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World Intellectual Property Day

GREEN INNOVATION

WORLD INTELLECTUAL PROPERTY DAY 2009

Message from Francis Gurry, Director General, World Intellectual Property Organization (WIPO)

Human activity, including decades of technological development, has damaged our planet. Wide-spread pollution and spiraling consumption of the world's mineral and biological reserves have put unprecedented stress on the environment. Climate change is one of the greatest threats ever faced by society: glaciers are disappearing; desertification is increasing; in Africa alone, between 75 and 250 million people will face increased water shortages by 2020.

As human activity caused the problem, so too can human activity find the solutions. Green innovation – the development and diffusion of technological means to tackle climate change – is key to halting the depletion of the earth's resources. The race is on to develop accessible alternative sources of energy, as we work to harness the wind and tides, capture the power of the sun, and tap the geothermal energy underground. New plant varieties are being developed to withstand drought and flooding. New environmentally-friendly materials will help us construct a more sustainable world.

On World IP Day 2009, the World Intellectual Property Organization highlights the contribution of a balanced intellectual property system to stimulating the creation, diffusion and application of clean technologies; to promoting green design, aimed at creating products that are eco-friendly from conception to disposal; to green branding, helping consumers make informed choices and giving companies a competitive edge.

The power of human ingenuity is our best hope for restoring the delicate balance between ourselves and our environment. It is our greatest asset in finding solutions to this global challenge, enabling us to move forward from the carbon-based, grey technologies of the past to the carbon-neutral, green innovation of the future.

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IP AND CLIMATE CHANGE NEGOTIATIONS

From Bali to Copenhagen, Via Poznań

Tracking the global response to the challenge of climate change requires a virtual world tour. It begins in Rio de Janeiro, in 1992, with the conclusion of the United Nations Framework Convention on Climate Change (the UNFCCC or the 'Framework Convention'). This Convention still provides the overarching objectives and the institutional basis for international efforts dealing with climate change.

The climate change conference held in Kyoto in 1997 saw the conclusion of the Kyoto Protocol, which entered into force in 2005 and provides for commitments until 2012. The international community is now working towards a global agreement that would succeed the Kyoto Protocol. The current round of negotiations began with a conference in Bali, in December 2007, which adopted a comprehensive set of decisions, set out in the Bali Road Map. This included the Bali Plan of Action, an ambitious program of multilateral work to tackle the challenges of climate change. It triggered an intensive series of negotiations leading up to the conference to take place in Copenhagen in December this year.

December 2008 marked the midway point in the journey from Bali to Copenhagen, with the convening of the Climate Change Conference in Poznań, Poland, which reviewed progress to date.

Increased focus on technology and IP

The Poznań meeting saw increasing attention paid to the role of technology, and debate over the potential role and impact of the intellectual property (IP) system in promoting the development of new technologies, and in leveraging access to technology. Technology is the principal source of the climate change caused by human activity – anthropogenic climate change, as the jargon puts it – ranging from the coal-fired industries of the industrial revolution to today's overwhelming dependence on hydrocarbon fuels for travel. Equally, however, the international community now looks to technology as a vital source of potential solutions to climate change – both technologies that could mitigate, or reduce, emissions of greenhouse gases, and those that would enable communities to adapt to the altered environment wrought by climate change. While not offering a stand-alone solution, the availability of new technologies clearly will be key to an effective global response to climate change. An international understanding on development and transfer of technology is likely to be an important component of any multilateral deal.

The issue of transfer of climate-friendly technology has in fact been on the table since the Rio Conference, and the 1992 Framework Convention highlights the key role of technology transfer and the development of endogenous technologies. More recently, the Bali Plan of Action called for "enhanced action on technology development and transfer to support action on mitigation and adaptation." Such action would include:

- removing obstacles and creating incentives to promote access to affordable, environmentally-sound technologies;
- accelerating deployment, diffusion and transfer of such technologies;
- cooperation on research and development of current, new and innovative technologies;
- and reviewing the effectiveness of mechanisms and tools for technology cooperation.

An extensive discussion is under way as to how to give effect to these objectives – including what new ways of using the IP system, or what reforms to it, may be required to ensure effective development and dissemination of needed technologies. This policy debate is complemented by several practical initiatives aimed at promoting innovation and leveraging technology transfer for environmental benefit (see page 4).

The debate over technology transfer and the role of IP continued at the Poznań Conference. Some called for reforms or other interventions to ensure that the IP system promotes transfer of environmentally-friendly technology and does not present barriers. Others urged that the current IP system is essential for the development and effective dissemination of the new technologies that will be needed to address climate change. Although these questions, which continue to spark debate, were left unresolved, the Conference welcomed the conclusion of the Poznań Strategic Program on Technology

Transfer. This initiative builds on the existing technology transfer activities of the Global Environment Facility (GEF) which, among other roles, is the designated financial mechanism for the implementation of the Framework Convention – in other words, the central mechanism for funding the transfer of environmentally-friendly technology under the Convention. The GEF has funded many significant technology transfer programs.

on a host of issues, including 'pre-grant questions' (what kind of technologies patent offices should grant patents for, and what claimed inventions should be denied protection) and 'post grant questions' (what forms of licensing and other access to technology should be encouraged; what steps should be taken to monitor and regulate the actual use of patent rights in the marketplace; and what forms of intervention may be required).


Photo: Omar Torres/AFP


Photo: Patrick Rowe/NSF


Photos.com


Photo: Liz Roll/FEMA

Side-event highlights practical aspects

An account of this work was given at Poznań at a side-event on the subject of technology transfer, the IP system and climate change – challenges and options. Participants included the UN Industrial Development Organization (UNIDO), the UN Department of Economic and Social Affairs and WIPO. The side-event illustrated the importance of ongoing practical work to advance the transfer and diffusion of environmentally-friendly technologies; discussed concerns about the effective use of IP and the role of regulators in ensuring the public interest; and highlighted the need and opportunities for more effective use of patent information to shed light on and monitor environmentally-friendly innovation. The need for greater empirical input to the debate was also emphasized. Clarifying the technology needs of developing countries was deemed critically important to focusing debate and practical initiatives. The GEF already supports the needs assessment process in many countries.

WIPO's presentation focused on the use of patent information, particularly the PATENTSCOPE® portal, as a tool for policymakers in the climate change field. It also introduced a paper setting out the key issues linking climate change to the IP system, as a background resource for policymakers and negotiators. The paper explains that the essential logic of the patent system is often portrayed as a 'balance'

The presentation underscored that a vast spread of technologies was potentially relevant to climate change mitigation and adaptation. It noted that it would be difficult to resolve post-grant issues – whether these issues concern legal, policy-related, practical aspects, or the development of needs assessments – without stronger understanding of the state of play: including the scope of patenting of relevant technologies and current and emergent trends in the development and diffusion of key technologies. Patent information, as a policy tool, can contribute greatly to that understanding. It discloses historic, current and emerging trends in relevant technologies, including the breakdown of public vs. private sector activity; emerging trends in developing country innovation; the relative contributions of established players and new actors; the changing research profiles of energy giants; and the extent to which innovators and investors are responding to policy signals regarding the emerging low-carbon economy.

Patent information systems offer a means of tracking those markets that are actively being pursued. Because these systems publish new technologies soon after their inception, they can also function as a kind of early warning system that disclose to the public new, potentially disruptive technologies at an early stage in their development.

The WIPO climate change issues paper and presentations are available at *www.wipo.int/patentscope/en/lifesciences/*

SHARING TECHNOLOGY TO MEET A COMMON CHALLENGE

Navigating proposals for patent pools, patent commons and open innovation


Photos.com

Climate change presents a collective challenge to the international community. Meeting that challenge is necessarily a collective endeavor. No other environmental threat has such a universal quality. In no other field can activity in one location potentially have such a direct impact across the globe. So it is no surprise that the world is turning to collective and collaborative initiatives to address climate change mitigation and adaptation. The innovation and widespread dissemination of new technologies will unquestionably form an integral part of this response. Technologies can both facilitate mitigation of climate change – such as those concerning carbon capture and sequestration, wind power or photovoltaics – and also enable communities to adapt to climate change – such as those for combating desertification or enabling agriculture in drier or more saline soils.

The earlier action is taken, the more widely new technologies are disseminated, the better the chance of significantly slowing the impact of climate change. This means that the rate of innovation, and the speed and breadth of dissemination of new technologies, are both critically important. Delivering to a global public an effective, commercially and technically feasible technology is rarely a stand-alone exercise. It usually requires a package of contributions from various sources. One product or process might combine breakthrough research, platform technologies, manufacturing know-how and downstream tweaks and field improvements that can greatly increase the practical effectiveness of a particular technology. So getting results does not just mean interesting findings in the laboratory or workshop: it means finding the best way of combining input and building pathways to develop and distribute finished technologies.

Companies must typically negotiate licenses and other forms of access to technology held by others to bring new products to market. They may also invest considerable effort in locating optimal technologies. But 'business as usual' may not be sufficient in exceptional times. The urgent need for technology diffusion and the complexity of some technology fields critical to addressing climate change lead to an active debate about how best to organize innovation structures and diffusion of technology. To the extent that technologies are covered by intellectual property (IP), particularly patents, this opens up a debate about how IP rights can best be managed and regulated so as to yield optimal outcomes both for innovators and society at large.

Policymakers are actively investigating appropriate collaborative structures and other means of pooling and sharing technologies. A host of ideas are circulating for arrangements such as patent pools, patent commons, open source innovation, open licensing arrangements and non-assertion pledges or covenants. These have typically been developed on a voluntary basis, by technology holders who realize that the benefits of pooling technologies from several sources outweigh any immediate advantage of closely restricting access to their technology. In these cases, there is a common incentive to share technology. This has been the experience, for in-

stance, with audio and video technologies involving a common standard, such as DVD and MPEG technology, where shared interests have led companies to form patent pools or joint licensing schemes.

More direct regulatory interventions, such as the use of compulsory licenses or government use authorizations requiring patented technology to be made available for certain public interest reasons – options discussed mostly in relation to public health – are also possible. A compulsory license is in principle an option in other fields of technology, although no recent cases have been reported directly concerning climate change technologies (access to medicines may also be a factor in future adaptation to climate change, for instance if changing climatic conditions affect the geographical spread of certain tropical diseases).

The challenges

The search for innovation and dissemination structures to meet the challenge of climate change seeks to:

- simplify the process of searching for and locating technologies that are essential to combating climate change;
- cut the costs and complexity of negotiating access to technologies;
- promote an environment of sharing pre-competitive, upstream or 'platform' technologies;
- facilitate access to and diffusion of technology to developing countries, especially least developed countries.

Accepting these general objectives in principle is one thing, but achieving them in practice is a tremendous challenge – partly due to uncertainty about which technologies should be prioritized and what barriers present obstacles to their diffusion. Some considerations that apply in exploring the practical options include:

The state of play: What fields of technology are most needed, where, and by whom? Do needs differ between mitigation and adaptation technologies? And of the key technologies, which are covered by IP rights – by whom are they held and in what countries? Which of these technologies are already in the public domain, and when will others enter it (for instance, as patents lapse or expire)?

The nature and purpose of the pooling structure: Is a scheme intended to focus on one specific outcome – such as making a hybrid engine available to developing country car manufacturers or providing a drought resistant strain of wheat to farmers? Or

Photo: Barefoot College

does a scheme aim to create a pre-competitive pool of technologies to promote competition and accelerate product development in a critical area, such as wind power or photovoltaic cells? Is the goal to open up access to general platform technology for all to use without constraint, or is it to ensure that further improvements and derivative 'downstream' technologies are fed back into a common pool for participants to share?

The scope of technologies covered: Does the arrangement zero in on very specific areas of technology (for instance, one existing patent pool contains only DVD technology)? Or does it cover a wide range of technologies of general relevance to climate change (and other related environmental or sustainable development goals)? How should relevant technologies be defined?

The legal character of the arrangement: Should access be granted automatically to all who meet certain conditions (e.g. all enterprises based in the developing world or those pledging to make technology improvements available on similar terms)? Or should the structure resemble a mutual agreement, whereby all participating parties grant licenses to one another? Does the contribution of technology automatically trigger an entitlement on the part of others to use it, or does it signal a willingness to negotiate on reasonable terms with anyone wishing to do so?

Incentives to participate: How can positive incentives be created that encourage firms to contribute technology – including commercial incentives, prospects for simplified access to others' technologies and corporate social responsibility considerations?

The role of the regulator: How can a regulatory environment be promoted that enables and promotes valuable technology-sharing and collaborative structures? Can or should official fees be structured to encourage formation of collaborative

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or open licensing approaches? When is the coercive tool of the compulsory license or government use authorization appropriate?

Technology sharing models

Clearly, the practical impact and legal implications of these different choices will differ dramatically, and no one model is likely to meet all the requirements for technology development and diffusion relating to climate change. The models under consideration fall into several general categories:

Photo: Tom Stoffel/NREL

Patent pools: Definitions of patent pools vary greatly, but the essential idea is that participating patent holders agree to license their technologies to one another – some are termed 'joint licensing scheme'. Usually the technology is in a well-defined field, or specific patents may be identified. A closed patent pool would restrict access to technology. In some cases, this kind of arrangement might attract the attention of competition watchdogs, particularly where it excludes legitimate competition by those not taking part in the pool. An open patent pool would enable access by any party to the technologies covered.

Patent commons: Generally broader in scope, patent commons allow technology holders to pledge their patented technologies for widespread use for no royalty payment – usually subject to certain general conditions (for instance, agreement not to enforce rights over technologies resulting from access to the commons). A recent initiative, the Eco-Patent Commons, includes patents on environmentally beneficial technologies which are not central to the business of the patent holders (see box). The participating companies legally pledge or covenant not to assert their patent rights against those implementing the technology to produce environmental benefits. These benefits include reduced/eliminated natural resource consumption, or reduced/eliminated waste generation or pollution.

License of right: In some countries, a 'license of right' system provides for a reduction in official fees for patent holders who agree to make their patented technology available to anyone requesting a license, subject to terms that can be negotiated or determined by the authorities. The U.K. Patent Office, for instance, maintains a database of patented technology that is endorsed as available for a license of right – this includes alternative fuel technologies patented by major automotive companies.

Non-assertion pledge or covenant: Rather than canceling or abandoning their patents, patent holders may choose to make their technology widely available by legally pledging not to assert their patent rights against anyone using the technology. This may be restricted to specific uses of the technology (such as for specific environmentally friendly uses), limited to certain geographical locations (such as countries below a certain average level of income), or conditional on the person who uses the technology making available improvements or derivative inventions on similar terms (in the spirit of a 'commons').

Humanitarian or preferential licensing: This type of licensing technology policy provides highly favorable or free terms to certain beneficiaries, for example, developing country recipients, social marketing programs or public sector/philanthropic initiatives.

Public domain: Placing technologies directly in the public domain is one avenue for their transfer and dissemination. Often, technologies are patented in a relatively small number of countries, effectively placing them in the public domain in all other countries as soon as the patent applications are published. New technologies may be consigned to the public domain, so that anyone is free to use them without legal constraint (unless, of course, health and safety, environmental, ethical or other regulations apply), by the simple act of publishing or otherwise communicating them to the public. Special patent search tools can identify those technologies that have entered the public domain when patents lapse or expire.

Open innovation, open source, commons-based peer production and distributed innovation: This cluster of related concepts features in current discussions about innovation models that emphasize a collaborative or shared technological platform for innovation. The term 'open source' originated from a soft-

ware development model that ensures access to the human-readable 'source code', and permits others to use and adapt the software, and to redistribute it, whether or not it is modified. The *Mozilla Firefox* web browser is a well-known example of open source software. Open source is now also used as a metaphor or description for other fields of innovation in which a technological platform is left open to others to use and adapt, and, on the basis of which, innovations can in turn be shared, for instance, open source biotechnology.

'Open innovation' describes a similar but broader approach, emphasizing the interest of many firms in seeking synergies and collaboration with other actors working on related technologies, as opposed to closed innovation which would emphasize firm boundaries between rival companies: according to one definition, open innovation is "combining internal and external ideas as well as internal and external paths to market to advance the development of new technologies."

'Commons-based peer production' refers to the development of new products through widespread collaborative networks without a formal hierarchy, often brought about by a sense of collective purpose: the *Wikipedia* online encyclopedia is a good example. 'Distributed innovation' refers to the development of innovative products through collective efforts in networks spanning different organizations, institutions or individuals. Some commentators have suggested these innovation models may be applied to some of the technology innovation, development and adaptation challenges of climate change.

Encourage a spirit of collective endeavor

The potential forms and applications of technology for addressing the challenges of climate change are numerous and diverse. Mitigation technologies may range from improvements to the efficiency of existing technologies (such as hybrid drives for motor vehicles) to entirely new technologies (such as the biological production of hydrogen through new strains of algae). Adaptation technologies may extend from new treatments for tropical diseases to new plant varieties that handle increased abiotic stress such as drought and salinity. The need for innovation may therefore include relatively straightforward adaptation of existing technologies as well as new breakthrough technologies.

Almost by definition, developing countries' needs for transfer and dissemination of technologies will evolve as rapidly as the cutting edge of technology advances, and as rapidly as the impact of climate change is experienced. No one structure for innovation, nor mechanism for technology diffusion, is likely to be sufficient, even at the level of general conceptual debate and policy analysis. Policymakers, research managers and commercial enterprises alike are likely to explore the full range of options across the broad array of technologies relevant to climate change, as they seek the most appropriate ways of encouraging a spirit of collective endeavor in meeting this most pressing of technological challenges.

Pooling Green Patents

A new technology-sharing initiative, dubbed the **Eco-Patent Commons**, was launched in January 2008 by the World Business Council for Sustainable Development (WBCSD), a Geneva-based group which includes some of the world's largest companies.

Inspired by the success of the open source software community in pooling knowledge to stimulate innovation, the scheme encourages companies to donate patents for inventions which, while not essential to their own business development, provide "environmental benefits." These are published in a searchable website, and made available for use by anyone free of charge. To join the Commons, a company needs to pledge only one patent. But the WBCSD hopes that the initiative will quickly snowball, encouraging fruitful collaboration between pledgers and potential users.

Among the first patents to be donated were a recyclable protective packaging material for electronic components from IBM, and mobile phones recycled into calculators and personal digital assistants from Nokia.

More information: *www.wbcsd.org*

CLIMATE CHANGE
THE TECHNOLOGY CHALLENGE

A collection of WIPO Magazine*'s articles on the challenge to find technological solutions to climate change has been compiled for this Special Green Innovation Issue to mark World IP Day. The articles look at examples of climate-friendly innovation, and explore how intellectual property can contribute to the development of low carbon technologies and their transfer to developing countries.*

Tuvalu, South Pacific. A tropical island dream of perfect blue seas, coral reefs and waving coconut palms? Or the beginning of a nightmare? With its highest point just 4.5 meters above sea level, tiny Tuvalu is one of the world's most low-lying countries. And as global sea levels rise, its inhabitants face the grim prospect of their land gradually disappearing beneath the waves. Climate change, caused by the release of greenhouse gases into the atmosphere, is already taking its toll on the life of the Tuvalu islanders. The underground rainwater tanks from which they draw their drinking water are contaminated by flooding. And salt water seeping into farmland has destroyed crops, making the islanders dependent on canned imports.

Tip of the iceberg

Tuvalu is just the tip of the proverbial iceberg. In November 2007, the world's scientists on the Intergovernmental Panel on Climate Change declared climate change to be "unequivocal." Few any longer question the reality of global warming, nor the potential consequences if it continues unchecked. Experts forecast melting glaciers, rising sea levels, droughts, floods, hurricanes, leading to crop failures, conflicts, famine, disease. Describing this as "one of the most complex, multi-faceted and serious threats the world faces," UN Secretary General, Ban Ki-moon has called for a massive mobilization by governments, the private sector and civil society.

To this end, over 11,000 participants gathered in Bali, Indonesia, for the UN Climate Change Conference in December 2007. Government representatives rubbed shoulders with environmentalists, industry groups with development lobbyists, human rights activists with carbon traders. Temperatures rose inside and outside the conference rooms as delegates differed over questions such as targets for reductions in carbon emissions. But all were agreed on one thing: that innovation and new technologies will play a crucial role in meeting the challenge.

Looking to innovation to save the planet

Developed and developing countries are equally anxious to avoid the sort of cut-backs, or restrictive energy policies, which would undermine their industrial growth or competitiveness. What everyone wants are solutions which are not only good for the planet, but also good for business and good for development. Technological innovation is seen as the best hope of delivering this triple whammy.

Technological solutions are needed for the challenges of both *mitigation* and *adaptation*, as they are referred to in climate change terminology. Mitigation is about slowing down global warming by reducing the level of greenhouse gases in the atmosphere. Among the many mitigation technologies already on – or nearing – the market are renewable energy sources, such as biofuels, biomass, wind, solar and hydro power; low carbon building materials; and emerging technologies which aim to capture carbon out of the atmosphere and lock it away.

Adaptation involves dealing with the existing or anticipated effects of climate change, particularly in the developing, least developed and small island countries, which are most severely affected. In addition to "soft" technologies, such as crop rotation, hard technologies for adaptation include improved irrigation techniques to cope with drought, and new plant varieties which are resistant to drought or to salt water.

The uptake of mitigation technologies has accelerated in recent years, encouraged by proactive government policies. Yet it is not enough for environmentally minded consumers in Europe and the U.S. to install solar panels on their homes and trade in their gas-guzzlers for hybrid cars. The impact and effectiveness of technological solutions depend on their being deployed on a global scale. The International Energy Agency estimates that, by 2020, 60 percent of greenhouse gas emissions will come from economies in transition and developing countries, underlining that these countries

"Climate change is one of the most complex, multifaceted and serious threats the world faces. The response is fundamentally linked to pressing concerns of sustainable development and global fairness; of economy, poverty reduction and society; and of the world we want to hand down to our children." **UN Secretary General Ban Ki-moon**

will need to "leapfrog a technological generation or two" if they are to avoid the fossil-fuel trap and move directly to environmentally-sound technologies.

Technology transfer from developed to developing countries, and increasingly *between* developing countries, will therefore be needed on what the secretariat of the UN Framework Convention on Climate Change (UNFCCC) describes as an unprecedented scale. A major, ongoing focus of the UN discussions is how best to make this happen. Strategies include funding mechanisms, capacity-building, international collaborative research networks, public-private partnerships, and using multilateral and bilateral trade cooperation agreements to create incentives.

What's IP got to do with it?

The intellectual property (IP) rights system makes no distinction between environmentally friendly and other technologies. IP contributes to the development and diffusion of new technologies for combating climate change much as it does in any other innovative technology field: it encourages innovation by providing the means to generate a commercial return on investment in the development of low carbon technologies (particularly as demand builds when the market is primed by appropriate policies); it gives companies the confidence to license their proprietary technologies for use or further development where they are most needed. Patent information can also make a valuable contribution. Published patent documents offer a vast, freely accessible source of technological information on which others may build. The development of hydrogen fuel cells as a renewable energy source is just one example of how new innovation grew from research results contained in earlier patent information (see page 23). Patent "landscaping" can also be used, for example, to chart the pace and direction of innovation in alternative energy technologies and identify future directions.

As efforts are made to accelerate the transfer of affordable climate-friendly technologies to developing countries, there will need to be on-going scrutiny in order to ensure that IP is working effectively to facilitate this process, and to address any problem areas. Such scrutiny is already underway, with some groups, such as the Third World Network, expressing concern that patents on the new technologies may be keeping prices too high and restricting access by developing countries. European parliamentarians recently proposed a study into the feasibility of amending the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) in order to allow for the compulsory licensing of "environmentally necessary" technologies. Other analyses, however, such as the detailed case studies[1] compiled by the Climate Technology Initiative, the International Energy Agency and the United Nations Environment Programme, conclude that one of the most significant impediments to the successful transfer of climate-friendly technologies is the lack of IP rights protection in some developing countries.

These questions are explored further in this edition of *WIPO Magazine* in an article by Professor John Barton (page 12), which examines the impact of patents in the transfer of renewable energy technologies to Brazil, China and India. We also talk to the inventor of a new environmentally-friendly construction material about his innovation and his IP strategy (page 10). Other articles in this issue will illustrate how WIPO is helping developing countries to build capacity in technology licensing skills; to foster collaborative research and development; and to create enabling environments for innovation and technology transfer. Small steps on the steep road to meeting the technology challenge.

Photo by Gary Braasch © 2005

Funafuti, Tuvalu. Photojournalist Gary Braasch has documented climate science since 2000. See *www.worldviewofglobalwarming.org*

1 Technology without Borders *www.iea.org/textbase/nppdf/free/2000/ctifull2001.pdf*

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TOWARDS A GREEN STONE AGE?

A small German engineering firm, TechnoCarbon Technologies, has developed a new composite material that its inventors hope may contribute to cutting greenhouse gas emissions in the construction and manufacturing sectors. They talked to WIPO Magazine *about the innovation process, about the use of IP in commercializing the resulting products, and about their plans for licensing the technology at low cost for developing country markets.*

"This," declares Kolja Kuse, "is the past." He leans across the aisle of the bus to hand us a heavy steel joist. "And this," he says, with a rhetorical flourish, unsheathing a sleek, light-weight bar, "is the future."

Photo: STONEplus Naturstein Magazin

Photo: TechnoCarbon

The ratio of pressure stability to specific weight of CFS is twice that of construction steel, aluminium or concrete. Shown here in the form of a granite beam and a flexible strip.

Inventor Kolja Kuse and two business partners were en route to the 2007 UN Climate Change Conference in Bali, Indonesia. Their mission: to seek partnerships to promote their innovative construction material, which they believe can play a part in reducing global carbon emissions.

Granite sandwich

The new, high performance composite, known as *CarbonFibreStone* (CFS), consists of a slice of granite with a fine laminate of carbon fiber on one or both sides. "A bit like a stone-and-carbon-fiber sandwich," explains Kolja. The resulting material is not only elastic, but is as strong as construction steel, as light as aluminium and has better vibration-damping properties than any other known pressure-resistant material.

The story began ten years ago in Kolja Kuse's garage. He was at the time an electrical engineer at Aachen University, specializing in energy production. His brother was a stone mason. Watching his brother at work one day as he cut a slab of granite to make a kitchen worktop, Kolja imagined a polished stone stove-top, with invisible induction coils hidden beneath a perfect, seamless working surface. Not given to idle dreaming, he built one.

"It looked great," he recalled. "But when the hob got above a certain temperature, the stone would always expand then crack, like an explosion." He tried compressing the edges with huge machines, but it was no good. "The mechanical engineers and material scientists told me, you can't stop the stone expanding. It's impossible. So I pretty much gave up on the idea."

Break through

There followed one of those moments of serendipity, which often precede a technological breakthrough. Flying home to Munich from a meeting, Kolja picked up a brochure about carbon fiber production which had been left on the seat. Carbon fiber, he learned, shrinks longitudinally when heated. Intrigued, he wondered what might happen if he were to coat his beloved granite with carbon fiber. He teamed up with a carbon fiber specialist and gave it a go. Somewhat to their astonishment, the experiment was a success. No matter how high they heated the new hob, the stone never fractured.

The explanation, as they subsequently discovered, lay in a complex field of applied mechanics well outside Kolja Kuse's own area of expertise. But the hunch had paid off. Engineers at the University of Munich subjected a prototype leaf-spring made of CFS to extensive testing and found an outstanding resistance to fatigue. With several more years of research, testing and refinement, the new composite was ready for the market. In 2007 it was awarded a Material of Excellence certificate by the trade publication, *Material ConneXion*.

Rock on

The stone stove is now a reality, marketed by Spring Switzerland AG. As indeed is an award-winning[1] ski with a CFS core, produced by Swiss manufacturer, Zai. Further licensing deals with several other com-

1 Best Product at the Materialica 2007 trade fair, awarded jointly to TechnoCarbon Technologies and Zai: *www.materialica-pressinfo.de/html/design_award_2007_winner.html*

"Without international IP rights, we would have no business model."

panies are under negotiation. But this is only the beginning of what the TechnoCarbon team sees as virtually unlimited industrial applications.

Companies within the carbon fiber industry have been quick to see the benefits of collaboration. Because of very high production costs, carbon fiber itself has tended to be used mostly in specialized applications, such as Formula One racing cars, aircraft parts, or high end sports equipment. The option of combining carbon fiber with CFS technology opens a range of new possibilities in the manufacturing and construction sectors which would not otherwise have been thought economically viable.

The team's vision is that CFS technology will lead to greener building and contribute to sustainable development by replacing steel, aluminium and even concrete. 60 percent of the earth's mantle consists of granite, they point out. And as it comes out of the ground "ready baked," it needs no smelting. TechnoCarbon's initial calculations suggest that CFS production generates less than half of the carbon emissions of steel, aluminium or carbon fiber production, including the energy required to quarry and process the stone. "It is true that, by volume, CFS would consume as much energy to produce as aluminium," notes Kolja Kuse. "But it has ten times more tensile strength. So even with a 5:1 ratio of stone to carbon fiber for high load bearing cases, the production energy would decrease by something approaching a factor of four in comparison to aluminium."

Building on IP

Kolja Kuse is animated on the subject of IP. "Without international IP rights, we would have no business model," he says emphatically. He now has published PCT applications relating to the technology and its applications, filed on the advice of his lawyer uncle as the most efficient means to protect the invention in international markets. "Though what patent lawyers don't warn you," he adds ruefully, "is how much it might cost to defend your patent once you've got it." They have also registered CFS (*CarbonFibreStone*) and *Techno Carbon Technologies* as trademarks, with a view to developing a "CFS inside" branding strategy.

Courtesy of Zai AG

Zai's *Spada* ski has a core of CFS using granite from the Swiss Alps. Elastic, and with greater vibration-damping properties than carbon fiber, the CFS provides what Zai describes as incomparable smoothness and agility.

Photo: STONEplus Naturstein Magazin

A seamless stone cooking hob.

He and the ten staff now working for TechnoCarbon Technologies are committed to using their IP to help make the technology available for industrial use in developing countries. They have partnered with Granidus, a small NGO in Berlin run by Matthias Bieniek, to explore technology transfer opportunities. The company plans to channel up to 80 percent of their profits from commercial licensing deals into subsidizing the transfer of CFS to developing countries. "We are also looking at possible cross-licensing arrangements with technology companies in developing countries," Matthias told us. "The ideal would be to encourage them to develop their own new CFS applications for local needs, and then to help them with the patenting."

The newest member of the team, Peter Kriebel, joins us on the Bali bus. Inspired by the potential of CFS, he had just left a lucrative banking career in Switzerland to head up TechnoCarbon's business development. "It was a no brainer!" he says, "a project for the heart as well as for the head."

More information:
www.technocarbon.com

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PATENTING AND ACCESS TO CLEAN ENERGY TECHNOLOGIES

in Developing Countries

For the world to make the transition to a low carbon economy, renewable energy technologies must be made available globally. One concern often flagged is that the intellectual property (IP) system may hinder access by developing countries. In a paper[1] for the International Center for Trade and Sustainable Development (ICTSD), JOHN H. BARTON, Professor of Law at Stanford University, explores whether IP is a bottleneck in the solar, biofuels and wind energy sectors. He briefly summarizes his conclusions in this article, focusing on Brazil, China and India.

In the politically-sensitive pharmaceutical sector, patents often have a substantial impact on price, as there may be no substitutes for a new product. In contrast, in the renewable energy sectors considered in this article, the basic technological solutions have long been off-patent. Usually, only specific improvements or features are patented. Thus, a number of competing patented products exist – and as a result of the competition, prices are usually brought down as compared to the royalties and the price increases that would be charged under a monopoly.

In addition, there is competition not only between firms within a specific renewables sector, but also between the sectors and alternate sources of fuel or electricity. As a result, much of the benefit of the technologies is shared with the ultimate customers.

Another characteristic of the photovoltaic (PV), biomass and wind sectors is that some of the renewable energy technologies, particularly PV technologies, are not yet inexpensive enough to compete without some form of subsidy or regulation (such as a feed-in law requiring that a portion of the electricity on a grid be supplied from renewable sources). Moreover, firms have been hesitant to invest in substantial research on their own, except in areas with significant subsidies – as seen in the current ethanol boom in the U.S. Hence, much of the research in these areas is funded by the government. At least in the U.S., the subsidised research will almost certainly end up protected by patent rights. When the research is licensed, a certain amount of favouritism is, by law, to be shown to U.S. manufacturers.

Renewable energy markets

There are three types of markets for renewable energy capabilities for developing nations. The most obvious one is the market for enabling the nation itself to reduce its CO_2 emissions (not currently required by international law, but possibly required in the future). The second is the market for providing carbon offsets under the clean development mechanism (CDM) under the Kyoto Protocol. Both these markets can be served by importing products incorporating the technology, e.g. photovoltaic panels for off-grid electrical supply.

The third type of market is for renewable products, such as biofuel (or conceivably electricity), and equipment, such as wind turbines, in which the developing country industry can become integrated into the global industry as a supplier. For this type of market, the nation must license the capability to produce such products, perhaps in an indigenous firm or in a joint venture between a local firm and a developed country firm. Alternatively, it can develop the national capacity to research and produce the products independent of a foreign licensor.

The photovoltaic sector

Basic PV technology involves manufacture and treatment of a silicon slice used to create electricity when illuminated by the sun. There are a number of PV firms, organised in a loose oligopoly; the leading 5 firms make up about 60 percent of the market. Hence, the benefits of the basic (silicon-slice) technology are likely to be available to developing countries even in the face of patents.

1 *Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar Photovoltaic, Biofuel and Wind Technologies*, by Prof. John Barton, is available on the ICTSD website at: *www.trade-environment.org/page/ictsd/projects/BARTON_DEC_2007.pdf*

Photo: CC Wim Koolhoven

Photo: Eclipse.sx

Basic photovoltaic technology is widely available. Here, a solar panel on a remote hut in Khevsureti, Georgia; and a PV plant in Freiberg, Germany.

If developing country firms wish to enter the field as producers, they are likely to obtain licenses on reasonable terms because of the large number of firms in the sector. The possibility of entry is demonstrated by Tata-BP Solar, an Indian firm based on a joint venture, and Suntech, a Chinese firm. Suntech has not only been able to develop its own technologies but has also purchased developed country firms.

Biofuel technology

Typical biofuel technology is based on the conversion of sugar or maize into ethanol, but there are many other ways to convert biomass into fuels. In this context, again, developing countries have reasonably good access to current technologies. Indeed, Brazil has long been a leader.

The questions become more challenging with regard to *future* biofuel technologies. There are government and venture-capital funded efforts underway to develop new processes, enzymes, or microorganisms for producing biofuel – particularly by breaking down lignin, an important component of many plants that is not now readily available for fuel use. There will be many patents in these areas. Nevertheless, production is necessarily decentralised and there is competition among biofuel manufacturing methods and between alternative fuels. Hence, it again seems likely that the holders of patents in this area will be willing to license their technology, and the licensing fees for these technologies are unlikely to remain high for very long.

The key barriers encountered by developing countries will probably not be related to IP, but to the tariffs and other trade barriers against the international sugar and ethanol markets. For example, the U.S. has a tariff in place on Brazilian ethanol – which is cheaper, both economically and environmentally – than U.S. maize-based ethanol.

The wind sector

The wind sector is more concentrated than the PV sector – here 4 firms make up roughly 75 percent of the industry. The sector is, however, competitive enough to allow developing nations to build wind farms incorporating equipment from the global market without enormous IP costs.

It could be more difficult for developing nations to enter the global market for wind turbines, however. The current industrial leaders are strong, and are hesitant to share their technology out of fear of creating new competitors. There have been significant patent battles in this sector in the U.S. In addition, the engineering aspects of technology transfer have sometimes proven difficult. Nevertheless, both China and India have succeeded in building major firms over the last 10 years. The leading Indian firm has been buying developed country competitors.

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Exports, firm purchases and IP

There do not seem to be significant IP barriers hindering the world from benefiting from reduced CO_2 emissions in developing countries. When it comes to developing country opportunities to enter the export markets for PV cells, ethanol (or other renewable fuel) and wind engines, the picture is slightly more mixed. Certainly, for ethanol, the key concerns would relate to tariff and similar barriers, not IP barriers. For PV, the IP system is unlikely to be a significant barrier. For wind energy, there is some ground for concern, but again, IP problems would probably be minor.

The world is also seeing a new technology transfer mechanism in the form of developing countries purchasing developed country firms. However, there is a simultaneous risk of global concentration, particularly in the wind sector, so the world should be alert to the risks of cartel behaviour.

The three renewable energy sectors discussed above serve as examples of other important questions developing countries are facing. Should they strengthen their IP protection in order to make foreign investors more willing to transfer technology? The evidence from these sectors suggests a possibility that stronger IP would help in the more scientifically advanced developing nations, and offers little indication of risks associated with such strengthening. The answer may be different in poorer nations.

The role of subsidies

The three sectors examined also underline the importance of public support for new technologies. The economics of renewable energy often requires support if the technology is to be developed. Developed country governments are likely to seek to ensure that national firms are favoured in the process of licensing technology that has benefited from support at the development stage. Part of the political basis for the support is the hope of helping national manufacturers. This builds a bias against developing nations. It is possible to eliminate this bias by asking developed countries to agree to forego their national favouritism by licensing publicly funded inventions, at least with respect to technologies of global environmental importance. This would be quite similar to the "humanitarian clauses" being considered in the medical and nutritional areas.

It would be far better to go even further – for developed countries to commit themselves to devote a portion of their technology development to the special needs of developing countries and to ensure that developing country firms have the opportunity to participate in the efforts.

Such arrangements could be negotiated in either of two ways. The first would entail commitment to make technology more readily available within the climate change negotiations. This could take the form of a quid pro quo for stronger environmental constraints upon developing nations. Making this work would require a stronger technology transfer commitment than has been typical for global environmental agreements. The other approach would be to create a stand-alone technology arrangement, with the quid pro quo based on reciprocity among research funders.

Removing trade barriers

Finally, the most important task would be to remove unnecessary barriers to trade in renewably sourced fuels, and perhaps in the future in renewably sourced electricity. Unless the world moves to a global carbon tax, renewable energy subsidies are essential. However, current subsidies are often designed in response to domestic concerns, particularly domestic agricultural concerns, and may end up discriminating against developing countries. Subsidies should ideally be redesigned so as not to distort trade or discriminate against developing country firms. A more equitable structuring of environmental market intervention would itself create stronger incentives for technology transfer to developing nations.

NEW RICE FOR AFRICA

Plant Breeding Technology to Fight Hunger

Climate change, drought, desertification, soaring food prices, hunger… Nowhere do these intertwined threats to development threaten more starkly than in Africa.

To mitigate the threats, UN Secretary-General Ban Ki-moon called, at the annual meeting of the Commission for Sustainable Development in May 2008, for a fresh generation of agricultural technologies to usher in a second green revolution – "one which permits sustainable yield improvements with minimal environmental damage and contributes to sustainable development goals."

Photo: © FAO/Giulio Napolitano

June 17 is World Day to Combat Desertification and Drought.

Plant-breeding technologies – often combining traditional knowledge with cutting edge biotechnological techniques – are already making real impact in meeting the challenge. The Food and Agriculture Organization (FAO) reports that rice production in Africa has risen consecutively for over seven years, and is forecast to rise further in 2008 to 23.2 million tonnes. A major factor in this growth has been the success of a new type of rice, known as the New Rice for Africa – or *Nerica*™.

The new rice was the result of years of work by a team of plant breeders and molecular biologists led by Sierra Leonean scientist Monty Jones at the West Africa Rice Development Association (WARDA – now the Africa Rice Center). When Dr. Jones set up the biotechnology research program in 1991, some 240 million people in West Africa were dependant on rice as their primary source of food energy and protein, but the majority of Africa's rice was imported, at an annual cost of US$1 billion. WARDA's objective was to produce a rice variety which was better suited to the harsh conditions in Africa.

Traditional varieties

There were two basic traditional rice varieties available to African farmers, each with very different characteristics:

- Native African rice (*Oryza glaberrima*) had been cultivated in the region for some 3,500 years. It is tough and rugged. Its prolific leaf growth smothers weeds, and it has developed a high genetic resistance to disease and pests such as the devastating African rice gall midge, rice yellow mottle virus and blast disease. But its yield is poor, not least because the plants are prone to falling over when grain heads are full and losing grain through "shattering" before they can be harvested. As a result, *O. glaberrima* has been almost totally abandoned by farmers in favor of the more productive Asian rice.
- Asian rice (*Oryza sativa*), introduced into Africa by Portuguese sailors some 500 years ago, has largely replaced the African rice strains. Asian rice is high yielding. But it requires a plentiful water supply to thrive. Its smaller sized plants are easily overcome by weeds and are vulnerable to African diseases and pests. It is particularly ill-adapted to the upland rice growing areas in Sub-Saharan Africa, where smallholder farmers do not have the means to irrigate the land or to buy chemical fertilizers and pesticides.

The obvious solution was to cross the two varieties. But having evolved separately over millennia, the two species are genetically so different that they will not inter-breed naturally. Repeated attempts to cross them had produced only sterile or unstable hybrids.

Working with partners from across the region and overseas, Dr. Jones' team collected and classified all available rice strains – including a gene bank of 1,500 strains of the native *O. glaberrima* species, which had been in danger of extinction. They then began the painstaking process of selecting parents for the best combination of characteristics, crossing them to produce offspring and backcrossing the offspring with the *O. sativa* parent to fix the desired traits. After a series of failures, they turned to "em-

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Photo: Africa Rice Center (WARDA)

Women farmers in Benin have seen their income rise since switching to Nerica.

bryo rescue" techniques, in which the cross fertilized embryos were grown on artificial media. By the mid 1990s they succeeded in producing robustly fertile plants, and so the first *Nerica* was born. Field testing of the new rice started in 1994, and with improved techniques many more lines were generated each year. There are now more than 3,000 *Nerica* lines.

Best of both worlds

While genetic differences between the two species had made breeding difficult, it gave the resulting new rice variety a high level of *heterosis*, *i.e.* the phenomenon in which the progeny of two genetically different parents outperforms both parents.

Photo: Africa Rice Center (WARDA)

The new rice variety is rugged, high yielding and fast growing.

New *Nerica* varieties can smother weeds like the African parents, resist drought and pests, or can thrive in poor soils. Like its Asian parents *Nerica* has a high yield. The grain head holds 300 to 400 grains compared to the 75 to 100 grains of traditional varieties grown in the region. Its strong stems and heads prevent shattering, and the taller plants make harvesting easier.

Moreover, the most popular *Nerica* lines take only three months to ripen, as opposed to six months for the parent species, thus allowing African farmers to "double crop" it in a single growing season with nutritionally rich vegetables or high-value fiber crops. As a further bonus, some of the new lines contain up to 12 percent protein, compared to about 10 percent in the imported rice sold in the local market. As WARDA director-general Papa Abdoulaye Seck comments, "*Nerica* is a powerful weapon in Africa's fight against hunger and poverty."

Technology from Africa for Africa

Monty Jones' technological advances in the war against hunger won him the World Food Prize in 2004. He was named last year by *Time* magazine as one of "The World's Most Influential People." The World Food Prize committee also highlighted Dr. Jones' leadership and innovation in the follow-up phase of getting *Nerica* rice technology quickly into farmers' hands. He built partnerships between WARDA, policy makers, NGOs and research services, trained farmers to become seed producers, and introduced community-based, participatory programs to disseminate the seeds rapidly and allow rice farmers – a majority of whom are women – an active role in planting and evaluating the new rice varieties and continuing outreach in rural areas.

As an upland rice, *Nerica* is not restricted to growing in paddies, thus enabling African farmers to grow rice in places not previously thought possible. In Nigeria, the new rice has resulted in over 30 percent expansion in upland rice cultivation. In Guinea the *Nerica* area has quickly superseded the modern varieties introduced by the national system. Since Uganda launched the Upland Rice Project in 2004, in which *Nerica* is a major component, the Ugandan National Agricultural Research Organization (NARO) reports an almost nine-fold increase in the number of rice farmers from 4,000 to over 35,000 in 2007. At the same time, the country has almost halved its rice imports from 60,000 tonnes in 2005 to 35,000 in 2007, saving roughly US$30 million in the process.

"Though we wish it were not so, scientists in Africa are engaged in the greatest war on earth. They are waging war against poverty and hunger." **Dr. Monty Jones**

And intellectual property? Helping agricultural research centers manage their intellectual assets as public goods is the *raison d'être* of the Central Advisory Service on IP (CAS-IP), a unit of the Consultative Group on International Agricultural Research (CGIAR) to which WARDA belongs. WARDA and CAS-IP are holding ongoing workshops to determine how IP mechanisms could best support the impact of this agricultural success story. *Nerica* was registered as a trademark with the USPTO in 2004, and as the expanding range of *Nerica* products are adopted by ever more smallholder farmers, CAS-IP notes that it will be increasingly important to protect the quality associations that have been so carefully established by WARDA, and to ensure that any *Nerica* seeds acquired by a farmer are the real thing.

As WARDA declares with pride on its webpages, the New Rice for Africa, a technology from Africa for Africa, has become a symbol of hope for food security in a region of the world where one-third of the people are undernourished and half the population struggle to survive on US$1 a day or less.

For more information: *www.warda.org*.

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FROM COWS TO KILOWATTS

A Case Study in Successful Technology Transfer

The "Cows to Kilowatts" initiative in Nigeria is a partnership project which aims to reduce the water pollution and greenhouse gas emissions from slaughterhouse waste. Building on innovative technology from Thailand, the project converts abattoir waste into household gas and organic fertilizer, providing local communities with clean, cheap fuel. This report by JULIA STEETS, who oversaw the Global Public Policy Institute's work on the Seed Initiative Research from 2004-2006, updates her earlier article published by the Climate Action Programme.[1]

In the face of the combined challenges of climate change, environmental degradation and poverty, an increasing number of companies, governments and NGOs are opting to join forces. Large scale partnerships involving global players are the most visible examples of such cooperative approaches. Yet projects initiated at the local level sometimes offer more tangible outcomes.

The Seed Initiative (Supporting Entrepreneurs for Environment and Development) was founded by the UN Development Program (UNDP), the UN Environment Program (UNEP) and the International Union for the Conservation of Nature in order to support locally driven, entrepreneurial partnerships for sustainable development. It found that a huge variety of such local initiatives exists, often working to enhance environmental sustainability while at the same time alleviating poverty and hunger. Many of these initiatives rely on the generation or transfer of relevant knowledge and technology.

The Nigerian *Cows to Kilowatts* initiative is an example of such a project. One of five Seed Award winners in 2005, it epitomizes how an innovative approach based on cooperative partnerships can have a real impact on the environment and on the well-being of local communities.

The problem

Slaughterhouses are a major source of water pollution and greenhouse gas emissions, especially in the developing world. Specific regulations for abattoirs often do not exist, or are poorly monitored and enforced. Untreated wastewater enters local rivers and water sources, affecting the development of aquatic life. Slaughter house waste often carries animal diseases that can be transferred to humans, while the anaerobic degradation of wastewater generates methane and carbon dioxide – greenhouse gases which contribute to climate change.

A Nigerian engineer, Dr. Joseph Adelegan, drew attention to this issue. He studied the effects of wastewater discharged from the Bodija Market Abattoir in Ibadan, where nearly two thirds of the animals in Oyo State are slaughtered. He found high levels of organic pollution with strongly negative impacts on nearby communities. Seeking a solution, Dr. Adelegan's NGO, the Global Network for Environment and Economic Development Research (GNEEDR), joined forces with two other Nigerian organizations – the Center for Youth, Family and the Law, and the Sustainable Ibadan Project, a UN-HABITAT initiative.

Courtesy of the Seed Initiative

A bioreactor, jointly designed by a Nigerian NGO and a Thai technology innovator, will significantly reduce greenhouse gas emissions from a slaughterhouse in Ibadan.

The solution

The first solution embraced by this group was simply to build an effluent treatment plant. Discussions with experts, however, revealed that, while treating effluents with conventional methods reduces water pollution, it also leads to increased emissions of methane and carbon dioxide. The team therefore set out to find an alternative approach which would minimize the carbon footprint of the initiative.

The solution involved capturing the gas emissions and transforming them into a useful product. They identified relevant technology that had been developed by a Thai research institution, the Center for Waste Utilization and Management at King Mongkut University of Technology, Thonburi. This was based on the use of anaerobic fixed film reactors in the treatment of agro-industrial waste and the production of biogas. By modifying this technology, slaughterhouse waste could be turned into clean household cooking gas plus organic fertilizer.

1. *www.climateactionprogramme.org*

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This approach offered three crucial advantages. Firstly, it would minimize water pollution from slaughterhouse waste. Secondly, it would significantly reduce the greenhouse gas emissions generated by the slaughterhouse and by the treatment of its waste. Thirdly, it would create valuable biogas by-products. Through selling the biogas, the project could become not only economically self sustainable, but profitable.

Implementation I: building partnerships

The project began in 2001. As a first critical step, Dr. Adelegan had to find competent partners for GNEEDR, able to contribute expertise and resources.

Several organizations have provided key inputs to the project:

- GNEEDR represents the initiative and handles the construction of the plant.
- The Nigerian Center for Youth, Family and the Law provides legal advice and helps engage local stakeholder groups, such as the local butchers' association and the Bodija market development association.
- The Sustainable Ibadan Project was central to securing the support of the Nigerian government.
- The World Bank's Global Development Marketplace gave an important impetus to the initiative by suggesting the integration of a renewable energy component in its design.
- The Thai research institute was the technology innovator and technical adviser in the design and construction of the bioreactor.
- The Seed Initiative helped further develop the project and brokered a crucial contact with UNDP Nigeria.

Implementation II: raising finance

The capital requirements for designing and constructing the waste treatment and biogas plant, as well as for administering the project and consulting with local stakeholders, amounted to around US$500,000.

The project is designed to be commercially viable and plans to sell its household cooking gas at a quarter of current market prices, i.e. US$7.50 per 25 liters. By producing around 270 cubic meters of compressed biogas a month, the plant would generate returns on investment after two years. With an estimated lifespan of 15 years, the plant is therefore expected to create substantial economic returns.

Despite these figures, it proved difficult to obtain affordable commercial finance for a promising but untested project in Nigeria. The initiative gained international recognition through its selection as a finalist in the World Bank Global Development Marketplace and as a Seed Award winner, but still no financial support. Finally, UNDP provided the necessary start-up capital through its Energy and Environment program.

Implementation III: transferring the technology

The Biogas Technology Research Centre of Thailand's King Mongkut University of Technology Thonburi had developed an innovative technology for treating agro-industrial waste and generating biogas based on many years of research under an Asian-Australian cooperation program. Through the use of anaerobic fixed film reactors, the institute had achieved much higher treatment efficiency, handling larger quantities of waste and generating high quality biogas at a faster rate than conventional biodigester technologies. Prior to the Nigerian initiative, however, the technology had been applied successfully only to treating waste from a rice starch factory and from a fruit canning factory.

The Thai institute agreed to work with GNEEDR to adapt its anaerobic fixed film reactor technology for use with slaughterhouse waste. Successful test results showed that the adapted reactor could handle from two to ten kilograms of "chemical oxygen demand" per cubic meter (COD is used as a measure of the amount of organic pollution in wastewater), with a retention time of two to four days. It yielded between 0.4 and 0.5 cubic meters of biogas per kilogram of COD, containing 60 to 70 percent methane.

Having signed a memorandum of understanding with the University, the partnership is currently in the

The compressed biogas by-product, to be supplied to local communities, will eliminate the smoke and health hazards caused by other commonly used cooking fuels in these homes.

process of patenting the new technology for treating slaughterhouse waste.

Implementation IV: building the plant

Even once financing was secured, project implementation could not start immediately. UNDP's Programme in Energy and Environment is executed nationally, which means that funds are normally only disbursed to national governments. In the *Cows to Kilowatts* case, the Nigerian Federal Ministry of Environment agreed to receive and transfer the resources to the partnership. This, however, involved a number of bureaucratic hurdles.

With the adaptation of the relevant technology completed and the design of the biogas and waste treatment plant finalized by the Thai research institution, construction finally began in 2007. The plant is scheduled to begin operation in June 2008.

Expected results

Once the waste treatment and biogas production plant starts operating, it is expected to generate 1,500 cubic meters of biogas per day and to capture 900 cubic meters of pure methane per day. This is equivalent to a reduction of greenhouse gas emissions from the slaughterhouse of over 22,300 tonnes of carbon dioxide per year. In addition, the sludge from the plant will be used as organic fertilizer.

The captured methane will be upgraded and compressed for use as household cooking gas to be sold locally, so generating additional employment. The gas is expected to be distributed to around 5,400 households each month at significantly lower cost than currently available sources of natural gas. A cleaner alternative to other commonly used fuels, the gas will reduce indoor air pollution and associated health hazards in the homes of these predominantly poor communities.

Through its use of innovative technology, the Cows to Kilowatts initiative offers a solution to waste treatment which minimizes the carbon footprint of slaughterhouse operations. It is economically self sustainable and even profitable, generating a classic win-win situation. The pilot project in Ibadan is financed with the help of international donor money. Since the plant is expected to repay its start up capital within two years, the necessary financial resources should be available for replicating the project by 2010.

This article was first published in *WIPO Magazine* Issue 2/2008

HOT PROPERTY

IP Strategies in the Solar Power Sector

Every day, the sun radiates down onto the earth a thousand times more energy than we could ever use. The demand for technologies capable of tapping into that energy is booming as pressure mounts to find solutions to climate change and sustainable development. Solar photovoltaic (PV) systems – which convert light energy from the sun directly into electricity – produce no greenhouse gases in their operation, have no moving parts, require virtually no maintenance, and have cells that last for decades.

PV systems are not new. A nineteen-year-old French physicist, Edmond Becquerel, is credited with having first described the photovoltaic effect in 1839. But it was not until the 1950s, when American researchers at the Bell Telephone Laboratories developed silicium solar cells, that the modern technological era of PV began – and even then only haltingly. U.S. government support for PV technology was initially tied to the space program, where it was used in 1958 to power the Vanguard satellite. Terrestrial commercialization was subsequently spurred by the 1970s oil crisis, and in the 1980s small markets began to appear, specializing primarily in stand-alone systems for rural areas.

Any good scientific book will tell you how to make a solar cell. What is complex is the know-how required to make it efficient, cheaper, in higher quantities, and better quality. **Jesús Alonso, Isofoton**

The turning point for the industry was the development in the 1990s of the market for grid-connected PV systems. Figures published by the Earth Policy Institute indicate that, since 2002, global PV production has been increasing by an average of 48 percent a year, making it the world's fastest-growing energy technology. The growth has created a flourishing industry which offers a wide range of applications, while investing major resources in R&D with the primary aims of reducing cost and increasing efficiency.

Inside Isofoton

One of the world's leading companies in PV and thermal solar energy technologies is Isofoton in Spain. The company was created in 1981, initially as a spin-off to develop and produce two patented bifacial solar cells invented by Professor Antonio Luque at the Polytechnic University of Madrid. Today, Isofoton manufactures modules, cells, trackers, inverters, regulators, lighting, batteries and pumping systems and develops new products and processes for attracting, transforming, storing and using the sun's power. It has a commercial presence in over 60 countries, with subsidiary offices in China, Ecuador, U.S., Italy, Morocco, the Dominican Republic, Algeria, Bolivia and Senegal.

Courtesy: Isofoton

Isofoton:
Facts and figures (2007)

Established: 1981
Headquarters: Malaga, Spain
Number of employees: 950
Turnover: €297 million
Investment in R&D: €18 million
PV production: 85 megawatts

As an innovation-driven company, intellectual property (IP) is central to Isofoton's business and R&D strategies. **Jesús Alonso**, Isofoton's R&D Director has been working in the field of solar energy for 20 years. Interviewed for the WIPO Academy, he offered the following insights into how the company uses IP to achieve its goals and to maintain a leading edge.

To acquire or to invent?

In the PV solar energy sector, explains Sr. Alonso, there are broadly two categories of companies: those, like Isofoton, which come from the semiconductor and microelectronics sector and those which historically belong to the energy sector, particularly to the oil industry. The former are generally technology developers, while the latter tend to buy in technologies from outside. "Bear in mind," Sr. Alonso notes, "any good scientific book will tell you how to make a solar cell. What is complex is the know-how required to make it efficient, at a lower price, in higher quantities, and with a better quality."

For Isofoton, the basic goal is that the company should as far as possible generate and own all its IP as a result of its internal research and development activities, so as to be independent from the competition in generating new technology and ahead of competition in the applications market. The guiding principle is to take advantage of being the first with a new technology, or in a market, and to use IP to make the most of that competitive advantage. The strategic backing of innovation has enabled Isofoton to become a pioneer in concentration technology – *i.e.* the use of optical systems to concentrate solar energy a thousand times in one point.

The protection of Isofoton's trademark is handled and monitored separately by the Marketing Department.

Where to protect?

Decisions as to which applications should be protected where, are linked to the specific type of application and the markets in which it is used. Isofoton divides its strategic markets into two main segments:

(a) The market for PV applications connected to the electric grid. This is mostly in Europe, Japan and the U.S. Here, Isofoton takes a broad approach, seeking to protect everything related to these types of applications.

Harnessing the Sun for Sustainable Development

Isofoton's management holds that going green is not only an obligation toward future generations, but is also key to boosting development in a world where, according to International Energy Agency estimates, a quarter of the population has no electricity. Among its many rural electrification projects, the company highlights the following achievements:

It has installed over 150 PV-powered water pumping systems in African and Asian countries, and is now researching new applications focused on high powered pumps to supply water for agricultural use, for example, in Ghana.

With financing from the Moroccan national electricity office, it is installing 34,500 PV energy systems in remote villages in Morocco beyond the reach of the national electricity network.

In Senegal, Isofoton has brought electricity to 10,000 homes, and has begun installing the first PV-powered plant for water desalination through reverse osmosis, which aims to produce three cubic meters of drinking water per day.

Courtesy: Isofoton

It has supplied 17,000 homes, schools and health centers in Bolivia with solar electricity. 85 percent of the project is financed by the World Bank, and the remaining 15 percent by users through taxes and a microcredit system.

A rural electrification project in Bolivia has brought solar electricity to 17,000 homes, schools and health centers.

Which IP rights?

Isofoton has a small – but strategically important – patent portfolio, including two patent applications filed under the PCT. The type of IP protection used by the company depends on what is to be protected and why. "For specific products already in the development phase, and above all in the application phase, it becomes crucial to patent," says Sr. Alonso.

On the other hand, patents are not necessarily used to protect the development of new technological processes within the company. Sometimes, Sr. Alonso explains, it is better to focus on protecting know-how, particularly in view of cost reductions that can be achieved through know-how protection compared to patenting.

(b) The market for isolated PV installations. This is strong and growing fast in developing countries, where Isofoton aims to reach the markets before its competitors with solutions – such as for water pumping or lighting systems – which are best adapted to local needs. Being the first company to offer an appropriate technological application brings a long lasting competitive advantage in these markets, Sr. Alonso emphasizes. Here, patenting decisions are made on the basis of actual and potential local use of each application with a view to maintaining the competitive advantage and facilitating further expansion. North Africa, for example, is a strategic market for Isofoton, where all its applications are used and therefore need to be protected by IP rights, together with the R&D associated with these applications.

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Licensing-in and R&D partnerships

There are a few cases where Isofoton does license-in technology for development or jointly develops technologies in cooperation, for example, with a research center or university. In such cases the key for Isofoton is that its own personnel should be directly involved in all phases of the R&D. This way, says Sr. Alonso, the company has the option of continuing research beyond the specific project objectives, in order to create or develop technologies independently from the original partners.

In its R&D contracts with external partners, Isofoton works with two models of IP rights ownership:

(a) When the company contracts with universities or other companies for a specific technology development, Isofoton insists on retaining 100 percent ownership of the IP rights in order to have first call in any subsequent exploitation. The company does, however, leave open to its partners the possibility of exploiting the development themselves, provided this does not cut across Isofoton's own strategic interests, and subject to Isofoton's prior consent.

(b) For R&D activities undertaken in the context of national programs or under the European Union Research Framework Programs, Isofoton requests free access to any IP generated for its own R&D purposes, but not necessarily for direct use or licensing.

Licensing-out and technology transfer

The PV manufacturing process, explains Sr. Alonso, can be divided into the manufacture of the solar cell and that of the module. As a strategic policy, he notes, it is central for Isofoton to retain complete control over the solar cell technology.

While Isofoton never assigns its IP rights to third parties, it does license out technologies for manufacturing the module. This is an option that the company would normally adopt in its second level priority strategic markets, with the aim of building a strong local partnership with the licensee and so securing a dynamic presence in the country. The technology transfer is also linked to sales of Isofoton solar cells, *i.e.* the leading company product.

Courtesy: Isofoton

A solar PV roof top installation by Isofoton has cut costs at the Torelli Pierluigi cheese factory in Parma, Italy.

Enforcing patents – Avoiding conflict

Isofoton has experienced few problems of patent enforcement. Sr. Alonso believes that this is due largely to the fact that there are relatively few competitors in the solar energy sector and each knows its own and each others' strong points, including in different geographical markets. "So rather than fighting with our competitors, the objective is to reach amicable agreements that safeguard Isofoton's interests in its strategic markets."

As Isofoton is a cutting edge technology company, IP policy sits at the crossroads between technology, marketing and finance. All IP-related policy and strategic questions, therefore, are handled collectively by the management board, which includes the directors of all company departments from engineering and applications, to marketing, commercial operations, finance and research.

"Having been born as a spin-off," Jesús Alonso concludes, "an IP-oriented mind-set comes naturally within Isofoton. IP is at the heart of the company culture."

Top PV Producers

The top five PV-producing countries are Japan, China, Germany, Taiwan and the U.S. Recent growth in China has been particularly dramatic: after almost tripling its PV production in 2006, it is believed to have more than doubled output in 2007.

With more than 400 PV companies, China's market share has rocketed from 1 percent in 2003 to over 18 percent today. China dislodged Germany from the number two spot in 2007, while the U.S., which gave the world the solar cell, has dropped from third to fifth place as a solar cell manufacturer since 2005.

Source: Earth Policy Institute and Prometheus Institute for Sustainable Development

This article was first published in *WIPO Magazine* Issue 3/2008

GREEN TECHNOLOGIES

Electric Cars with Hydrogen Fuel Cells

Over two hundred years ago in 1806, Swiss engineer François Isaac de Rivaz invented an internal combustion engine that used a mixture of hydrogen and oxygen as fuel. But the car he designed to go with it was a failure. The first electric cars were invented some 25 years later, long before Messrs. Daimler, inventor of the modern gas engine in 1885, and Benz, recipient of patent DRP 37435 for a gas-fueled car in 1886, came along.

At the turn of the 20th century electric cars were more popular than gasoline-powered models, for much the same reasons that consumers are taking a second look at electric cars today: they did not emit noxious fumes, were quiet, smoother and easier to drive. So why did the more-polluting gasoline-powered cars take over the market? Several factors came into play.

Henry Ford, good roads, cheap gas

"I will build a car for the great multitude," declared Henry Ford in 1903. And so he did: the Model T, with an internal combustion engine that ran on gasoline, was released in 1908, selling for US$950. During its 19 years in production, its price tag would fall as low as US$280. No other car could compete – let alone electric cars, which, when at their peak in 1912, sold on average for US$1,950. The writing was on the wall.

Electric cars also lost out because of their limited range. At the turn of the century, this had not been a problem, as the only suitable roads for driving were in towns. But after the First World War, nations started to build highways and roads to connect their towns. Car owners soon wanted to venture out further than the electric cars could take them.

The discovery of plentiful crude oil resources reduced the price of petrol, making gasoline more affordable. But electric cars did not disappear – nor did the use of hydrogen as fuel. They simply faded out of the mass consciousness until the 1970s gas crisis and environmental concerns brought them back to the fore.

Clean energy

Today's internal combustion engines can be readily converted to run on a variety of fuels, including hydrogen. However, hydrogen fuel cells used to power cars with electric motors are two to three times more efficient than gas-fuelled internal combustion engines. Moreover, they have zero-emissions and, because they have few moving parts, are quiet and vibration-free.

Hydrogen is one of the most plentiful elements in the universe. It can be extracted from natural gas, coal, crude oil, etc., but water is the only pollution-free source of hydrogen. The hydrogen and oxygen atoms in water can be easily and cleanly split apart by electrolysis, ideally using electricity from clean sources such as solar panels and wind turbines. The resulting hydrogen can be compressed for storage and use in fuel cells.

It was a Welsh physicist, William Grove, who in 1842 invented the first simple hydrogen fuel cell. Grove recombined hydrogen with oxygen – the reverse of the process of electrolysis – to produce electricity with only pure water as a by-product.

Francis Bacon, a chemical engineer at Cambridge University in the U.K., whose interest was piqued when he read the papers published by Grove some 100 years earlier, dramatically advanced the technology in the 1950s. Pratt and Whitney licensed Bacon's fuel cell patents in the 1960s and further developed the technology for use by NASA – the same fuel cell could provide electricity for in-flight power, heat and clean drinking water for the crews aboard space crafts. The Apollo, Gemini and all subsequent NASA missions, including the space shuttle, used fuel cells. Grove's technology had come of age.

A number of companies founded after the oil crisis of the 1970s based their business models on the hydrogen fuel cell as a clean source of renewable energy, using Grove's paper and Bacon's patent information as the starting point for their research. Researchers are now working on many types of fuels cells, as shown by the hundreds of international patent applications filed under the Patent Cooperation Treaty (PCT) for fuel cell-related inventions over the last few years.

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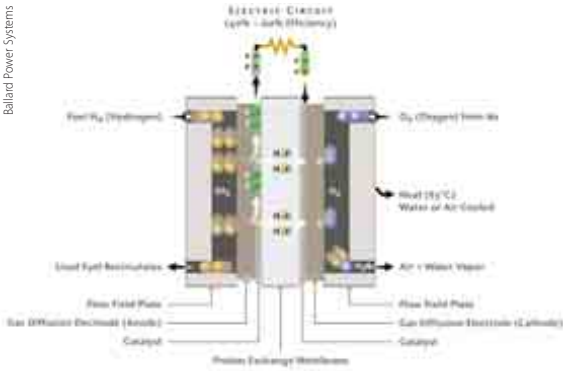
But is it Safe?

Mention hydrogen and many people think of the Hindenburg disaster of 1937, when a hydrogen filled Zeppelin went up in flames, killing all 35 people aboard. But numerous studies, such as those conducted by retired NASA engineer Addison Bain in 1997, have concluded that hydrogen played no part in starting the Hindenburg fire. The extreme flammability of the Hindenburg's aluminum fabric envelope caused the disaster, not the gas inside.

Hydrogen is very flammable, but so is gasoline. Moreover, hydrogen is not inherently explosive, and where there are no ignition sources, it is highly unlikely that hydrogen will ignite in the open atmosphere. While petrol will self ignite at temperatures between 228-501ºC, the self ignition temperature for hydrogen is 550ºC. In principle, for an explosion to occur, hydrogen would first have to accumulate and reach a four percent concentration in air in a closed space and then an ignition source would have to be triggered. With proper safety systems in place, this is unlikely to ever happen. Hydrogen is lighter than air and dissipates rapidly, so the risk of a hydrogen fire or explosion in an open area is also much lower than that of gasoline.

Source *www.fuelcellmarkets.com*

Ballard Power Systems



Ballard has filed over 200 international patent applications relating to hydrogen fuel cell technology since the company first started using the PCT in 1991.

Credit: DaimlerChrysler

In 2003 the NECAR 5 crossed the U.S. in 12 days, proving that fuel cell cars could go the distance.

In the 1990s, a research team at Ballard Power Systems in Canada made a major breakthrough when they discovered a way to increase the power density of hydrogen, upping the average figure from 200 Watts/liter to some 1,500. Using Ballard's PEM fuel cell technology, a car with a motor of similar size to that of a gasoline car can match it in performance – going from naught to 100 km/hour in 15 seconds, with top speeds around 150 km/hour. The technology is also viable for residential use – electricity and heating – or as backup power applications.

Fill her up: Compressed hydrogen, please

DaimlerChrysler, Ford, Honda, General Motors, Mazda – all of these big car companies have developed fuel cell concept cars, some of which have been delivered to customers for trial. In 2003, a team from DaimlerChrysler crossed the U.S. in 12 days with the fuel cell NECAR 5, reaching a record speed of 160 km/hour and proving that fuel cell cars could go the distance. Mazda started leasing fuel cell RX-8s to commercial customers in Japan in early 2006, making it the first manufacturer to put a hydrogen vehicle in customer hands.

Madrid System trademark 801390 registered in 2002.

Photo: Intelligent Energy Ltd.

Sleek and silent – the ENV Bike

Courtesy Honda

Honda demonstrates the FCX Concept Vehicle, a fully functional next-generation fuel cell electric car. Honda has filed over 40 fuel cell-related PCT patents.

Refueling currently remains a problem for customers, unless they live in California, which plans to build 150 to 200 hydrogen-fueling stations by 2010. A number of car companies aim to tackle the problem by providing consumers with home hydrogen refueling units. Honda recently unveiled the third generation of a home unit designed in conjunction with U.S. fuel cell company Plug Power Inc. And GM, whose Vice Chairman Bob Lutz believes fuel cells could create a new golden age for the company, plans to release a home model, which would make hydrogen either from electricity or sunlight, in 2011. GM aimed to place 100 hydrogen fuel cell Chevrolet Equinox SUVs for trial with consumers in 2007.

Looking good

François Isaac de Rivaz's car failed due to its poor design. But a glance at the fuel cell vehicles in these pages shows that manufacturers are now keenly aware of the strategic importance of good design. Their eco-friendly credentials may win consumers' minds but it is good design that will win their hearts.

The ENV Bike from Intelligent Energy Ltd. won an IDEA gold award for design in 2006 (see *WIPO Magazine* issue 5/2006 – News Round Up). It was built from the ground up to demonstrate the use of hydrogen fuel cells, is virtually silent and has a top speed of 80 km/hour. Intelligent Energy intends to make the bike available to consumers in mid 2007 for under US$10,000. The company started using the PCT in 2003 and has ten published international patent applications for their fuel cell technology, including "Core," a portable hydrogen fuel cell that can be used in the ENV Bike, to power a boat or a small house.

On the road again

The government of Brazil announced that São Paulo, one of the world's most polluted cities, which also has the world's largest metropolitan bus fleet, started operating five hydrogen fuel cell buses in November 2007. The US$16 million project is supported by the United Nations Development Program (UNDP), the Global Environmental Facility (GEF) and the Financing Agency of Studies and Projects (FINEP). The project objectives are:

- To develop a zero emission public transportation solution;
- To build an understanding of fuel cell and hydrogen technology, enabling Brazil to obtain a leading position, due to its potential market;
- To work to develop expertise and knowledge in Brazil with the objective of creating a market for hydrogen and fuel cell technologies; and
- To develop Brazilian specifications for the safe and efficient production, handling, stationary and automotive applications, enabling the development of a safe and efficient use of hydrogen.

Santa Clara, U.S., Perth, Australia, Beijing, China and ten European cities already have hydrogen fuel cell buses undergoing trials in their public transportation systems. The results so far are positive. The three buses operating in Perth since September 2004 have been running more than eight hours a day, five days a week. Says bus driver Paul Wroblewski, "Passengers

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Courtesy General Motors

The GM Sequel is expected to reach the market in 2012. With acceleration to 100 km/hour in under 10 seconds, it is much faster than the current average for fuel cell cars.

Photo: Ballard Power Systems

Hydrogen fuel cell buses undergoing trials in Perth, Australia.

Solar-Hydrogen Home

Mike Strizki, an engineer at Renewable Energy International, Inc. and Advanced Solar Products, Inc., built a pollution-free power system for his home, using 56 solar panels and an electrolyzer to pull hydrogen out of water, which he then stores in tanks on his property. The solar panels provide 160 percent of the electricity needs of the home during the summer and 60 percent of such needs during the winter. Seasonal power management builds a supply of hydrogen during the summer for use during the winter. And, sufficient hydrogen is available to power vehicles and household appliances, including hydrogen cooking, throughout the year. He has more than enough energy to power his hot tub, swimming pool, big-screen TV and hydrogen fuel cell cars.

Photo: Renewable Energy International

have been very keen on the new fuel cell buses. The quietness inside the bus has allowed me to overhear some lively discussions about the new technology and their new found knowledge."

Are we there yet?

Not quite. There are a few drawbacks to hydrogen:

- It takes quite a bit of energy to extract hydrogen from water.
- Hydrogen, a gas at room temperature, is difficult to store: It has to be strongly compressed – requiring pressure safe storage tanks – or liquefied by cooling (cryogenic hydrogen).
- Fuel cell technology is relatively new and the cells are fragile and expensive.

Work is ongoing to develop less costly fuel cells that meet or beat the performance specifications for the applications in which they are being used. Researchers recently announced an alternative method of creating hydrogen directly from sunlight and water through a metallic catalyst, which may provide an economical, direct conversion of solar energy into hydrogen. Scientists are also investigating metal hydrides and crystalline materials as solutions to the storage problems. Metal hydrides result from combining pure hydrogen with a pure or alloyed metal and permit a higher storage density of hydrogen than compression.

In a relatively short time, research and human ingenuity have developed what was a moribund technology into a possible solution to the renewable energy problem, providing clean and attractive vehicles. Who knows what other nuggets may lie languishing in faded scientific papers and patent information?

This article was first published in *WIPO Magazine* Issue 1/2007

GREEN DESIGN FROM CRADLE TO CRADLE

Sustainability is today's buzzword in design. The green market is expanding rapidly and eco-friendly design is helping companies to stand out from the competition. Green designers – a new breed of environmentally conscious engineers and architects – are rethinking entire product life cycles, from the industrial manufacturing processes, to what happens at the end of the life of the product. They aim to build non-polluting factories, which make products that are safe for the environment and 100 percent recyclable, by designing new industrial methods and scrutinizing every raw material that goes into fabrication. Some products created according to these principles now carry a new certification mark: Cradle to Cradle™ (C2C).

Photos: W. McDonough & M. Braungart

The book embodies the authors' philosophy: It is printed on a 'paper' made from plastic resins and inorganic fillers, which is waterproof and rugged, but can be completely recycled.

The C2C certification mark (silver, gold or platinum level) distinguishes products the entire life cycles of which are based on sustainable design.

The C2C certification mark is the brainchild of one of the leading lights of the movement, the architect and industrial designer William McDonough, who co-wrote "Cradle to Cradle" in 2002 with his business partner, German chemist Michael Braungart. Mr. McDonough's vision differs from that of traditional environmentalists. Rather than seeking to reduce consumption, he wants to help bring about a new Industrial Revolution: the reinvention of industrial processes to produce clean solutions and create an industry where "everything is reused – either returned to the soil as nontoxic 'biological nutrients,' or returned to industry as 'technical nutrients' that can be infinitely recycled."

The goal is to remodel industry and architecture to emulate the balance found in nature's ecosystems. It may sound an impossible dream, but hard-headed Fortune 500 companies are already working with him.

Fabric "safe enough to eat"

In 2002 the Swiss textile manufacturer Rohner Textil made headlines, cut costs and won new business when the company teamed up with Mr. McDonough and U.S. textile design firm Designtex to produce a biodegradable upholstery fabric that they describe as "safe enough to eat."

While Rohner's textile mills already complied with Swiss environmental regulations, its fabric trimmings had been declared hazardous waste. To produce the new fabric, Climatex® Lifecycle™, a fundamental re-design took place in every aspect of production, from the factory work space, to the elimination of all toxic dyes and chemicals, to the sourcing of raw materials. It is woven from the wool of free-range New Zealand sheep and from ramie, an organically grown fiber from the Philippines. The manufacturing process generates no pollutants. Extensive testing identified just 16 out of 1,600 color dyes that met the consortium's sustainability criteria. As a result, Rohner claims that its factory waste water now tests cleaner than the water coming into the plant. The fabric trimmings are recycled with a consortium of strawberry farms, which use the biodegradable scrap as mulch for ground cover and plant insulation. Moreover, the elimination of regulatory paperwork reduced production overheads by 20 percent.

William McDonough notes: "Not only did our new design process bypass the traditional responses to environmental problems (reduce, reuse, recycle), it also eliminated the need for regulation, something that any businessperson will appreciate as extremely valuable."

Sustainable building

Mr. McDonough is also working with the China Housing Industry Association, which has a commission from the Chinese Government to build homes for 400 million people over the next 12 years –

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Living Roof

Planted with sedum, the living roof on the Ford Company's Rouge Factory helps reduce the urban "heat effect" created by acres of tarred and paved surfaces. It also insulates the building, reducing heating and cooling costs by up to 5 percent. The sedum traps air-borne dust, absorbs carbon dioxide, and creates oxygen. By protecting the under-lying roof structure from ultraviolet radiation and the thermal shock caused by warm days and cool nights, the roof is expected to last over twice as long as a conventional roof, so potentially saving millions of dollars in replacement costs.

The sedum is planted in a four-layer, mat-like system, which collects and filters rainfall as part of a natural storm water management system. Combined with other elements, such as porous pavements, underground storage basins and natural treatment wetlands, this reduces the amount of storm water flowing into the Rouge River, while also improving water quality. Even when soaked with water, this innovative vegetation blanket weighs less than 15 pounds per square foot.

(Source: *www.thehenryford.org*)

Photo: Ford Motor Company

The roof on the Ford Rouge Factory is a 4.2 hectare garden, filled with birds and butterflies.

seven new cities. He is working with them to identify environmentally safe building materials, such as a polystyrene from BASF which uses no noxious chemicals and can be used "to build walls that are strong, lightweight and super-insulating," he told Newsweek Magazine. "The building can be heated and kept cool for next to nothing. It's so silent, if there are 13 people in the apartment upstairs, you won't hear them."

And that is just one of his home solutions. He has designed a new luxury toilet bowl that requires only a light mist to flush, and has included bamboo wetlands in the project planning to purify the waste and provide wood. He is making rooftops into farmland, such as the "living roof" on the Ford Company's Rouge Factory, which cleans storm water and cuts down on energy costs.

In the office

Office cubicles have also been built in accordance to C2C standards. The evidence that PVC (polyvinyl chloride) – ever present in construction materials, furniture finishing and wiring – is a carcinogen and that its disposal is harmful to the environment, ruled out its use in any C2C certified product. So PVC laminated work surfaces were replaced by wood, and suppliers of non-PVC-coated wiring were identified.

Many paints contain volatile organic compounds (VOC), which cause paint to release toxins in the air for years after application – the principal reason why indoor air tested by the Environmental Protection Agency was three times more polluted than outdoor air. Green designers had to work with industry to develop environmentally friendly zero-VOC paints for their office space.

Accepting the challenge

Many companies are accepting the Cradle to Cradle challenge. From diapers to artificial turf, from prefabricated building exteriors to office chairs – the list is long and growing.

For more information, visit *www.mbdc.com*.

This article was first published in *WIPO Magazine* Issue 2/2007

GREEN BRANDING
CASHING IN ON THE ECO-MARKET

As consumers rally to the climate change challenge, companies have rapidly learned that being green – and being seen to be green – makes good business sense. Certification marks figure prominently among the proliferating eco-labelling schemes, which signal a company's climate-friendly credentials. In this article for *WIPO Magazine*, journalist JO BOWMAN, who has worked extensively with the consumer research sector, takes a look at the growth business of green branding.

For anyone who thought their green obligations stopped with a bit of household recycling, the last couple of years have proved a stark awakening. Al Gore's documentary, *An Inconvenient Truth*, the international *Live Earth* concert series and intensive media coverage of the United Nations December summit in Bali have helped make climate change a universal and pressing concern.

Among mainstream consumers there's now a real sense that environmental protection is urgent. They want to live a greener life, and their spending patterns reflect their desire to see the brands they use go green as well. In the U.S. alone, consumer spending on products and services perceived to be environmentally friendly will double to US$500 billion this year, according to the 2007 Green Brands Survey conducted by Landor Associates, Penn, Schoen & Berland Associates, and Cohn & Wolfe.

Paying more for green alternatives

Consumers not only want to buy green, they're prepared to pay more for it. Nearly 70 percent of some 2,000 people surveyed in the U.S., U.K., Germany, the Netherlands, Australia and Japan, said they would pay a premium for green energy alternatives, such as wind and solar power. According to last year's poll by IBM Global Energy & Utilities Industry, Australians were the most willing to pay more for renewable energy, but Americans said they would pay the highest premium – 20 percent or more.

This greening of consumer consciences is not just taking place in the West. The Eye on Asia study by Grey Global Group found that 86 percent of people in the region rate protecting the environment more highly than economic development, and 75 percent say they're willing to pay extra for green products. Chris Beaumont, CEO of Grey in Japan, says the levels of concern appear higher in less affluent countries – Bangladesh, the Philippines, India and Viet Nam – than in Japan and other wealthy markets.

It is not just altruism which fuels the demand. Consumers are also motivated by rising energy prices and tax policies that punish polluters. The British national budget for 2008, for instance, introduced vehicle tax breaks for new cars with the lowest carbon emissions, while almost doubling taxes on the least-efficient cars.

Consumer brands have been quick to respond to shoppers' desire to buy green. Wal-Mart announced last year that it would provide carbon ratings for all its electronics items. Procter & Gamble, the consumer goods giant behind such brands as Gillette and Olay, has committed to selling US$30 billion worth of greener products over the next five years. Rival Unilever – makers of Dove and Lipton – has pledged to reduce waste and water consumption in its supply chain. In Brazil, Unilever and Wal-Mart have built "sustainable houses" within stores, made from recycled products and showing how to make everyday living more eco-friendly.

Eco-labelling

Certification marks, labels and logos are increasingly being used by brand owners to signal their green credentials and so boost their market share. A properly controlled eco-label offers consumers a guarantee that a product or service has been independently verified to meet given environmental standards. Such schemes may be run by government agencies, consumer protection groups, industry associations or other non-governmental organizations.

In Australia, for example, the Greenhouse Friendly™ label is a registered certification mark, administered by the Government Department of Climate Change.

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To be eligible to display the mark, products and services must pass a rigorous verification and certification process. "Displaying the Greenhouse Friendly logo means your products and services stand out from the crowd and it gives you a marketing edge," says the Australian Government's sales pitch. Another Australian certification mark, the Good Environmental Choice label, is managed by a non-profit organization. A member of the Global Ecolabelling Network, it has mutual recognition arrangements with Thailand's Green Label, the Korea Eco-Label, Germany's Blue Angel mark and other national programs.

The greenwash backlash

Jacob Malthouse, a co-founder of the Vancouver-based consumer advice site *ecolabelling.org*, says eco-labels can, however, be something of a mixed blessing for consumers. "The sheer number of labels available can be enough to make your shopping trolley spin," he says. In Britain alone, there are at least four labels to tell consumers about a product's carbon footprint. To help consumers navigate through the eco-label maze, the *ecolabelling.org* website, launched this year, details more than 300 eco-labels and sets out who runs them and what they mean. A further 150 will be added soon.

The EU Ecolabel aims to stimulate both supply and demand of products with reduced environmental impact. Criteria for its use are set by the EU Ecolabelling Board.

Australia's Greenhouse Friendly™ label is a registered certification mark administered by the Government Department of Climate Change.

Chile's Sustainable Forest Management Certification system requires forests to be used in such a way that they do not compromise the needs of future generations.

The Thai Green Label Scheme was launched in 1994 by the Ministries of Environment and Industry. The symbol signifies hope and harmony with nature.

In the U.S., more than 2.5 billion products bearing the Energy Star logo have been sold since the program was launched back in 1992 by the U.S. Environmental Protection Agency and the Department of Energy. "We know it has a very positive effect," says Energy Star communications director, Maria Vargas. She cites consumer research according to which 79 percent of people who had knowingly bought an Energy Star product said the label had influenced their decision to buy.

Some companies are developing their own eco-standards and product labelling. BASF is one; Philips is another, launching its Green Logo and tick symbol last year to identify products with "significantly better energy efficiency than the nearest competitor products." Shai Dewan of Philips in the Netherlands says the development of an additional eco-logo in preference to existing third-party stamps of approval stemmed from the international nature of the Philips business and the variety of products it makes. "There are several logos for various criteria, and in the three sectors we represent there's no single logo across all three that represents a green product and some logos only exist in certain countries," she says.

The potential for confusion is risky, explains Jacob Malthouse. "People see ecolabels and think 'perfect, this is green.' Then they start to hear about *greenwashing* and they question the credibility of what's being done." Greenwashing, the term used to describe companies trumping up their green credentials without any real basis, can backfire on a brand.

Getting ahead

The Carbon Neutral Company, which offers consulting services and carbon offsetting packages to businesses seeking to go carbon neutral, stresses that the business benefits of going green – and being seen to be green – come not just from satisfying consumer demand. Reducing energy consumption cuts costs, influences investors, and puts companies ahead of legislation that is likely in future to oblige companies to reduce their environmental impact.

On the shop floor, however, it's the consumer that's king. Grey's Chris Beaumont sums up: "Ask anyone whether they're concerned about the environment and it's almost an academic question. Everybody is."

This article was first published in *WIPO Magazine* Issue 2/2008

PCT PORTRAITS

Eco-Inventors

More than 1.6 million international patent applications covering new technology of every description have been filed since the Patent Cooperation Treaty (PCT) began operating in 1978. Continuing our series of snapshots, WIPO Magazine seeks out the people behind the patents. In this edition, inventions by a Chinese-Canadian chemical engineer, an American construction worker and two Norwegian brothers from the supermarket business, put waste to work for a greener planet.

Not afraid of the big bad wolf

People react differently to bad news. When David Ward, a former construction worker from Oregon, in the U.S., was told by his doctor that exposure to building materials had made his "blood chemistry read like a list of industrial solvents," he did not retire or seek redress, but rather set about finding a less harmful way to build homes.

Knowing that traditional bricks of mud mixed with plant fiber were an effective building material, he began to investigate ways of using straw, an agricultural waste product, to construct building panels. This in itself was not new. Industrial processes already existed to produce compressed straw building blocks. David Ward's creative vision was to move the process from the factory to the field. This cut out factory overheads. And by using uncut, uncrushed straw straight from the field, he greatly increased the strength of the resulting composite.

By December 2002, with the help of the Oregon State University and a grant from the Environmental Protection Agency, David Ward had completed and field-tested his first *StrawJet* combine-harvester. This produces as "waste" a continuous five centimeter diameter straw cable, held together with a clay and paper-pulp bonding agent. In the next stage a "loom truck" weaves the cable into mats, and then into strong construction panels. Mr. Ward has formed a non-profit corporation, the Ashland School of Environmental Technology, to take forward the project. His PCT application for the *StrawJet Harvester* was published this year.

It has taken Mr. Ward 13 years to get this far. "At times," he admitted, "I was pretty sure it was never going to work." But perseverance paid off, and the *StrawJet* project is gaining wide recognition after winning the 2006 Modern Marvel of the Year award from the U.S. National Inventors Hall of Fame.

Courtesy of ASET/StrawJet Project

The *StrawJet Harvester* produces as "waste" a straw cable, which is woven into mats and compressed into robust building panels.

The *Strawjet* technology aims to serve both developed countries as an ecologically sustainable building material, as well as developing countries, where straw or other plant fiber by-products (such as palm fronds or hemp) could provide a plentiful and cheap alternative to conventional materials. ■

More information:

www.greeninventor.org/strawjet.shtml

Treating Waste with Waste

Oil-sand deposits are an important source of crude oil in Canada and Venezuela. But the potential environmental cost of exploiting them is high. The extraction process can leave behind noxious waste products; and for every barrel of synthetic oil produced from oil-sands in Alberta, Canada, more than 80 kg of greenhouse gases are released into the atmosphere.

Enter Professor Charles Jia – a chemical engineer from China and expert in the environmental applications of sulfur chemistry, now at the University of Toronto in Canada. With his colleague, Professor Don Kirk, he developed the *SOactive* process, which uses sulfur-dioxide to convert oil-sand fluid coke into active *ECOcarbon*, and to remove mercury from industrial waste.

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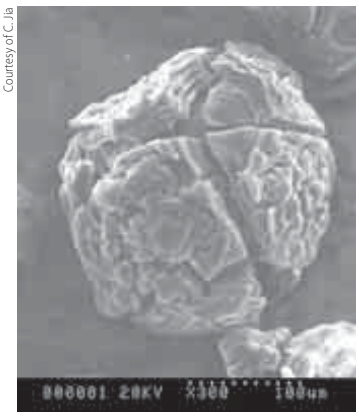
"Our biggest problem," Professor Jia told *WIPO Magazine*, "was the common belief that a waste is a waste. No-one believed that the oil-sand fluid coke, a solid with a dense, layered structure, could be activated." He and Professor Kirk are now securing funding to field-test the effectiveness of *SOactive* and *ECOcarbon* in removing mercury at the site of a company that emits both mercury and sulfur in its industrial waste.

Courtesy of C. Jia



The professors themselves drew up the draft patent application and claims before getting them finalized by a patent attorney. "For me it was a learning process," comments Professor Jia, "and quite demanding in time and money." Their PCT application was published in 2003. ■

"To me, this is among the most beautiful pictures." Professor Jia shows a scanning electron microscope image of an ECOcarbon particle, produced from oil-sand waste.

See also *www.wipo.int/pct/en/inventions/* for WIPO's PCT website Gallery of Notable Inventions and Inventors, featuring a selection of other interesting innovations.

Cashing in on Trash

Courtesy of TOMRA

TOMRA has installed 50,000 reverse vending machines worldwide to encourage the recycling of beverage containers.

There are estimated to be some 700 billion plastic drinks containers, bottles and cans in circulation in the world, the majority of which still end up in landfill sites. The raw materials and energy consumed in manufacturing ever more bottles exacerbates the depletion of natural resources. In Norway, however, consumers now return 90 percent of their used drinks containers to supermarkets for recycling in return for a cash refund. The success of the Norwegian effort was made possible in part by the ingenuity of two brothers, Petter and Tore Planke, the founders of TOMRA.

Their story began in 1971, when the owner of one of Oslo's biggest supermarkets sought their help: The Norwegian government required shops to refund customers for empty bottles, but supermarkets were unable to cope with the quantities. They needed some kind of automated processing system. Within a year the brothers had devised a prototype "reverse vending machine," containing a single hole for the return of all types of bottles, and a printer to issue receipts for the amount of the refund due. Tore Planke filed their first patent with the Norwegian Patent Office in December 1971.

From there, the brothers began to develop new products and processes covering the whole process from bottle collection to delivery to the recycling point. Thirty-four years on, TOMRA is a market leader in reverse vending machines for glass and plastic bottles and cans. Under the slogan, *Helping the world recycle*, the company has installed 50,000 machines on four continents.

The company has more than 30 PCT applications, which cover devices for lifting, rotating and conveying empty bottles, as well as sophisticated image recognition technology to identify different sorts of containers. Maintaining the patents is expensive. But, says TOMRA's chief scientist, Andreas Nordbryhn, without patent rights, "you have no way to calculate the possible losses if you run into problems. It is a lot like insurance. Who would run a business today without appropriate insurance?"

More information: *www.tomra.com*

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WHEN INNOVATION IS CHILD'S PLAY

At the end of another school day in Acornhoek – a rural community in the semi-arid eastern part of South Africa – children shriek with laughter as they whirl each other around on a colorful merry-go-round. Women carry home buckets of water. Boys chase a football.

But there is more to this scene than meets the eye. Forty meters under ground, each turn of the merry-go-round powers a pump. At 16 rotations per minute, it pumps water effortlessly to a 2,500-liter storage tank, supplying the needs of the entire community at the turn of a tap.

The storage tank above the children's heads displays four billboards. These carry educational, public health and HIV/AIDS-prevention messages, as well as commercial advertising, generating enough revenue to fund ten years' maintenance of the system.

The idea was first dreamt up by engineer and borehole-driller, Ronnie Stuiver. As he traveled the country drilling wells, fascinated children would crowd round him – most with boundless energy and few outlets for play. He devised a merry-go-round attached to a simple pump. It worked. But it took the entrepreneurial vision of advertising executive Trevor Field, who stumbled across the pump at an agricultural fair in 1989, to transform an ingenious invention into an innovative, sustainable solution to one of the region's most pressing problems.

Turning point

With two business colleagues, Mr. Field licensed the concept from the inventor and launched Roundabout Outdoor. They developed and patented the PlayPump™ water system. For years it remained a small venture. Then in 1999 President Nelson Mandela opened a new school with a PlayPump merry-go-round and took a spin on one. The press photos captured the imagination of donors and investors. A collaboration began to flourish between the PlayPumps International non-profit organization and big business and government sponsors. The following year, Roundabout Outdoor won the World Bank Development Marketplace Award, bringing extra visibility and new funds.

Today, some 700 PlayPump™ systems are installed in disadvantaged communities across South Africa, Mozambique and Swaziland, transforming the lives of over a million people.

Take Boikarabelo village, for example. Journalist Kristina Gubic describes the scene: Two hours drive from Johannesburg, Boikarabelo is home to 700 people living in corrugated iron shacks. Before, the residents had to walk across boulders and grasslands to the edge of a farm to collect water from an underground spring. Just carrying the minimum for cooking and washing was exhausting work. Today, each family has a vegetable garden and laundry hangs everywhere. The school is constructing greenhouses to make it independent of the sporadic donations on which school meals used to depend. With cabbages, spinach and beans to supplement the maize diet, the children's nutrition has improved dramatically.

The economic and social impact reaches further. Clean water prevents the diseases which kept children from school and parents from work. Freed from the daily toil of water-carrying, girls have time for education; and the women elders of Boikarabelo have started a small craft business. Across the street, another resident has begun raising chickens, which he sells to the local supermarket. "Being able to bring them fresh drinking water and to wash out their cages makes them healthy so I can fetch a good price," he says.

Photo: Courtesy of PlayPumps International

An hour's play produces up to 370 gallons of water. The billboards carry public health messages and generate advertising revenue to fund maintenance.

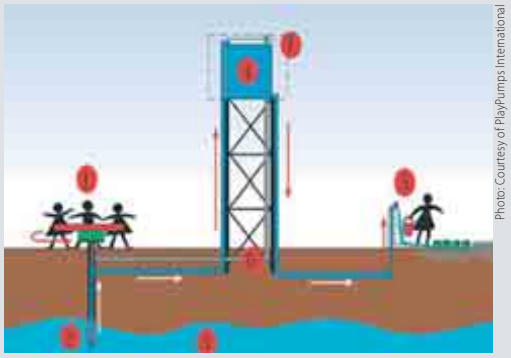

Photo: Courtesy of PlayPumps International

The project continues to gather speed. If PlayPumps International achieve their goal, they will have to reach 10 million people throughout Sub-Saharan Africa within the next three years. (More information: *www.playpumps.org*)

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