

GREEN INNOVATION & DESIGN

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Clive Cookson looks at how companies such as Riversimple with its two-seat car powered by fuel cells are thinking ahead

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Big names see which way the wind is blowing

Fiona Harvey finds that reshaping products and services around sustainable principles is a business issue that will not go away – despite the recent financial crisis and recession

Sustainability is now the key driver of innovation. So proclaimed three prominent business thinkers – CK Prahalad, Ram Nidomolu and MR Rangaswami – in the Harvard Business Review a year ago.

"In the future, only companies that make sustainability a goal will achieve competitive advantage," they warned. "That means rethinking business models as well as products, technologies and processes."

Rethinking products and business models requires huge effort, and input from all parts of a company. As the authors note, it is a process that can easily take a decade to achieve. Yet in research covering 30 big companies, they found that the decision to "green" a company's products and services quickly became a "motherlode of organisational and technological innovations that yield both bottom-line and top-line returns" – even in the midst of a recession.

Green innovation has been one of the most striking trends in business in the past five years, with a variety of big multinationals and household names reshaping their businesses along green principles.

One of the first was General Electric, which with much fanfare in 2005 launched its "ecomagination" initiative. The company put all its environmental goods – energy-efficient lighting, wind turbines, eco-friendly paints and many more – under a single "ecomagination" brand, and pledged to increase the value of the portfolio, and to pour research and development dollars into it.

GE has come under some criticism for including products in the brand that some do not regard as green, such as nuclear power technology and fossil fuel power components that qualify because they are more energy-efficient than their predecessors. However, it has continued to expand the product range.

Competitors were swift to follow. Philips announced it too would separate out the revenues from its green products, including energy-efficient lighting, and that they would account for a rising proportion of the company's revenues and profits. Siemens has been increasing the value of its green product portfolio, including wind turbines.

In part, companies are responding to external pressures. In many regions, including the European Union, the US, China and Japan, companies are facing increasing environmental regulation. They are also under pressure from consumers, civil society groups, and a small but growing – and increasingly vocal – chorus of well-organised investors who demand higher green standards.

However, the financial crisis and

recession have exerted very different pressures on companies. With the focus on survival and protecting profits and revenues, many have been less keen to trumpet their environmental credentials.

That does not mean the issue has gone away, however, says Solitaire Townsend, co-founder of Futerra Sustainability Communications. "I would say the opposite, in fact – we're seeing a lot of interest in green product innovation from big companies."

She points to Unilever, which this year announced an initiative to focus on greening its vast product portfolio. "Unilever realised that if it wanted to decouple its economic growth from its emissions, it had to make products that would reduce consumers' environmental footprints – and that this was not a nice-to-have, but the only available option," she says.

GE also recently launched its "Ecomagination Challenge", which it calls an "innovation experiment". In conjunction with several venture capitalists, it is offering \$200m for ideas that would revolutionise the power grid, renewable energy, and energy in buildings.

In the past few weeks, Sony has also joined in, inviting designers and inventors from all over the world to come up with ways to "repurpose" existing technologies to solve environmental problems. Setting up its Open Planet website in early September for people to submit their thoughts, the company explained: "We're not looking for ideas for building environmentally friendly new products. Instead, we're looking for unusual, incremental or radical new applications that use existing technologies to tackle environmental issues."

"To have such big companies doing this is serious stuff," says Ms Townsend. "These are very big companies who are putting very big budgets into this. It is not about the little quirky green toys that some companies were coming up with a few years ago – the solar backpacks and so on, that are nice but don't really get to the root of green innovation."

This evidence of growing involvement from big companies in green innovation defies those who predicted that the recession would put an end to environmental initiatives, she says.

Perhaps this should not be surprising.



No sunset industry: wind power has a bright future but initial financing can be a problem. See article on Page 2

dreamstime

Governments' environmental regulations are still in place, and the financial implications of greening companies still hold good. These can be benefits to – rather than a burden on corporations' bottom lines, according to the HBR article.

One area of concern to Ms Townsend is smaller companies. "My worry is that small businesses, for whom innovation is high risk and high effort, are the ones who are going to be feeling the pinch in their research and development," she says. "That could suffer in the recession."

This could prove to be a problem in

the future. Small businesses are one of the most important sources of "sustainable innovations", according to Katie Webber, campaign director of the Mayday Network, a coalition of businesses brought together by the Prince of Wales.

For companies seeking ideas on how to redesign their products and services, the most valuable resource could be their own staff, says David Grayson, professor at the Doughty Centre for Corporate Responsibility at Cranfield.

He urges organisations to look for a new breed of "social intrapreneurs" – entrepreneurs within a big organisation – among their own ranks. "Engaging employees is absolutely essential," he says. "If you support intrapreneurs in the right way, you could see hugely profitable ideas come out of it."

He points to companies such as Google, which allows employees to use 20 per cent of their working hours as free time. They can spend this on green projects that could benefit the company in the future.

Marks and Spencer is another. Under its "plan A" initiative to reduce its environmental footprint, and those of its customers, the company offers grants to employees to fund ideas that will further the programme.

"I'm not suggesting these methods will work for all companies, but they show some of things that are possible, as a way of furthering innovation

within companies," says Prof Grayson.

Giving employees time to think, and redesigning products will not be enough in itself, however.

Ian Cheshire, chief executive of Kingfisher, suggests businesses will have to think more radically. He is encouraging his executives to think of how businesses services will evolve in the next two decades. For instance, he says, whereas now retailers focus on selling goods that consumers take home and keep, in future a more common model could be to rent goods, effectively changing their consumption model from buying a good to buying a service.

Kingfisher has worked closely with Ellen MacArthur, the yachtswoman who has turned green evangelist. She has set up a foundation with the aim of "working with education and business to inspire people to rethink, redesign and build a sustainable future".

She says she is pleased with the response so far, but warns that companies need to think beyond "green" labels. "I've met an encouraging number of chief executives and engineers whose work is guided by a real desire for change," says Ms MacArthur. "And the conclusion I've come to is that we should perhaps forget the colour of the flag and think in a more comprehensive, encompassing way, or as Michael Braungart [the green design guru] would say, encourage plain 'good' business, not 'green' business."

Five green indicators of material importance

Design principles

Fiona Harvey on the key points that companies need to keep in mind

Green design is a new departure for most companies, lying outside their traditional expertise.

The principles that govern conventional product design – such as, does it work, will it last, could it be made any cheaper – all still apply, but there are a host of other considerations, from whether the raw materials are ethically sourced, to what happens at the end of a product's life.

There are five key environmental indicators that companies need to keep in mind: cutting down on greenhouse gases; energy; water; waste; and other resources.

Designers should also be aware of any possible impact on biodiversity.

For instance, a campaign by Greenpeace recently led several luxury goods companies to re-examine their supply chains, to ensure they took no leather from cattle ranches in the Amazon, where cows are raised on land that was once rainforest.

The best products and services should tick several of these boxes, says Solitaire Townsend, co-founder of Futerra Sustainability Communications, which advises companies on their environmental impact.

"If you have a product that reduces energy use, but uses more water, that is not good enough," she explains.

Companies seeking the greatest impact should focus on products and services that help reduce the environmental footprint of consumers, she advises.

"That is where the big wins are."

This is borne out by research from Ricoh, which found that nearly two-thirds of the environmental impact of its products over their life cycle came from their use, rather than their manufacture or disposal.

Designers of green goods and services should "be holistic" – and iconoclastic, says Hugo Spowers, founder of Riversimple, a UK company whose hydrogen fuel-cell cars are to be tested on the streets of Leicester.

He says: "Designers and entrepreneurs of green businesses have to go beyond just the product itself and look at the whole value network. You need to start again from the bottom up, so that legacy constraints don't terminally compromise the outcome."

When designing the hydrogen car, the company took nothing for granted about conventional car

design. Rather than evaluating components to see whether they were lighter or more efficient, it examined their place in the whole system.

"Counter-intuitively, if you resist the temptation to compare components directly, you may choose one that is heavier, more

Designing a new, greener version of an existing product can cannibalise a company's sales

expensive or less efficient, because it delivers a car that is lighter, cheaper or more efficient overall," Mr Spowers explains. "The [conventional] car companies still start with a metal-bashing philosophy – some of them think that the answer is to open the boot

of their existing models and slap in a massive heavy battery. But, as the saying goes, 'You shouldn't start from here!'"

Breaking the mould in seeking new approaches could also mean smashing another taboo and collaborating closely with rivals.

Greenpeace, for instance, helped to bring together a group of companies, including bitter rivals Coca-Cola and PepsiCo, to find alternatives to the use of damaging greenhouse gases in refrigeration units. In another example of companies forming unusual alliances, a group of UK retailers have banded together to share delivery vehicles.

But companies should also be prepared to deal with other conflicts of interest, says Malcolm Fox, director of sustainability programmes at NSF International, which certifies companies' environmental credentials.

He notes that designing a greener version of a product can cannibalise a company's sales, or create rivalries within the business.

There are ways round this. Mr Fox says: "Green versions [of products or services] are often designed in response to tangible market demands – it's easy to see the benefits of low-solvent paint or a more energy efficient refrigerator. These can command a price premium that differentiates them without risk to existing product portfolios. Manufacturers can go to market with two products and increase volumes."

However, consumers can be "sceptical" when they encounter green alternatives to products, he warns. "Whether or not products are seen as better, they are certainly seen as different, and tend to attract an entirely new customer base – with all the uncertainties that can entail."

Tom Wagland, manager of the environmental group at Ricoh Europe, adds that companies looking to make their products more environmentally friendly must pay close attention to the "end-of-life" phase – when products are thrown away.

His company espouses the "cradle-to-cradle" model propounded by William McDonough, the US architect and environmental guru, and Michael Braungart, a chemist.

This is the idea that at the end of their lifespan, products should be able to be reused or recycled in some fashion into other products of equivalent value.

The growing number of companies using this approach must find ways not just of reducing the waste from their manufacturing processes, but of thinking beyond the product to what it could become in the future.

Pioneers display towering ambition

Energy

From wind power to solar, new ideas are making a significant impact, writes Jane Bird

When Holger Giebel, chief executive of Hanover-based TimberTower, told his wind energy contacts he wanted to build turbine towers out of wood, they were sceptical. In an industry dominated by steel and concrete, the idea seemed bizarre.

"They were very suspicious and thought we were crazy," he says. "It seemed as inappropriate to them as using wood to build a car engine."

But when Mr Giebel explained further, they became interested. Steel turbine towers are very heavy and have to be transported in large pieces on special vehicles. To fit under motorway bridges, their diameter is limited to 4.2m. This restricts their maximum height to 110m.

By contrast, wooden panels are relatively light and modular, so can be transported much more cheaply on standard trucks, and once on site used to build wider, taller towers. Higher towers are more efficient.

"Every extra metre corresponds to an extra per cent in revenue," says Mr Giebel. The first timber tower will be built over the next few months in Hanover with a turbine belonging to Vensys Energy, which is based in southern Germany and owned by China's Goldwind. It will generate 1.5MW of energy.

TimberTower uses spruce and pine, although most woods are suitable, so the company hopes the idea will prove attractive in forested areas such as North America and Scandinavia.

In addition to being greener to manufacture and transport, each timber tower locks up 367 tonnes of carbon dioxide that would have been released if the timber had been burnt or the tree had been left to rot or die.

The fact that Mr Giebel and his partners understood wind power and worked in the sector for 10 years helped establish credibility for TimberTower, he says.

"Lots of people in green energy have ideas about making the world a better place, but they haven't thought of their potential customers, and this is particularly true of techies."

Having the courage of his convictions also worked for Alex Berger, chief executive of Johannesburg-based AAP Carbon, which has designed the world's first system to produce clean electricity from waste gases at ferrochrome smelting plants.

Production of ferrochrome, which is used to make stainless steel, traditionally involves flaring off waste gases into the atmosphere. "Industry experts initially thought our plan to

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Spruced up: TimberTower's wooden turbine tower

Green Innovation & Design

Pioneers display towering ambition

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capture and clean this gas to generate electricity was too ambitious," says Mr Berger.

The doubters were worried about waste gas impurities, storage, safety, expense and fluctuations in supply. But AAP Carbon gained financial backing for its system, which is customised to the ferro-alloy industry and eliminates the need for storage.

Its first implementation will be switched on shortly at International Ferro Metals in Buffelsfontein, South Africa.

To generate electricity, the system uses internal combustion engines developed by GE Jenbacher of Austria. With a capacity of 17MW, it does the equivalent of capturing 160,000 tonnes of CO₂ a year or taking 45,000 cars off the road.

The new system will generate 140,000MW hours of electricity a year — about 12 per cent of IFM's overall energy consumption — helping ensure continuous operation in a region where electricity supplies are unreliable.

AAP Carbon is designing a similar system for Tata Steel's Richards Bay smelting plant, and hoping to sign up further customers in South Africa, which accounts for more than 60 per cent of global ferro-chrome production.

In the UK, Martin Wright, managing director of Bristol-based Marine Current Turbines (MCT), has fought hard to win credibility for his tidal power technology and has raised some £38m funding, of which about £7m came from government.

Tidal power has the advantage of being more predictable than wind and is more energy-efficient, says Mr Wright. The company's 1.2MW SeaGen prototype tidal turbine is feeding electricity into the grid in Northern Ireland and can supply the needs of 1,500 homes.

It is "on the cusp of commercialisation," but will need up to £30m more to become fully commercialised, Mr Wright says. "Otherwise, it will wither on the vine."

To achieve this, he says, governments should create incentives for energy companies to become customers. "Subsidies are not necessary, but governments should use their legislative powers to create a market."

This would let investors understand the level of risk and decide how much capital to deploy.

"It's no good expecting something just out of the egg to be massively capital-efficient on day one," says Mr Wright. "But the single most important thing is that there has to be a market."

Even the relatively developed solar market is not yet fully commercialised. While solar panels are cheap to maintain, installation is labour-intensive and expensive.

Dow Chemical has received \$20m of US government funding to develop a roof tile, or shingle, that is "intuitive and straightforward" enough to be installed by existing roofers.

The shingle, which is in pilot production in Michigan, is designed for the US. Russel Mills, Dow's global director of energy and climate change policy, acknowledges that it may not suit countries with different climates and construction methods.

Once US sales of the shingle have taken off, Dow will look at adapting it for other markets.

But as with all renewable energy, the challenge is bringing the cost down, says Mr Mills. "Whether green or brown, it looks exactly the same to the consumer, so it has to be priced competitively."

Despite progress, coal will continue to be by far the world's biggest source of fuel for at least 20 years, he says.



Making waves: tidal power can take a decade to generate revenues

AFP/Getty Images

Good ideas can overcome challenges to win funding

Financing

Jane Bird looks at how green start-ups raise the capital they need to grow

Life is much tougher for entrepreneurs with innovative green ideas than for their counterparts in other new sectors, because their projects take longer to become commercial and cost more money.

Moreover, the industry is surrounded by complex, evolving regulation. And the numerous government initiatives and policies aimed at stimulating green-tech development sometimes distort the market.

While a digital media company could expect to achieve revenues within a year on start-up funds of €5m, a typical green-tech venture would need more than five years to generate revenues and €50m, says Christian Reitberger, general partner at Wellington Partners, a pan-European venture-capital firm. For wave or tidal power it could be 10 years and €100m.

Despite this, seed capital is available for good green ideas. "It's a myth and an unjustified lament that business angels only provide €500,000 start-up funding — they have shown they can raise €5m by joining forces in consortia," Mr Reitberger says.

In the US, start-up funding of \$50m is not unusual. On the other hand, the regulatory climate is unhelpful, says Ron Norman, a member of PA Consulting's energy capital markets practice, based in Boston.

Green innovation in the US is largely driven by non-commercial priorities such as reducing unemployment. This twists and distorts the market, he says.

"The energy industry has high capital costs and long time horizons, whereas near-term job programmes are the antithesis of this, coming and going with economic events and political whim."

States such as Texas have chosen to build wind energy plants in areas of high population, which might bring short-term construction job gains, whereas in the long term the plants might be better located elsewhere.

In California, legislators face pressure to postpone laws mandating the reduction of greenhouse gases because of public protest at extra fuel costs at a time of high unemployment.

US government policy also dictates percentages for different forms of renewable energy. But rather than focusing on trying to pick winners, Mr Norman advocates a regulatory environment similar to the acid rain "cap and trade" programme of the 1990s.

This created a set of long-standing rules enabling industry to invest efficiently and the market to respond, he says. "Unfortunately, that's not what we're seeing today with lots of issues round green technology."

Large-scale government loans in the US have also had a serious market-distorting effect. In March last year, California-based solar start-up Solyndra was awarded \$535m, and the following June, Tesla Motors received \$465m to build an electric vehicle. This has made life difficult for their competitors.

Europe has also had problems caused by government intervention. In Spain, the withdrawal of large-scale subsidies for solar power in 2008 brought an end to huge growth. However, government feed-in schemes for solar power in Germany, the UK, France and Italy have proved highly successful.

Europe's green-tech ventures

are outstripping the US in return on investment, according to the British Venture Capital Association. Between 2004 and 2008, the VC industry in Europe had three times as many 10-fold returns on investments than the US, and was significantly more capital-efficient, it says. "On average, a \$100m exit in Europe received \$40m of VC financing compared with \$70m in the US."

These results are even more impressive, given the fact that Europe has fewer large-scale groups to buy start-ups — effectively Siemens, Alstom and Areva, compared with numerous US corporations with deep pockets. This weakens the negotiating position and limits the options for European companies seeking a trade sale or IPO.

Fledgling companies cannot show a track record, which deprives them of access to working capital

The high return on investment reflects the fact that European ventures tend to be more capital-efficient, with cheaper labour and lower staff turnover. By contrast, bigger budgets enable US companies to spend more on marketing, says Mr Reitberger. "The comparative frugality of European ventures is a good discipline that tends to guarantee efficiency."

Another strategy adopted by start-ups in Europe and the Middle East is an incremental approach to fundraising. Israel-based EnStorage, which makes energy storage systems, has done this — initially raising \$2m and closing a further \$15m round last April.

Entrepreneurs in Europe and the US are continuing to suffer from the banks' aversion to risk.

Chinese ventures do not have this problem. Suntech, Yingli Solar and Trina Solar have raised up to three times their revenues in working capital, and are exploiting the advantage. "They are using their access to debt as a competitive weapon," Mr Reitberger says.

The fact that fledgling companies cannot show a track record for their technologies deprives them of access to working capital. "This debt gap is a big problem," says Mr Reitberger. Other, non-infrastructure related technology companies escape this because the semiconductors or wireless technologies on which their innovations are based are well established, he says.

In countries struggling to catch up with green innovation, complex international regulations such as the Kyoto protocol's Clean Development Mechanism can make life harder. To present their businesses in the most favourable light to investors, they need to understand the rules on carbon credit trading units.

These can act as "deal sweeteners", enabling companies to access new sources of finance and making projects financially viable by reducing entry costs, says Johannesburg-based Glenn Hodes, head of Africa Carbon Asset Development, which advises green-tech ventures.

Sub-Saharan Africa is the final frontier for green innovation, and with only 3.5 per cent of the global market in carbon credits, has historically been slow to capitalise on its market potential, behind countries such as China and Mexico, says Mr Hodes.

African entrepreneurs are gradually building their expertise in this area, he says. "But banks also need to gain a better understanding of carbon financing with successful examples, as this would lower their perception of risk."

Design schools aim to make environment a matter of course

Education

Sustainability is now an integral part of many curriculums, writes George Cole

If tomorrow's products are to be developed with sustainability at the core of their design, today's students need to be educated in its importance.

Many design institutions have made sustainability an integral part of their curriculums, but there is still some way to go.

In 2007, Mariano Ramirez, an industrial design lecturer at the University of New South Wales, Australia, published the results of an online survey of industrial design course leaders from 221 schools around the world. More than half the respondents (52 per cent) reported that sustainable design courses were compulsory or core subjects in their curriculum.

Mr Ramirez concluded that the results sent "a strong message to industry that more industrial designers are graduating with an increased awareness of their responsibilities to the environment and to society".

One in five industrial design students graduating from Delft University of Technology in the Netherlands specialises in sustainability. Han Brezet, head of the design for sustainability research programme at Delft, says it is important that students "learn that there is not an endless amount of energy, materials or space in the world".

"The importance of sustainability is stressed early on in our courses," says Conny Bakker, assistant professor at Delft's design for sustainability programme. Third-year students also have the option of doing a six-month sustainability project.

In the UK, the Design School at Loughborough University covers sustainability in its first-year core module. Students are encouraged to take a life cycle approach to design — for example, can a product be reused, or elements of it reused or recycled?

Vicky Lofthouse, senior lecturer in industrial design, says: "The development of corporate social responsibility has seen sustainability being linked to business strategy. We tell our students that their job prospects are affected by this strategy — you can't afford to ignore sustainability."

UWIC — the University of Wales Institute, Cardiff — removed an environmental design module from its architectural design course. "We wanted to reflect the fact that all building design must be considered from an environmental angle and that it's wrong to see it as a separate design approach," says Nick Evans, senior lecturer at UWIC's architectural design and technology department.

UWIC's students also explore ethical issues, analyse case studies and conduct exercises on sustainable design. Mr Evans says students are assessed on their ability to use sustainable design intelligently. "It's not just about putting a wind turbine on top of a house — we're not interested in designs that simply include eco-bling."

John Currie, director of the Scottish Energy Centre at Edin-

burgh Napier University, says his institution introduced an energy engineering course in 1980. He notes that many accreditation bodies insist that sustainability is a core component of design courses. "Designing for sustainability is an essential part of the job," he says.

At Brunel University, sustainability is a compulsory topic for first-year design students and an optional module for final-year students. "We want students to develop their own personal and ethical position on sustainability, and draw on this whenever they design," says David Harrison, design professor at the school of engineering and design.

Teaching resources on sustainability have been developed to help institutions cover the topic in depth. Tracy Bhamra, director of research at Loughborough's Design School and Ms Lofthouse have produced the Toolbox for Sustainable Design Education, a series of modules for engineering and design courses, available online.

The Industrial Designers Society of America (Isda) publishes Okala, a 72-page document on eco-design for designers and design students. Okala (which means "life sustaining energy" in the indigenous Hopi language) has been produced by Steve Belletire, an industrial design professor at Southern Illinois University, Carbondale; Louise St Pierre, an industrial design associate professor at the Emily Carr Institute of Art and



Han Brezet: students must learn there is not an endless amount of energy or materials

Design in Vancouver; and Philip White, an assistant professor at the School of Sustainability in Arizona State University.

More than 7,000 copies of Okala have been distributed worldwide. "It's essential that sustainability becomes part of the design student's DNA," says Mr Belletire.

Sustainable design education has come a long way, but problems remain. Lesley Morris, head of design skills at the UK's Design Council, says: "We should be teaching sustainable design from the bottom-up, and that means in schools. There, you are not only reaching the designers of the future, but the consumers of future designs."

The Design Council runs an Eco Design Challenge for schools. Martin Charter, director of the Centre of Sustainable Design in Farnham, southern England, says students should be encouraged to create sustainable design concepts for the real world. "A wooden computer is interesting, but how commercial is it? I think there's still an issue about what's being taught in design schools."

Mr White at Arizona says: "We can't ignore the social side of sustainability, but this is proving difficult to define and measure."

Even so, Mr Belletire is optimistic, and says: "I believe that in 10 years' time, sustainability will be an integral part of every design curriculum around the world."

Powerful argument for cutting IT energy consumption

Computing

Rod Newing finds there is still plenty of room for improvement

The information technology industry accounts for about 2 per cent of global carbon dioxide emissions — about the same as the airline industry. Although the technology is increasingly power-efficient, more innovation and design are required to offset the growing use of computers, especially in China and India.

"The focus on innovation has led to a host of developments, through green ideas and exotic new equipment," says Sumir Karayi, chief executive of IE, a power management software vendor that claims to have cumulatively saved its customers 4m metric tonnes of carbon dioxide emissions.

He adds: "It has also sparked the redesign of technology and the revival of old ideas that

have gained a new relevance to reduce resource use and cut greenhouse gas emissions."

According to The Greening of Business, a white paper from T-Systems, the IT services arm of Deutsche Telekom, existing energy-conservation approaches can nearly halve carbon dioxide emissions.

However, there is potential to reduce them by 75 per cent. This comes from better use of server capacity (35 per cent), optimising cooling (20 per cent), more energy-efficient equipment (15 per cent) and reducing data and applications (5 per cent). This still leaves enormous opportunity for innovation and design.

Computer processors are becoming greener, as each generation has smaller transistors that require less power. Also, manufacturers have moved from improving performance by raising the speed of their processors, which increases energy consumption, to using multiple processors, or "cores", on the same chip to share the load. Power management has

improved and there has been a general move from power-hungry desktops towards laptops with long battery life.

"Globally, the number of installed PCs is growing at 10 per cent a year," says Jim Tully, vice-president for electronics at Gartner, the analyst, "but their total energy consumption is only growing by 0.9 per cent. In data centre servers, you get a multiple benefit because processors with more cores require less cooling."

He points out that although a lot of attention is given to servers and datacentres, governments and regulators look at aggregate energy consumption. Gartner expects personal computers to consume 272 terawatt hours of energy globally in 2010, against 136TWh for servers.

Nevertheless, the design of datacentres is receiving a lot of attention. Datacenter 2020 is research being carried out by T-Systems and Intel, the processor manufacturer, into design for energy-efficient data centres, focusing on reducing power

usage effectiveness (PUE). This is determined by dividing the amount of power entering a data centre by the power used to run the computer infrastructure within it. It is expressed as a ratio, with overall efficiency improving as the quotient decreases towards 1.

The annual average for PUE is currently 1.9. Reducing the fan speed in the cooling system reduced it to 1.55 and improving cold and warm air isolation in the room brought it down to 1.48. The project objective is to reduce it to 1.3.

Eric Woods, an analyst at PikeResearch, a clean technology market intelligence company, points out that innovation is required to design more flexible power and cooling equipment. "While IT servers might be replaced every three years," he says, "the data centre infrastructure is expected to last 10 to 15 years."

"As IT becomes more dynamic with virtualisation and cloud computing, a new dynamic data centre infrastructure is emerg-

ing that is more closely integrated with the IT assets it supports, flexible in its deployment and adaptable to rapidly changing operational conditions — like a green data factory."

As Mr Woods says, the overall design of computer systems is changing rapidly. Virtualisation software converts dedicated computing equipment, such as servers and storage, into a single shared infrastructure. This allows spare capacity on physical machines to be utilised, sharply reducing the number of servers required.

The next stage is to use intelligent software, both on the machine and on the network, to manage energy consumption by the servers. Simon Mingay, vice-president for research at Gartner, says: "It monitors server usage to see if it can turn down or turn off components, reduce processor speed or shut down memory modules. It substantially improves energy efficiency, particularly where a server has a 'bursty' load."

The final step in the new com-

puting architecture is "cloud computing", in which multiple organisations use a shared public infrastructure.

"It is not aimed at energy efficiency or being green, but has the potential to deliver order of magnitude improvements above anything we have seen so far," says Mr Mingay.

Giles Hutchins, global director for sustainability at Atos Origin, points out that IT encourages green innovation through collaborative websites, such as Eco-Patent Commons and GreenXchange.

Eco-Patent Commons is operated by the World Business Council for Sustainable Development and enables several large companies to share their environmental patents.

Still in beta testing, GreenXchange was set up by Nike, Best Buy and Creative Commons, a not-for-profit company, for community-based knowledge transfer. "People can share patents," says Mr Hutchins, "to come up with new ideas and new green solutions."

Contributors

Fiona Harvey
Environment Correspondent

Clive Cookson
Science Editor

Robert Wright
Transport Correspondent

Jane Bird, George Cole,
Dan Lett, Rod Newing
FT Contributors

Andrew Baxter
Commissioning Editor

Steven Bird
Designer

Andy Mears
Picture Editor

For advertising details, contact:

Liam Sweeney,
Tel +44 (0)20 7873 4148,
Fax +44 (0)20 7873 4006,
E-mail liam.sweeney@ft.com

Sustainability worries begin to hit home

New buildings

Owners, architects and contractors all have a role to play, writes **Dan Ilett**

Viewers of *Star Trek* will have been treated to a vision of a future containing sleek buildings that house bright corridors, thronged with people in strange robes. No one ever worries about where the energy comes from – that problem was solved long ago.

Emphasis on such a clean, Utopian future is a distorted view of what the coming decades are likely to bring: a planet with 8bn people trying to live as comfortably as possible with limited resources and energy supplies.

Almost 40 per cent of energy consumption can be attributed to buildings, the US Department of Energy states. To address these problems, the construction industry has to make new buildings more sustainable. But how will it achieve that?

"It's our view that architects know how to design efficient buildings; the challenge is getting them built to design," says Peter Lacy, managing director of Accenture's sustainability services practice. "Building owners, architects and contractors play a role in determining building efficiency. All parties have incentives to cut costs, so good design is rarely translated into the building as built."

"A sustainable building would be not only resource efficient but have the lowest possible environmental impact through its life cycle through design, construction, use and demolition. It would be determined by proximity to mass transport and workplaces and help occupants live sustainably through its design."

Some 41 per cent of energy used in buildings is on space heating, while lighting and water heating take up 26 and 20 per cent respectively, according to

Panasonic's Eco Ideas House works as a big appliance, maximised for energy efficiency

the US Energy Information Administration.

To balance these figures, architects in Scandinavia and Germany have become fond of an energy-efficient design standard called PassivHaus – where a building is so airtight that it requires no central heating. It takes heat from everyday appliances and even the humans who live in it. The technology has been around for 20 years.

When combined with solar technologies for heating water, buildings become almost self-sufficient, apart from the energy used for lighting and appliances.

But passive houses have their limits: "There is a discussion on whether it should be called 'passive' or just 'energy-efficient'," says Mattias Westher, energy strategist for Poseidon, a Swedish property company.

"The risk with a passive house is that you get very advanced set-ups, so you need a lot of control systems. These are sometimes troublesome and can be expensive."

But the passive house demonstrates that insulation remains one of the biggest challenges in the housing industry today, especially for retrofits on old housing stock.

A study by McKinsey, the management consultancy, found that carbon emis-



Well insulated: a typical continental European PassivHaus

Retrofitting case study Gårdsten project, Sweden

For all the heritage and culture that many of Europe's buildings embody, architects have realised they pose a problem for the future. They waste a lot of energy and heat. The regulations around listed buildings are inflexible for retrofit projects and the materials needed to modernise them are still too expensive.

But a project near Gothenburg in Sweden has bucked this trend. Gårdsten is a housing estate that was built for low-income families in the early 1970s. Before renovation, its residential blocks were dilapidated, and plagued by structural problems and leaks.

By the late 1990s, 60 per cent of tenants were unemployed and the tatty estate had become a hotspot for crime. In addition, the divide between ethnic groups was widening.

"It was a slum," says Katarina Ahlqvist, managing director of Gårdstensbostäder (Gårdsten Housing), the public housing management company in charge of renovating the estate. "There were no companies or shops in the area and there was garbage everywhere."

"We had to start by giving



Flower power: once a slum, the Gårdsten estate has been transformed

people hope for the future. That's why it was important to develop Gårdsten economically,

environmentally and socially. We had to do that in conjunction with the tenants – that's why the project has been successful."

Today, Gårdsten looks and feels very different. The residential buildings are no longer concrete eyesores but modern blocks, complete with orderly lines of hot-water solar panels on their roofs and neat gardens that the residents tend.

The entire estate runs on renewable energy – a mixture of wind and solar power. Each tenant is given a discount on rent if they use less power or hot water than allocated in their all-inclusive rental package.

The management company says energy consumption has been falling continuously, because of "a greater consciousness of the residents. The individual monitoring of each unit is allowing residents to reduce their household energy consumption, with the incentive of saving money."

The facelift included some structural changes. A refit of

insulation and ventilation systems led to almost all heat generated being captured and reused.

The Gårdsten blocks are now equipped with their own greenhouses, energy-efficient utility rooms (designed for optimum sunlight) and anaerobic digestion units that turn rubbish into biogas and provide compost for the vegetable patches. The lighting for common areas is all sensor-controlled.

"The project has created 1,300 jobs over 14 years. But it's very important that we always see how we will get our money back. We have to be very systematic about that – and this way, you'll always have the tenants with you," says Ms Ahlqvist.

The total cost of the initial renovation was about €12m, which was part-funded by the European Union and Swedish Energy Agency.

"We did have financial support from the EU, but we were working with several partners and that lowered our infrastructure costs," says Ms Ahlqvist. "Our partners made this much easier."

Dan Ilett

ADVERTISEMENT



Green Cities

Cities consume too much energy. State-of-the-art environmental technologies reduce consumption and even make carbon dioxide-free cities possible.

Pedro Miranda - Corporate Vice President Siemens One
Dr. Willfried Wienholt - Vice President Urban Development

And the champion is: Copenhagen. Denmark's capital is Europe's most eco-friendly city. This fact was confirmed in the European Green City Index, a study conducted by the Economist Intelligence Unit in cooperation with Siemens that took a close look at 30 cities throughout the continent. In general, Scandinavian cities earn the highest rankings in the index. The annual energy consumption of residential buildings in Copenhagen, at 554 megajoules per square meter, is the lowest of the 30 cities in the survey. However, the city's administration is not resting on its laurels and plans to turn Copenhagen with its 528,000 residents into a carbon dioxide-neutral city by the year 2025. Other cities have similar goals: Munich, Germany, for example, intends to cut its carbon dioxide emissions in half by 2030.

Megacities with millions of residents are still far from such ambitious goals. All urban centers worldwide account for 75 percent of global energy consumption and 80 percent of the greenhouse gas emissions although they cover only one percent of the planet's surface. This situation could get worse, since around 70 percent – or roughly 6.4 billion people – of the world's population is expected to live in cities by 2050. Today the figure is just over 50 percent, or 3.3 billion people. This explosive rate of urbanization presents enormous challenges, and there will be mounting burdens on infrastructures in particular. In view of these forecasts, strategy consultants at Booz, Allan & Hamilton estimate that city managers throughout the world will have to spend 27 trillion euros for developing adequate water, power and transport systems over the next 25 years. And the German Institute for Urban Affairs predicts that communities in Germany alone will have to invest more than 700 billion euros in infrastructure measures by 2020.

These huge challenges also offer major opportunities. If urban planners rigorously rely on the latest environmental

technologies, cities can substantially reduce their consumption of valuable resources. The fact that carbon dioxide-free cities are not a utopian dream is proven by Copenhagen's plans or the plans for the Masdar eco-city in Abu Dhabi.

There are already countless technologies available for reducing the energy appetite of major cities. Measures taken for buildings, which devour 40 percent of the world's primary energy, pay off especially fast. Siemens AG, which has already modernized thousands of public buildings, estimates that state-of-the-art lighting, heating, ventilation and air conditioning systems slash energy costs by 40 percent, on average. One important lever here is energy-saving lighting. Many countries have already decided to ban incandescent light bulbs and eventually replace them with energy-saving solutions, such as light-emitting diodes (LEDs), which are far brighter and use much less energy. Some 16,000 LEDs from Osram, for example, illuminate the 190-meter skyscraper "Turning Torso" in Malmö, Sweden, which was designed by Spanish architect Santiago Calatrava. With immense savings in operation costs and a significant reduction in CO₂, a model eco-friendly construction project is currently being developed in Shanghai: the new Siemens headquarters with a floor space of 18,000 square metres will open within the next months. Efficient building technology, heat pumps, cold storage and many more techno-

logical refinements will make this building one of the most efficient in this million-strong city – and it will consume around 25 percent less energy than the U.S. standard.

Despite all energy efficiency measures, growing cities will continue to consume huge amounts of electricity – and this power should come, if possible, from renewable sources. Yet large green power plants such as big offshore wind farms or the DESERTEC solar energy project of Dii GmbH which wants to construct large solar power plants and wind farms in North Africa are being built far from the population centres that need the electricity. High-voltage direct-current power lines with very low electric losses will transmit huge amounts of electricity over thousands of kilometers in the future.

As the 'Global Partner of Expo 2010' in Shanghai, Siemens is presenting its solutions to the issues of energy, industry and health not just by means of many activities on site. There is a great deal of Siemens technology to be found all over the Expo compound. The Hamburg House, for example, is equipped with the very latest solutions from Siemens, and requires virtually no energy input from outside. And the Expo Boulevard, the Theme Pavilion, the Expo and Culture Center as well as the China Pavilion all have one thing in common. These buildings save up to 25 percent in energy, and up to 50 percent in running costs compared with their traditional counterparts thanks to the state-of-the-art building technology from Siemens. Projects with a signal effect: these five 'Permanent Constructions' will become the landmark of Shanghai after the exhibition, giving sustainability its very own face.

Siemens has provided infrastructure equipment with a value of over one billion euros for the Expo and additional projects. Green solutions account for around 90 percent of the Expo order value – for clean air, clear water, sustainable building technology, lighting, and better medical care. The sustainable city solutions from Siemens are already being tested, or even being used, in many locations all over the world – including large Chinese cities. The technologies are available, now it's a question of implementing them.



The City Cockpit offers simulation and forecast options for city managers

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Green Innovation & Design

New train of thought helps improve energy efficiency

Transport

Robert Wright finds that everything boils down to basic physics

It might seem odd to associate the huge trains that carry iron ore across Western Australia's outback with concern for the environment. But Richard Cohen, general manager of the 1,300km of railways operated by Rio Tinto, one of the biggest miners, in the Pilbara region, would love to take improvements in the environmental performance of its diesel-electric locomotives a stage further.

At present, when each train's three locomotives apply the brakes to a 33,000-tonne, 230-wagon laden train, the electric motors on its six axles turn into generators, producing electric-

ity. The energy is dissipated by heating up banks of electrical resistors. If some of the electricity could be stored and used to restart the train, the saving in fuel and carbon-dioxide emissions could be substantial.

The iron ore trains are an excellent illustration of the challenges all transport modes face in trying to improve their energy efficiency.

All boil down to basic physics. Environmental performance improves when the most efficient use is made of the fuel that accelerates a vehicle; when the vehicle becomes easier to accelerate; when the friction that dissipates momentum is reduced; and when the energy generated slowing the vehicle is stored and reused.

The US's General Electric, builder of the Evolution locomotives that form much of Rio Tinto's fleet, has already taken one key step by overhauling its

engine design. Further design improvements, such as a better turbocharger and higher pressure pistons, have allowed GE to replace its 16-cylinder engine with a 12-cylinder model producing the same power. Fuel consumption has fallen by at least 3 per cent.

The improvement echoes steps taken in both the car industry and aviation, where computer-assisted design of pistons and turbine blades, and electronic control of fuel injection, have substantially improved the forward momentum extracted from each millilitre of fuel. Modern marine engines consume far less fuel than even relatively recent predecessors, while some ships now recover and use the heat in engines' exhaust gases.

Lorenzo Simonelli, chief executive of GE Transportation, the locomotive-building division, says the company is investing to

create the locomotives that will be needed to keep rail competitive over the next 10 to 20 years.

"People have to get more on to rail," he says. "It's the right thing to do – and it's the mode of transport that's most efficient."

Rio Tinto's diesels carry added weight to prevent their

Reducing drag from air friction can have a marked impact in some transport modes

wheels from slipping. In transport modes where the main weight is the vehicle itself, a reduction in weight can be one of the most effective means of saving energy.

The Boeing 787 Dreamliner is lighter – and more fuel-efficient – than older airliners because it

uses composite materials far lighter than traditional aluminium fuselages.

Japan's Shinkansen trains consume less energy than other high-speed trains because they need less strong bodies and are consequently far lighter.

Reducing drag from air friction can also have a marked impact. Germany's Siemens claims the redesigned nose of its Velaro-D high-speed train will cut energy consumption by 10 per cent compared with previous versions.

The hulls of the E-Class ships of Denmark's Maersk Line – the world's largest container ships – are covered in a non-toxic paint that stops build-up of barnacles and other sea creatures from increasing the water drag on the ships' hulls.

Yet the biggest potential saving for trains such as Rio Tinto's – the harnessing and reuse of the power from braking

– has been unrealised until now because of the technology's complexity. There has been an attempt on electrified railways in recent years to use more such energy by feeding currents generated during braking back into the overhead wire or third rail for another train to use.

The main problem is that, when no other train is accelerating, rheostatic braking – as the banks of resistors are known – is still required.

For non-electrified transport modes, the challenge is far greater – to produce a battery robust enough to survive repeated cycles of charging and discharging but light enough not to waste the energy savings in the effort of dragging the battery around.

While such technology is already widely used in hybrid cars, it is far more difficult to handle the huge electrical loads generated when slowing down

trains such as Rio Tinto's. But Mr Simonelli says new investments should ensure GE can produce effective hybrid diesel and battery-electric locomotives. "We're investing \$150m in sodium battery technology that allows the hybrid to become a reality," he says.

Henry Posner, a US railway investor, says that, even with Evolution locomotives' fuel-saving levels, the small Iowa Interstate Railroad which he controls was surprised to be able to justify buying new locomotives because the fuel savings would fund them.

It is hardly surprising, then, that Mr Cohen, running far heavier, more energy-intensive trains says he is keeping in close contact with GE about trying out the far more revolutionary hybrid technology when it is sufficiently developed.

"It's something very interesting on our horizon," he says.

Fresh approach aids mission to curb emissions

Redesign

Clive Cookson looks at activity in a range of sectors

In 2008, Adnams launched East Green, "the UK's first carbon-neutral beer", showing that any product, however ancient, can be redesigned to reduce its environmental impact.

"Every stage in the development of East Green, from the growing of the hops to the packaging, has been designed to minimise our carbon emissions as far as possible," says Andy Wood, managing director of the Suffolk company.

Adnams produces East Green in a new brewery with an energy recovery system that recycles all the steam created during the brewing process and uses it to heat 90 per cent of the next brew. All the malting barley is grown locally in East Anglia to reduce emissions from transportation, a naturally pest-resistant strain of hops is used to cut pesticide spraying and the finished beer is distributed in a lightweight bottle.

The beer illustrates the point that, while many peo-

ple think of design as an activity that concentrates on the look and feel of a product, it encompasses far more than that.

"Design thinking is a way of looking at challenges and problems in a holistic way," says Marianne Guldbrandsen, head of design strategy at the Design Council in London. "By asking the basic questions, designers can help multidisciplinary teams rethink the problem and come up with innovative solutions."

Green redesign may focus on the "upstream" (production and manufacturing) stages – as with East Green

What happens to the product at the end of its life is another aspect of green redesign

beer – or on the "downstream" (use and disposal) stages, she says.

A good downstream example is Procter & Gamble's redesign of its detergents. The US company says Ariel Excel Gel, its latest generation of laundry products, uses 20 to 50 per cent less energy during washing because the gel is

active at temperatures as low as 15°C.

"During the laundry life cycle, 70 per cent of energy consumption happens during the product's use, heating the water needed to wash," says P&G. "Eliminating the need to heat the water cuts energy use dramatically."

The transport sector is full of examples of green redesign at various levels. Every car manufacturer is trying to improve its downstream performance, by selling vehicles that go further for every unit of fuel consumed. But there are also some impressive upstream achievements.

For instance Toyota makes cars in Europe with just 23 per cent of the energy per vehicle today compared with 1992, when the Japanese company started European manufacturing. By rethinking every step of the production process, it has stopped sending any waste to landfill from its 11 European plants.

Redesign in transport can also take place at a service level. Ms Guldbrandsen says Streetcar is a good example here, because it enables urban inhabitants to drive a car occasionally, when they have to, without owning one. Every Streetcar on the road replaces 26



Going local: Riversimple's innovative two-seat car, powered by hydrogen fuel cells

privately owned cars.

Ocado, the internet-based home delivery service for food and groceries, is another example of green service redesign. Its "green van" delivery slots save fuel while reducing road traffic, by clustering deliveries in the same area. The company estimates that each Ocado van can replace up to 20 cars on the road because people no longer make individual journeys to the supermarket.

Riversimple, a younger and equally innovative UK company, is carrying out a more fundamental redesign of the car itself. It is developing a two-seater for local use, powered by hydrogen fuel cells, which will provide highly energy-efficient personal transport.

Another aspect of green redesign is what happens to the product at the end of its life. Steelcase, the international office furniture company, redesigned its desk chairs to produce a range

called Think. Steelcase worked with McDonough Braungart Design Chemistry, a US-based sustainability consultancy, to come up with a chair that is 98 per cent recyclable by weight and contains 37 per cent recycled materials.

Steelcase says a non-

expert can disassemble Think for easy recycling in five minutes, using common hand tools.

But traditional, long established products such as beer and chairs are not the only targets for green redesign. There is much scope for cutting the energy

consumption of information technology, too.

Wyse Technology of California, takes advantage of "cloud computing" to install "thin clients" instead of conventional desktop computers in offices. These access their computing power – for

applications and data – over a network, so local energy consumption is only one-tenth that of the PCs they replace. Thin clients emit less heat, so offices require less air conditioning.

There is more on green IT on page 2 of this report.

Premium brands respond to growing consumer awareness

Luxury goods

Dan Ilett finds that indulgence can still be sustainable

A luxury is an indulgence rather than a necessity, so demonstrating it is "sustainable" is no easy task.

"[Sustainable luxury] is, of course, an oxymoron because luxury essentially means 'not needed', which goes against thinking around sustainable consumption," says Dorothy Mackenzie, chairman of Dragon Rouge, a sustainable branding agency.

"However, if one considers a luxury is often a superior version of something that has a justifiable function, then there can be a case for the concept of sustainable luxuries.

"In fact, many of the factors that contribute to something being perceived as a luxury can support a more sustainable approach to consumption."

Ms Mackenzie argues that tailoring and craftsmanship lead to an appreciation of the value of materials and the skill in design and creation. She says it creates a desire to use something for a longer period of time and has more intrinsic meaning.

"We have to think of 'luxury' as being different from simply high-priced and premium," she says. "Sustaina-

ble luxuries could be role models for a more sustainable approach to consumption overall. Use less resource and derive more value from it. Use things for much longer and don't waste anything."

Consumers and non-governmental organisations have put pressure on the luxury products industry that it has never felt before.

Greenpeace now ranks the top 18 technology brands in the world on their environmental efforts, forcing them to take note.

Luxury vehicles are ranked by the same government carbon performance



statistics (and taxes) as any other car – meaning performance and fuel economy are linked to brand status.

Luxury brands have started to react. The Range Rover – one of the world's most luxurious and stylish 4x4s, has long been regarded as a gas-guzzling "Chelsea tractor" by environmental protesters. Land Rover, the company that makes the car, has responded.

Earlier this year, Victoria Beckham fronted a cam-

paign for Land Rover to show off a lighter and smaller version of the Range Rover – the Evoque. The company says this will have a front and four-wheel drive option that will emit about 130g per kilometre of carbon dioxide and achieve more than 58 miles per gallon on the 2.2 litre engine. This compares with CO₂ output of 299g/km and 25 mpg on the 2002 2.9 litre Range Rover.

"There is a move away from pure indulgence to muted signs of intelligent purchase around design, engineering and sustainability, so we are responding to that," says Phil Popham, managing director of Land Rover.

"Our aspiration is to be best in class on operations and customer product against [our] competitor set by 2018. To achieve this we've set some very challenging targets, which involve engaging our workforce to deliver through a programme called 'environmental innovation'. Yes, the brand benefits but this is about being responsible and future-proofing our business."

But how do you define "responsible" or "sustainable" actions? The terms are largely open to interpretation, as few globally and legally binding standards exist, making it difficult to validate such claims. As a

result, industry associations are responding to their members' needs and have started to interact with the NGOs to build frameworks for sustainable and ethical production.


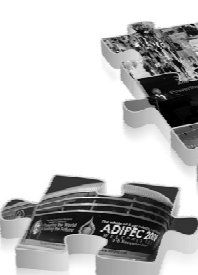

For example, the WWF recommends that jewellery consumers seek benchmarks or goods validated by organisations such as the Responsible Jewellery Council and the Framework for Responsible Mining.

"Some luxury brands are clearly aiming to adopt responsible and ethical raw material sourcing policies, such as De Beers avoiding conflict diamonds and Boucheron ensuring gold comes from socially responsible mines," says Ms Mackenzie.

Bang & Olufsen, the luxury sound systems firm, says it follows a sustainable approach when developing products for a life cycle of up to 15 years.

"Many households throughout the world have perfectly working products that are 20-30 years old," says John Bennett-Therkildsen, vice-president of operations at B&O. "But we do make repairs and spare parts available for a long time after a product has ceased to be manufactured."

"In the design phase of every product, we carry out tests that simulate the dismantling process for the product's disposal after 15 to 20 years of use to ensure our designs can actually be separated into the appropriate fractions."

Exhibition	Conference	CEO Summit	Gala Reception	Awards	Careers
Under the patronage of the President of the United Arab Emirates H. H. Sheikh Khalifa Bin Zayed Al Nahyan					
					
ADIPEC 2010 www.adipec.com 1-4 November					
 POWERING THE WORLD FUELLING THE FUTURE					
The world's most prestigious oil and gas exhibition is back! ADIPEC will have a number of new features to enable you to network, learn, celebrate and develop this year.					
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MyADIPEC www.adipec.com/myadipec			The all new personalized event planner to maximize your time over the 4-day show. www.adipec.com/myadipec		
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