of those available at ground level[5].
WHY IS IT POTENTIALLY GAME-CHANGING?	High-altitude wind is a global and abundant energy resource. Technology enabling access to altitudes of only 500m would result in significant increases in wind power density. Though high-altitude winds are on average more constant and reliable than low-altitude winds, they still present a problem of intermittency due to fluctuating jet streams. In practice, this means that power generation is likely to require supporting battery technology for energy.

1,000m

A HIGH ALTITUDE WIND TURBINE CAN FLY AS HIGH AS 1,000M – DWARFING EXISTING 100M TURBINES.

[5] Cristina L Archer and Ken Caldeira, 'Global Assessment of High-Altitude Wind Power', Energies 2, no. 2 (5, 2009): 307-319.

Hovering turbines or kites have the potential to harness high altitude winds to generate electricity.

UTILITIES

ONSITE FUEL CELL POWER GENERATION

DEFINITION	Onsite energy generation using solid oxide fuel cells. These fuel cells convert fuel to electricity using an electro-chemical process. Low-cost ceramic materials and high electrical efficiencies make solid oxide fuel cells (SOFC) cost-effective, even without the combined heat and power (CHP) operation that fuel cells typically rely on to provide economic value.
WHO ARE THE INNOVATORS?	**Bloom Energy** was founded in 2001, and has its headquarters in Sunnyvale, California. Bloom Energy has developed 'Energy Servers' which use SOFC technology to generate 100kW of power.
WHO ARE THE ADOPTERS?	Though Bloom's Energy Servers have only recently been launched, early adopters include Google, ebay, FedEx, Bank of America, Walmart and Coca-Cola.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	**Bloom Energy Servers** offer highly efficient onsite power generation. It also has the capacity to convert fuel to electricity at nearly twice the rate of legacy technologies. They are typically fuelled by natural gas but are compatible with biogas, which is a renewable fuel. They also come in many sizes – a stack of Bloom Energy cells (the size of a loaf) will be enough to power an average home.
WHY IS IT POTENTIALLY GAME-CHANGING?	Rising energy prices and the threat of future energy supply crises makes efficient, onsite energy generation attractive for energy-hungry facilities such as data centres.

100kW

EACH BLOOM ENERGY SERVER PROVIDES 100KW OF POWER, ENOUGH TO MEET BASELOAD NEEDS OF 100 HOMES OR A SMALL OFFICE BUILDING.

UTILITIES

COUPLING PROFITS TO ENERGY DEMAND REDUCTION

DEFINITION	Regulation model that couples utility provider profits to a reduction in consumer demand.
WHO ARE THE INNOVATORS?	**Californian Power Utilities Commission**. California applies a complex body of legislation, comprising regulation of utilities and financial incentives. The key innovation has been to decouple energy sales from profit, by fixing revenues. Firms are thus given incentives to maximise profits through fixed or variable cost savings, including supporting customer energy-efficiency applications.
WHO ARE THE ADOPTERS?	The state of California.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Improvements in customer energy efficiency are achieved through the efforts of utility companies.
WHY IS IT POTENTIALLY GAME-CHANGING?	State-level regulation that decouples sales from revenues has enormous potential to increase energy efficiency, as demonstrated in California. The applicability of this type of regime extends to all privatised utility markets, where demand reduction plans are desirable – principally in electricity and water markets.

55%

THE AVERAGE CALIFORNIAN USES ABOUT A THIRD LESS ENERGY THAN THE AVERAGE AMERICAN AND EMITS ONLY 55% AS MUCH CO_2.

UTILITIES

ESCOS FOR HOUSEHOLD RENEWABLE ENERGY

DEFINITION	An Energy Service Company (ESCO) operating in the residential market, offering household renewable energy generators with no up-front costs. The revenues from the electricity generated are shared between the energy service company and the household.
WHO ARE THE INNOVATORS?	**SolarCity**, based in California, provides solar energy to businesses, homeowners and government. Its **SolarLease** offers homeowners onsite solar panels with no upfront costs, overcoming a key barrier to uptake among homeowners.
WHO ARE THE ADOPTERS?	PG&E has announced a US$60 million financing package to enable SolarCity to install more than 1,000 solar systems for households. PG&E will receive a share of the revenues from the SolarLease contracts.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Accelerated installation of residential solar energy.
WHY IS IT POTENTIALLY GAME-CHANGING?	While contracting for energy efficiency and renewables has been commonplace among businesses for decades, ESCOs servicing the residential market are extremely rare[6]. This is a high potential market: approximately 20% of US carbon emissions is generated from residential buildings[7], of which a significant part can be addressed by generating solar electricity.

[6] Liberating the power of energy services and ESCOs in a liberalised energy market, Paolo Bertoldi, Mark Hinnells and Silvia Rezessy, European Commission DG JRC, University of Oxford and Central European University, 2006.

[7] Towards a climate-friendly built environment, M Brown, F Southworth, T Stovall, Pew Centre on Global Climate Change, 2005.

UTILITIES

BIOMASS POWER SUPPLY FOR THE DEVELOPING WORLD

DEFINITION	Electricity is provided on a 'pay-for-use' basis, with participating households connected up to a local biomass plant. The biomass plants are installed at no cost to the villages by the energy supplier, and biomass fuel is supplied by the villagers at negotiated rates.
WHO ARE THE INNOVATORS?	**Husk Power Systems** (HPS), founded in 2008, is providing electricity to the Indian market using 35-100kWh biogasification plants fuelled by rice husks.
WHO ARE THE ADOPTERS?	HPS currently supplies electricity to around 25 villages across the state of Bihar, India. Each village is composed of around 500 households. HPS expects to establish over 1,000 new installations across India, Nepal, Indonesia and Cambodia over the next five years.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Renewable power generation for off-grid rural villages in South Asia. A successful business model for delivering renewable energy supply to developing world villages would meet both development and environmental needs.
WHY IS IT POTENTIALLY GAME-CHANGING?	It is estimated that 1.6 billion people worldwide still lack access to electricity services. Meeting this development need with renewable energy sources is a great challenge, but one that HPS has demonstrated is possible. Rice husks are an abundant source of biomass in the rice growing regions of rural South Asia. This technology simply converts what would otherwise be a waste stream into a fuel for renewable power generation.

100kWh

A BIOGASIFICATION PLANT FUELLED BY RICE HUSKS CAN GENERATE UP TO 35-100KWH OF POWER

UTILITIES

PRINTED THIN FILM SOLAR PANELS

DEFINITION	Thin film solar photovoltaic (PV) panel manufacture, applying technology from the printing industry to reduce production costs. This is an area of continuous innovation as firms experiment with new materials, printing technologies and processes.
WHO ARE THE INNOVATORS?	**Nanosolar** applies equipment from the printing industry to reduce the production costs of its thin film solar cells. Californian start-up **Solexant**, founded in 2006 by Dr Damoder Reddy, is currently developing a printed thin film solar cell incorporating inorganic nanocrystals.
WHO ARE THE ADOPTERS?	**Nanosolar** manufactures its Nanosolar Utility Panel for utility firms EDF EN, Beck Energy, AES Solar and JuWi to build solar power plant projects.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Low cost solar panels enable greater uptake of small-scale generation, and greatly improve the economics of utility-scale solar installations.
WHY IS IT POTENTIALLY GAME-CHANGING?	Thin film solar PV has the potential to break the cost barrier and rapidly accelerate the implementation of utility-scale solar power installations, without relying on government subsidies.

UTILITIES

CLOSED CYCLE WATER RECYCLING

DEFINITION	The use of reclaimed wastewater in potable water supply. Closed cycle water recycling uses a combination of established water treatment technologies (microfiltration, reverse osmosis and ultraviolet radiation) to reclaim potable water from wastewater.
WHO ARE THE INNOVATORS?	The city of **Singapore** meets 30% of its potable water demand by using reclaimed wastewater. **Orange County**, California has implemented the technology as part of its Groundwater Replenishment System. It does not add treated water to potable supply, but returns it to aquifers to prevent the intrusion of salt-water.
WHO ARE THE ADOPTERS?	The citizens of Singapore and Orange County.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Wastewater reclamation results in greater water efficiency by lowering the volume that needs to be extracted from aquifers and other water resources. The process also results in reduced energy consumption, as water is only purified once, rather than purification before its release into freshwater resources and further purification on later extraction.
WHY IS IT POTENTIALLY GAME-CHANGING?	Forecasts point to increasing water stress in many regions of the world as the 21st century progresses. Many areas are already experiencing shortages of potable water and dangerously low aquifers. Shifting to highly-efficient utilisation of water resources through recycling is a priority in many regions. Key steps towards this goal are innovative reclamation processes and building consumer acceptance of drinking reclaimed water.

30%

SINGAPORE MEETS 30% OF ITS POTABLE WATER DEMAND BY USING RECLAIMED WASTEWATER.

NETWORK

INDUSTRIAL SYMBIOSIS FACILITATOR

DEFINITION	A membership network that brings together organisations for the physical exchange of materials, energy, water and/or by-products together with the shared use of assets, logistics and expertise. For instance, it enables them to reuse, re-process and recover waste streams in ways that are mutually profitable.
WHO ARE THE INNOVATORS?	UK-based **International Synergies** was established in 2005 to identify and deliver industrial ecology solutions worldwide. It runs the **National Industrial Symbiosis Programme** (NISP) in the UK, which between 2005 and 2010 achieved cost savings of £780 million, saved 47 million tonnes of industrial water, and reduced industrial CO_2 emissions by 30 million tonnes amongst its network.
WHO ARE THE ADOPTERS?	**Spectrecom** was able to source waste insulation material for new premises from **Laing O'Rourke**. **MJ Allen's** foundry avoided the significant cost of sending 500 tonnes of waste sand to landfill by partnering with **Hanson**, where it was used in asphalt manufacturing.
WHAT ARE THE ENVIRONMENTAL SUSTAINABILITY BENEFITS?	Improving resource efficiency and reducing waste through mutually profitable partnerships. The cumulative impact of individual firms making more productive use of waste is very large. From 2005 to 2010, the UK NISP managed to divert 35 million tonnes of waste from landfill, and reduced demand for virgin materials by 48 million tonnes.
WHY IS IT POTENTIALLY GAME-CHANGING?	Industrial symbiosis programmes can facilitate partnerships that generate mutual value and improvements in resource efficiency, cost savings and new revenue. Typically firms are unaware of the value that their waste materials may hold for other industries. In the UK, NISP was established in response to demand from industry, and has demonstrated the benefits of membership and sharing information on available waste resources. This model is applicable worldwide.

KEY OF BENEFIT ICONS

Carbon reduction

Energy generation

Energy efficiency

Reduce, reuse, recycle

Water efficiency

Low carbon transport

Biodiversity protection and restoration

Green game-changing facts

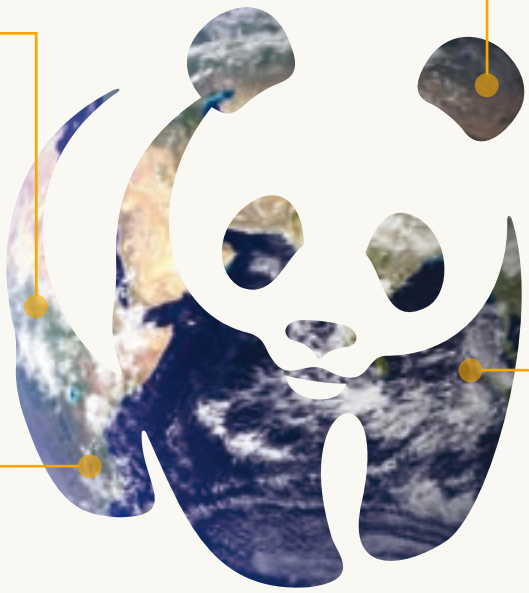
100% RECYCLED

US$500BN

Markets for low carbon technologies will be worth at least US$500 billion by 2050 if the world acts on the scale required.

2014

According to our *Climate Solutions 2* report, the world must initiate a low carbon revolution by 2014 or else it will make it impossible for market economies to lower emissions enough to mitigate the worst impacts of climate change.



US$2-6TN

Sustainability-related business opportunities in natural resources (including energy, forestry, food and agriculture, water and metals) may be in the range of US$2-6 trillion by 2050.

2020

The certified agricultural products market was valued at over US$40 billion in 2008 and may reach up to US$210 billion by 2020.

WWF

Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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