



Non-conventional Energy

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Highlights

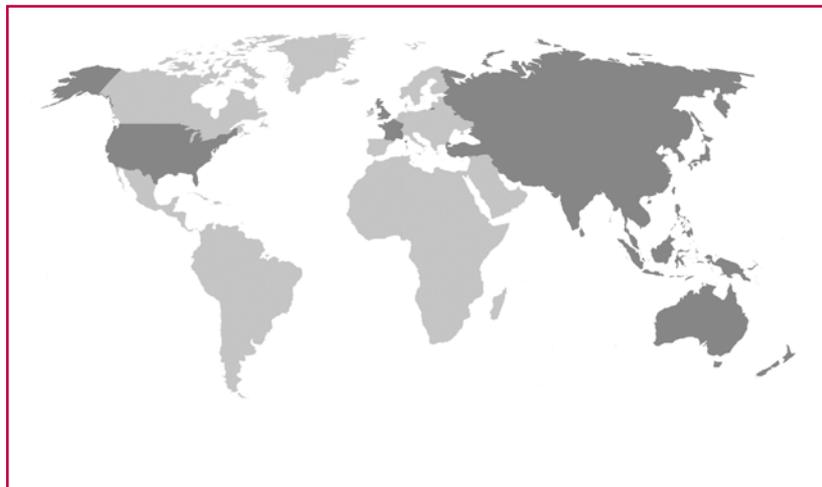
- Peel-and-stick thin-film solar cells
- A wind turbine that catches sun on its blades
- Practical, affordable wave energy
- A cheaper, easier way to build electrolyser
- Breakthrough in hydrogen fuel production
- Benefit of ethanol-to-butanol conversion



The **Asian and Pacific Centre for Transfer of Technology (APCTT)**, a subsidiary body of ESCAP, was established on 16 July 1977 with the objectives: to assist the members and associate members of ESCAP through strengthening their capabilities to develop and manage national innovation systems; develop, transfer, adapt and apply technology; improve the terms of transfer of technology; and identify and promote the development and transfer of technologies relevant to the region.

The Centre will achieve the above objectives by undertaking such functions as:

- Research and analysis of trends, conditions and opportunities;
- Advisory services;
- Dissemination of information and good practices;
- Networking and partnership with international organizations and key stakeholders; and
- Training of national personnel, particularly national scientists and policy analysts.



The shaded areas of the map indicate ESCAP members and associate members

Cover Photo

Alstom's 1 MW tidal turbine has started generating power at the tidal test site of European Marine Energy Centre (EMEC) in Orkney, Scotland.

(Credit: Alstom, France)

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Germany to support India's renewable energy sector

Germany will support India in the renewable energy sector by providing soft loans of up to 1 billion euros for a six-year period starting 2014. As part of its development cooperation with India, Germany made the offer in a "joint declaration of intent" signed by the Indian Union Minister for Renewable Energy Mr. Farooq Abdullah and German Parliamentary State Secretary in the Federal Ministry for Economic Cooperation and Development Ms. Gudrun Kopp. The assistance will finance joint development of technical solutions to overcome the problems facing the integration of power grids and also to speed up the construction of power lines to efficiently transport electricity generated by renewable energy sources.

For more than five decades, India has been a main partner of Germany's development cooperation, and the two nations are currently focusing on environment protection and combating climate change, promotion of renewable energy and energy efficiency, adaptation to the climate change and support for environmentally relevant urban infrastructure development. Building up the power transmission lines and efficient feeding of electricity generated by renewable energy sources into the power grid presented "enormous challenges" to India and Germany is keen to support its Indian partners in these areas, Ms Kopp said.

Source: www.business-standard.com

Nepal turns to renewable energy

Nepal's recently adopted policy of subsidizing renewable energy is the

latest of many attempts to electrify long-deprived areas; however, experts say that much more is needed. More than half of Nepal's households – almost all of them in urban and semi-urban areas – are connected to the national electricity grid. But 80 per cent of the population live in rural areas, where less than one-third have electricity. With grid extension to the country's hilly and mountainous areas prohibitively expensive, "renewable, off-grid energy solutions [are] the only realistic way to provide energy in parts of the country," according to the country's National Rural and Renewable Energy Programme (NRREP), a five-year framework launched in 2012. The new policy funds technologies in hydropower, solar, biogas and – for the first time – wind. The policy also seeks more efficient use of biomass, a traditional energy source.

Despite Nepal's potential wealth in solar energy and hydropower (the highest after Brazil), development of these renewable energies has not kept pace with population growth. The little renewable energy that has been harnessed is poorly distributed owing to crumbling infrastructure. Renewable energy technology is almost entirely absent in the most inaccessible and deprived regions. Most of the country's current energy needs are met with inefficiently used biomass, including firewood (75 per cent), agricultural residues (4 per cent) and animal waste (6 per cent). The rest is met by commercial sources, including petroleum, coal and electricity. Only about 12 per cent of the country's population uses electricity derived from water, wind or sun.

Nepal's new policy emphasizes on targeted subsidies reaching women and the "socially excluded". The new power subsidies will no longer be flat-rate and will take into account the actual costs of tapping alternative

energies for communities. Solar and micro-hydro energy subsidies will now be higher for areas less accessible by road, and subsidies for biogas will be higher for communities in mountainous areas. The average subsidy for renewable energy technology will increase from 25 per cent to 40 per cent. The policy also promotes micro-financing through private financial institutions (backed by a central government fund), which will grant loans of up to 40 per cent of the technology cost.

Source: www.irinnews.org

China tops in renewable energy sector investments

China emerged as a world leader in terms of attracting investors to its renewable energy sector overtaking the United States, a research report from Pew Charitable Trusts has found. Pew's report on clean energy found that China attracted US\$65.1 billion in renewable energy investments in 2012, pushing the United States to the second spot (with US\$35.6 billion) and Germany to the third (US\$22.8 billion). Only China posted a net increase in attracting investors to its renewable energy sector when compared with 2011 figures.

The report also found that technologies are shifting along with national investments. For the second year in a row, solar technologies attracted more financing than any other technology by a wide margin: US\$ 126 billion was invested in the sub-sector in 2012, or 58 per cent of the G20 total. China, Europe and the United States were the top markets for solar investment. Pew report said wind energy investments were down 14 per cent in 2011 among the 19 major industrialized economies plus the European Union, but still managed a total of US\$ 72.7 billion.

The United States, a G20 member, renewed a wind tax benefit through 2013. The Pew report found that the renewable energy sector grew globally by 88 GW in 2012 even though investments were down 11 per cent to US\$269 billion from their 2011 totals.

Source: www.upi.com

Philippine clean energy tariffs to kick in from 2014

After a long regulatory struggle, the first power project under the Philippines' main incentive scheme for renewable energy should finally come on-line in 2014. Solar power plants of 3-5 MW each are expected to be the first to supply electricity under the plan, said Mr. Mario Marasigan, Chief, Renewable Energy Bureau of the Department of Energy. The feed-in tariff (FiT) guarantees energy producing companies an extra amount of money above the market rate for every kilowatt of clean power they sell. FiT is one of the main planks of a 2008 renewable energy law to spur investment and see that half the country's energy come from renewable sources by 2030 (about 39 per cent, currently).

Industry and green groups complain that since the law was introduced, the tariff scheme has been relegated to a low priority and got lost in red tape while the government has focused on boosting power from fossil fuels. The government approved the tariff rates only in July 2012, and is yet to approve any of the hundreds of projects that have applied to participate. "It (the FiT scheme) needs a stronger push from the government... there is too much red tape in renewable energy investments," states Mr. Beau Bacongus, Programme Manager with Greenpeace Philippines. Mr. Marasigan, however, defended the pace of the roll-

out, stating that the government was introducing a completely new energy financing scheme and this took time to get right. It took a while to learn and decipher "what is the best means for us," Mr. Marasigan said.

Source: business.inquirer.net

Biodiesel gets a push in Malaysia

Led by Felda Global Ventures Holdings and Sime Darby Bhd., a private sector-led initiative – Biodiesel Malaysia Sdn. Bhd. (BMSB) – is to be established in Malaysia to support the implementation of the B10 biodiesel programme nationwide. B10 is a blend of 10 per cent palm-based methyl ester and 95 per cent petroleum diesel – more environmentally friendly compared with conventional diesel. B10 will be available for industrial operations and transport purposes by mid-2014. BMSB, expected to commence operation in the second quarter 2013, will offer equity participation to other companies involved in the oil palm and biodiesel sector, according to Minister of Plantation Industries and Commodities Mr. Tan Sri Bernard Dompok. The company will support the local biodiesel market before embarking overseas (Europe and the United States markets).

With the push to B10 from the existing B5, domestic utilization of palm oil for biofuel purposes is expected to increase to 1 million tonnes from 0.5 million tonnes a year. In the long run, B10 is expected to push the crude palm oil prices upwards with increased job opportunities through the increased operations. To facilitate the implementation of B10, the government will allocate an annual subsidy of M\$13.6 million (US\$4.3 million) to M\$1.1 billion (US\$347.2 million) to cover the blending of palm oil and petroleum diesel. The government will also work with Sirim

Bhd. and automotive manufacturers to speed up the process of acquiring engine warranties.

Source: www.mmail.com.my

United States and Indonesia set up green energy project

In a comprehensive partnership, the United States and Indonesia have launched the "Green Prosperity Project", a US\$332.5 million programme to promote economic development in rural parts in Indonesia. The programme will be open for proposals from businesses, the government and non-government organizations for projects in the renewable energy sector. "Indonesia has a huge potential for geothermal energy production, more than any other country in the world," stated Mr. Scot Marciel, the United States Ambassador, in a public lecture at Atma Jaya University. Cooperation on environmental issues was an important part of the United States-Indonesia ties. As the world's third and fourth most populous nations, the United States and Indonesia were big emitters of greenhouse gases. "This is an area where Indonesia is incredibly important globally, because this problem cannot be addressed without Indonesia," Mr. Marciel stated.

At the G20 meeting in the United States in 2009, Indonesia's President Mr. Susilo Bambang Yudhoyono had announced that Indonesia would reduce greenhouse gas emissions by 26 per cent, and 41 per cent with international help. The new project is funded under the Millennium Challenge Corp., an agency of the United States government that plans to provide a total of US\$ 600 million in grants over five years for the Indonesia compact, signed in November 2011.

Source: www.thejakartapost.com

ADB loan for solar power in Thailand

The Asian Development Bank (ADB) will lend US\$85 million to developer Solarco, a unit of Thailand's Electricity Generating Public Co. (EGCO), for three Thai solar plants totalling 57 MW of power generation. The three projects will be located within the Nakhonpanthom and Suphanburi provinces in central Thailand. ADB approved a US\$52 million loan for Solarco, and an additional US\$ 33 million will be given through the ADB Clean Technology Fund. EGCO plans to raise its installed renewable energy generating capacity to over 300 MW by 2015 from its current 9.9 MW of biomass and 64 MW of solar energy.

Source:

www.newenergyworldnetwork.com

REC installs 5.8 MW solar plant in India

REC, a leading global provider of solar electricity solutions, shipped 5.8 MW of solar panels to India for installation at a power plant owned and operated by BMD Pvt. Ltd., a market leader for automotive furnishings and part of the LNJ Bhilwara Group. The ground-mounted system is located at Gajner in Rajasthan. "We are delighted to have provided REC Peak Energy Series solar panels for this project in record time," commented Mr. Anil Yadav, Head of India Market, REC. "We expect the plant to operate efficiently for more than 25 years and to reduce carbon dioxide emissions by around 7,272 t/y," he added. The plant built by AEG Power Solutions, Germany, comprises 23,200 units of REC's Peak Energy Series solar panels and is expected to generate about 9,700 MWh/y of electricity. The installation was completed in just four months, from start to finish.

"One of the decisive factors for selecting REC solar panels was that we get the maximum yield, which in turn translates to more tradable Renewable Energy Certificates," stated Mr. Shantanu Agarwal, Executive Director, BMD. "Since these certificates have a fixed price in a specific time-frame, the aim is to maximize the return of investment within this time period and therefore, REC is the right choice." REC expects the Indian market to grow to 1.6-1.8 GW in 2013, as the country gets ready to enter Phase II of its National Solar Mission. *Contact: Mr. Anja Hesse, Public Relations Manager, REC Solar Sales and Marketing GmbH, Leopoldstr. 175, Munich 80804, Germany. Tel: +49 (89) 5404 67223; E-mail: anja.hesse@recgroup.com.*

Source: www.recgroup.com

Waste-to-energy plants in China bag US\$200 million loan

The Asian Development Bank (ADB) has given US\$200 million loan for kick-starting waste-to-energy projects in Chinese cities. The money has been handed over to Dynagreen Environmental Protection Group, the environmental infrastructure arm of Beijing State-owned Assets Management Co., to assist small and medium-sized cities in China turn their growing solid waste mountains into renewable energy. China is the world's second largest producer of solid waste, generating more than 220 million tonnes a year. Although the per capita production of solid waste in China is only about 20 per cent of the average in industrialized nations, it is expected to increase considerably in small and medium-sized cities where huge population growth is expected by 2030. ADB's loan will help build at least nine plants capable of converting up to

6,300 t/d of municipal solid waste into electricity. The plants are expected to generate approximately 610 GWh/y of electricity by 2018.

According to Mr. Hisaka Kimura, Principal Investment Specialist of ADB's Private Sector Operations Department, the loan targets small and medium-sized cities because "unlike large cities that are implementing waste-to-energy projects through public-private partnerships, smaller municipal governments have difficulty attracting private sector interest, resulting in large amounts of untreated waste, thereby leading to harmful gas emissions and soil and groundwater contamination."

Source:

www.powerengineeringint.com

Philippines chosen for pilot test renewable energy programme

The Tennessee Renewable Energy and Economic Development Council (TREEDC), the United States, has chosen the Philippines to pilot test its international exchange programme for creating awareness among renewable energy (RE) stakeholders. TREEDC has partnered with the Renewable Energy Association of the Philippines (REAP) to develop the programme wherein Philippine colleges and cities become members of the TREEDC network of 92 cities, counties and 23 colleges in Tennessee, Mississippi and Arkansas. The programme is also meant to establish collaborative projects between Tennessee and the Philippines. TREEDC will work with REAP to organize several community outreach forums at various schools across the country shortly. It also plans to replicate its renewable energy network developmental model in the Philippines.

Source: businessmirror.com.ph

Peel-and-stick thin-film solar cells

In a cooperative effort, researchers at Hanyang University, the Republic of Korea, and Stanford University, the United States, have developed a new silicon (Si) wafer that offers a clean peel-and-apply option for thin-film solar cells (TFSCs). The technology works on just about any structure or surface, and the peel-off TFSCs made from the new Si wafer are light and flexible. Prof. Dong Rip Kim of the Department of Mechanical Engineering, Hanyang University, succeeded in fabricating peel-and-stick TFSCs in collaboration with the Stanford team led by Prof. Xiaolin Zheng. This method overcomes the hardships related to working with traditional solar cells, namely the lack of handling, high production cost and limited flexibility while maintaining performance.

One of the main aims of the joint research project was to bring down the price of solar cells. Another was to make solar cells that were not rigid and heavy, which brings in vulnerabilities and demands a lot of concentration in handling. The non-conventional or universal substrates developed by Prof. Kim and team address these issues, besides widening the application spectrum of solar cells. For the peel-and-stick solar cells, the researchers use the same fabrication method for standard Si wafers or glass substrates, but add a metal layer between the fabricated a-Si:H TFSCs and the underlying Si/SiO₂ wafer. Following several attempts and trials, Prof. Kim and colleagues found a method to reliably peel the TFSCs from the Si/SiO₂ wafer by using water penetration between the metal layer and the SiO₂ layer on the wafer. Importantly, the researchers fabricated the light-weight flexible solar cells without modifying existing fabrication

processes, and their performance was maintained even after the transfer. Furthermore, the technology is not limited to solar cells only: numerous other applications like flexible displays can adopt this method.

Source: cleantechnica.com

Trees used to create recyclable, efficient solar cell

In the United States, Georgia Institute of Technology and Purdue University researchers have developed efficient solar cells utilizing natural substrates derived from trees. Just as importantly, by fabricating them on cellulose nanocrystal (CNC) substrates, the solar cells can be recycled quickly in water at the end of their life cycle. The researchers report that the organic solar cells reach a power conversion efficiency of 2.7 per cent – unprecedented for cells on substrates derived from renewable raw materials. The CNC substrates on which the solar cells are fabricated are optically transparent, enabling light to pass through them before being absorbed by a very thin layer of an organic semiconductor. For recycling process, the solar cells are simply immersed in water at room temperature. Within only minutes, the CNC substrate dissolves and the solar cell can be separated easily into its major components. Prof. Bernard Kippelen from Georgia Tech College of Engineering, who led the study, says that his team's project opens the door for a truly recyclable, sustainable and renewable solar cell technology.

To date, organic solar cells have been typically fabricated on glass or plastic, neither of which is easily recyclable or very eco-friendly. In comparison, paper substrates are better for the environment, but have shown limited performance because



Solar cell fabricated on cellulose substrate

of high surface roughness or porosity. However, cellulose nanomaterials made from wood are green, renewable and sustainable. The substrates' surface roughness is a low 2 nm. The researchers are aiming to improve the power conversion efficiency to levels similar to solar cells fabricated on glass or plastic substrates. They plan to achieve this by optimizing the optical properties of the solar cell's electrode. They plan to also coat the cells with an eco-friendly, thin environmental barrier coating to protect the cells from water and oxygen when operating in the field.

Source: www.gatech.edu

Hybrid cell generates electricity from both light and sound

In the Republic of Korea, a nanotech hybrid solar cell developed by the Samsung Advanced Institute of Technology and Sungkyunkwan University generates electricity from both light and sound. The hybrid solar cell is essentially two generators stacked on top of each other, but the whole assembly is just a few hundred nanometres thick. The solar cell layer uses new nanopillar construction, which is about 3 per cent efficient in converting solar energy into electricity. On top of the nanopillars, a piezoelectric layer is added to develop a 0.8 V charge

when exposed to noise at 100 dB. These numbers may not sound impressive, but researchers expect to improve on it by further tweaking the process and materials. The hybrid solar cell could find new uses in generating electricity on vehicles of all kinds, both from the sun when present and from the vibrations when the vehicle is in motion.

Source: www.greenoptimistic.com

Nanowire solar cells raise efficiency limit

Scientists from the Nano-Science Centre at the Niels Bohr Institut, Denmark, and the Ecole Polytechnique Federale de Lausanne, Switzerland, have shown that a single nanowire can concentrate sunlight up to 15 times of the normal sunlight intensity. The results hold the potential for developing a new type of highly efficient solar cell. Owing to some unique physical light absorption properties of nanowires, the limit of energy from the sun's rays that can be utilized is higher than previously believed. These results demonstrate the great potential for the development of nanowire-based solar cells.

Nanowires naturally concentrate the sun's rays into a very small area in the crystal by up to a factor of 15. Because the diameter of a nanowire crystal is smaller than the wavelength of light coming from the sun, it can cause resonances in the intensity of light in and around nanowires. Thus, the resonances can give concentrated sunlight, where the energy is converted, which can be used to give a higher conversion efficiency of the sun's energy, says Mr. Peter Krogstrup who just completed his Ph.D. at the Niels Bohr Institute, University of Copenhagen. The Shockley-Queisser Limit – the typical efficiency limit – has been for many years a landmark for solar

cell efficiency among researchers, but now it seems that it may be increased. If the limit were to move even by a few per cent, it will have a major impact on solar cell development and perhaps the extraction of energy at the international level.

Source: www.sciencedaily.com

Solar cell maximizes energy output with fewer materials

A more efficient and unobtrusive solar cell could be made with fewer materials and less energy, according to research conducted at the University of Michigan, the United States. Silver nanoparticles added to a restructured and thinner silicon layer inside the solar cell captured more light and improved electricity flow. The cell efficiency improved by 8 per cent. The green design advance is in the important silicon layer that absorbs sunlight. The silicon is spread thinner and mixed with silver nanoparticles. Less silicon used makes the cells cheaper without sacrificing efficiency or durability. Using fewer materials reduces waste and conserves resources. Another benefit is that the solar cell can be made directly on flexible and clear plastic, which eases installation and lowers costs.

Typically, solar panels use highly purified silicon that can account for almost half of their total cost. The high-efficiency solar cells – such as those found on buildings – use 99.9999 per cent pure silicon. The silicon in this updated cell is up to 10 times less pure and 2-5 times cheaper. Research shows that the inferior silicon absorbs just as well as the purified type if it is spread thinner and restructured. The thinness of the silicon creates paths for the electricity to flow without being disrupted by the larger number of impurities. With less material to ab-

sorb light, small amounts of silver nanoparticles were added to capture and transfer more light to the thin silicon, where it can be used to generate electricity. These solar cells put out almost as much energy as existing cells, and the scientists hope to improve this further.

Source:

www.environmentalhealthnews.org

Solar cell design based on dots and nanowires

A research team at Massachusetts Institute of Technology (MIT), the United States, has taken further the concept of using quantum dots as the basis for a photovoltaic (PV) cell. By adding a new wrinkle – embedding quantum dots within a forest of nanowires – the team has given a significant boost to PVs. The nanowires are conductive enough to extract charges easily, but long enough to provide the depth needed for light absorption. By using a bottom-up growth process to grow these nanowires and embedding them with lead sulphide quantum dots produces a 50 per cent boost in the current generated by PV cell, and a 35 per cent increase in the overall efficiency. The process produces a vertical array of these nanowires, which are transparent to visible light, sprinkled with quantum dots. If one shines light along the length of the nanowires, you get the advantage of depth. But this also decouples light absorption and charge carrier extraction, since the electrons can hop sideways onto a nearby nanowire and be collected. Further research will explore using longer nanowires to make thicker films and also work on better control of nanowire spacing to improve the infiltration of quantum dots between them.

Source: phys.org

Vertical turbine array could make more of the wind

According to Prof. John Dabiri, an aeronautical and bioengineering researcher at California Institute of Technology (Caltech), the United States, arrays of tiny wind turbines could produce cheaper power than big ones. Igiugig, a remote Alaskan village of about 50 people will be the first to demonstrate a new approach to wind power that could boost power output and, its inventors say, just might make it more affordable. The way to lower the cost of wind power is to use small vertical-axis wind turbines (VAWTs), while using computer models to optimize their arrangement in a wind farm so that each turbine boosts the power output of its neighbours, says Prof. Dabiri. He demonstrated the basic idea at a 24-turbine test plot in southern California. The first 10 turbines will be installed this year in Igiugig, and the goal is to eventually install 50-70 turbines to produce roughly as much power as the diesel generators the village uses at present.

According to Prof. Dabiri, VAWTs produce a wake that can be beneficial to other turbines, if they are positioned correctly. Wind moving around the VAWTs speeds up, and the vertical blades on downstream turbines allow effective catching of that wind to generate more power. The vertical arrangement of blades also makes it possible to pack more turbines onto a piece of land. Prof. Dabiri's 10 m tall wind turbines generate 3-5 kW, unlike the 100 m tall, multi-megawatt machines in conventional wind farms. The smaller ones are easier to manufacture and could cost less than conventional ones if produced on a large scale. Also, maintenance costs could be less because the generator sits on the ground, rather than at the top



Vertical-axis wind turbines at a demonstration facility

of a 100 m tower, and thus is easier to access. The performance of the wind farm at Igiugig will help determine whether Prof. Dabiri's estimates of maintenance costs are correct.

Source: www.technologyreview.com

A wind turbine that catches sun on its blades

Researchers at University of Liverpool in the United Kingdom have developed the ultimate renewable energy-generating structure by incorporating solar panels on regular wind turbines. The team developed the idea of installing solar blades on conventional wind turbines to answer critics who claim that wind turbines are only beneficial while the wind blows. The technology thus makes it possible to generate both wind energy and solar power at the same time. The leader of the group, Dr. Joe King, highlighted the benefits of the development especially in sunny countries.

The development of the system has not been without its problems. The main issue the team faced had to do with the solar panels reflecting beams of sunlight into the immediate environment, which could blind

aircraft pilots or the people in the area. The issue could also have resulted in concentration of solar rays into beams lethal enough to cause fires. The solution to this problem was to 'tint' the solar panels so that the sunbeams would not be reflected. The aptly named "Heat Waver" is set to be installed later this year, after a battery of tests and analyses of their results.

Source: www.greenoptimistic.com

Bladeless wind turbine with no moving parts

Researchers at Delft University of Technology (TU Delft), the Netherlands, have created a bladeless wind turbine with no moving parts that produces electricity using charged water droplets. Most wind turbines convert the kinetic energy of the rotating blades into mechanical energy, which in turn generates electrical energy. Ewicon (stands for Electrostatic Wind Energy CONverter), on the other hand, creates electrical energy directly from wind energy. It does this through the displacement of charged particles by the wind in the opposite direction of an electrical field.

The device comprises a steel frame holding around 40 horizontal rows of insulated tubes. Each tube has several electrodes and nozzles that release positively charged water into air, through a process that has been dubbed "electrospraying". Positively charged particles naturally move towards the negative electrode, but when the wind is allowed to push the particle away from the negative electrode, it increases its potential electrical energy. This increased energy can be collected.

The whole system comprises a battery, inverter, a high-voltage, direct current (HVDC) source, pump and

charging system. All components are placed on a metal plate supported by ceramic insulators. The insulated metal plate functions as a capacitor, which is charged by the removal of the charged droplets. Ewicon's advantages include the fact that it can come in many different shapes and sizes, and it has no moving parts, which means lower maintenance costs. Thanks to the lack of moving parts, it is also much quieter and creates less vibrations, making it suitable for urban settings. So far, the researchers have only made a few small-scale working prototypes of the Ewicon; however, the team is seeking funding to build a larger model. The amount of energy that can be generated depends on the number of cones employed to spray-charged particles and the wind flow rate.

Source: www.wired.co.uk

Twin-rotor 11 MW turbine edges closer to physical prototype

About a year ago, Airgenesis, the United States, had completed the design for a twin-rotor wind turbine that was reported to have a power generating capacity of 11 MW. The Airgenesis turbine boasted of other features, such as a shaft to transmit power down tower to several generators arranged in a circle at the tower base. Twelve generators, two 500 kW units and 10 rated for 1 MW each, will allow the turbine begin generating power in usually unproductive 3 m/s winds. According to Airgenesis spokesman Mr. Clayton Troxell, "We are making good progress in that we have completed more testing on the digital prototype by aerospace engineering firm DARcorp. From their simulations, we found that best clock angle for the blades is a 30° separation, not 60°. It turns out that 30° lets the



A rendering of Airgenesis' twin rotor wind turbine

wake from the front rotor more often miss the aft rotor, allowing a 92 per cent yield." While the company originally thought that low rpms would be good for the aft rotor, simulations showed that increasing the rotor speed to 15-20.6 rpms achieved a higher electrical production and, at the same time, reduced the torque on the entire drive train. This in turn, reduced the size of the gearing. The tests also tested other assumptions and explored new possibilities. For instance, it was found that the output could be bumped to 16 MW if blades larger than the planned 48 m blade are used.

Source: www.windpowerengineering.com

Bladeless turbine boasts impressive efficiency, low cost

Saphon Energy, Tunisia, has developed a new bladeless wind turbine drawing inspiration from the design of a ship's sails. The turbine is said to convert the kinetic energy of the wind into electricity at up to double the efficiency – and half the cost – of a typical wind turbine. Dubbed "Saphonian", the turbine utilizes a patented "Zero-blade technology" to harness the wind's energy. This involves channelling wind in a back and forth motion, until it is converted into mechanical energy using pistons. The pistons then produce hydraulic pressure, which can be instantly converted to electricity via a hydraulic motor and a generator,

or stored in a hydraulic accumulator. The savings in manufacturing result from being able to discard the blades, hub and gearbox needed in a traditional wind turbine Energy. The company also claims that the turbine works to a level of efficiency exceeding the Betz limit. It is seeking collaboration with a manufacturer to bring the technology to market.

Source: www.gizmag.com

New wind turbine concept uses heat

Apple Inc., the United States, has applied to patent an "On-demand generation of electricity from stored wind energy", an invention wholly dedicated to solving problems of variability associated with the alternative energy production method. Most contemporary wind turbines convert kinetic energy from wind into mechanical energy, and then to electricity. The process depends on a steady supply of wind which, as Apple's application notes, is very variable. To address this, Apple's concept proposes a system that converts rotational energy from the turbine into heat, which is stored in a "low-heat-capacity" fluid, and selectively transferred to a "working fluid" that is used to generate electricity during lulls in wind activity. In some embodiments, heat is generated from the friction created between blades connected to the rotor shaft and the low-heat-capacity fluid (mercury, ethanol or an inert gas) in which they are immersed. Thermal energy is stored in an insulated vessel. A radiator or conductive rod can be used to transfer heat selectively from the low-heat-capacity fluid to the working based on electrical demand. Finally, the working fluid boils to create steam, which rotates a turbine connected to an electric generator.

Source: appleinsider.com

Power conversion system for tidal power generation



Optima Control's power conversion system for tidal power

In the United Kingdom, Optima Control Solutions Ltd. has developed a new power conversion system for the ocean tidal stream generator being developed by Ocean Flow Energy Ltd. The system is designed to capture energy within a floating, horizontal-axis tidal stream generator. The system recently completed the testing stage and is now ready to be fitted into the Ocean Flow's generator for deployment. The generation of energy from ocean tidal flow is an emerging technology with the potential to add 6-12 GW of clean power to the United Kingdom's renewable energy mix.

Tidal generators can be located in the sea at a distance of 1 km or more from the shore but are susceptible to the effects of fast tidal streams and must also survive the battering from waves generated by storm activity. Furthermore, a robust electrical transmission system is needed to transmit generated power back to the shore with minimal loss. Ocean Flow has been working on a floating tidal stream generator for the past five years. The project consists of a mono turbine floating device called the Evopod. The device floats along, with most of the structure just below the surface of the sea, and is moored to the sea bed using cables. As the tide flows past

the system, the turbine turns and generates electrical current from an on-board generator.

A prototype Evopod capable of generating around 25 kW of power in nominal tidal flows is under construction at present. The prototype will be used to study the effect of the marine environment in preparation for a full-scale device expected to generate 1 MW at nominal tidal flow. *Contact: Ocean Flow Energy Ltd., Hotspur House, 15 East Percy Street, North Shields, Tyne & Wear NE30 1DT, The United Kingdom. Tel: +44 (0191) 2982 170; E-mail: info@oceanflowenergy.com.*

Source: www.renewableenergymagazine.com

1 MW tidal turbine produces electricity in real conditions

The 1 MW tidal turbine of Alstom, France, generated power for the first time at the tidal test site of the European Marine Energy Centre (EMEC) in Orkney, Scotland. After the successful test of Alstom's 500 kW device, this is its second tidal turbine supplying power to the grid. Both 500 kW and 1 MW variants of the tidal stream turbine have been already subject to extensive testing, with the latter currently *in situ* Scotland, as part of the Reliable Data Acquisition Platform for Tidal (ReDAPT) consortium project commissioned and co-funded by Energy Technologies Institute (ETI), based in the United Kingdom. Testing and analyses in different operational conditions off Orkney will continue throughout 2013 over an 18 month period, in order to further improve tidal power technology. The next step is to install pilot arrays prior to full commercial production.

Alstom's tidal turbine consists of a three-bladed, pitch-controlled rotor,

with a diameter measuring 18 m, a standard drive-train, and power electronics inside the nacelle. The 22 m long nacelle is installed onto a separate seabed-mounted foundation and weighs less than 150 t. This tidal stream turbine has several notable features: it is simple, and easy to transport; its buoyancy makes it easy to install and retrieve in a single tidal cycle using small vessels, reducing installation and maintenance costs; it has an intelligent nacelle, managing ebb and flood tides seamlessly as well as maximizing energy production; and it allows turbine blade pitching to be altered to control load on the turbine and optimize use of the tidal conditions locally.

Source: www.alstom.com

Tidal turbine built using composites

A 2 kW prototype of the SeaUrchin™ tidal turbine constructed using composite materials is currently being tested in Australia. The turbine was developed by Elemental Energy Technologies Ltd. (EET), based in Sydney, Australia. The SeaUrchin is claimed to cost as little as half that of competing marine generators to manufacture, install and maintain. The turbine generates electricity by harnessing kinetic energy from free-flowing ocean streams, tides and flowing rivers. No dams or barrages are necessary, thus reducing environmental impact.

The prototype 2 kW SeaUrchin currently being tested is about 1.2 m long with an overall diameter of approximately 1.1 m. A feasibility study has been finalized for a 1 MW utility-scale turbine that is around 15 m long and 9.5 m in diameter at the intake. All structural elements are made out of composites, with only the electrical, shaft and bearings made using other materials. RPC

Technologies, an Australian designer and manufacturer of composite components, was in charge of researching and advising on the composites utilized in the turbine.

Source:
www.reinforcedplastics.com

The world's first wave energy converter array for small waves

With support from Spring Singapore's Technology Innovation Grant and in partnership with SembCorp Marine Technology, Hann-Ocean Energy (HOE), Singapore, has developed a twin-chamber wave energy converter (WEC) named "Drakoo" (for Dragon King of Ocean). The turbine allows for low-cost electricity generation from all wave scales (0.2-5.5 m) and hence is very suitable for both shallow water and deep sea deployments. The internationally patented Drakoo transforms sea waves into a continuous water jet that drives an on-board hydro turbine generator. Drakoo has been tested successfully in national research laboratories, at sea and in deep wave flume. The performance of Drakoo has also been validated by Narec, the United Kingdom, for achieving a peak wave energy capturing efficiency beyond 90 per cent. Drakoo-B0016, the first commercial model, has an overall conversion efficiency (waves to electricity) of up to 55 per cent.

Drakoo has been designed to last in stormy seas with an in-built pressure release mechanism. It is not only eco-friendly but also will not impose any danger to marine lives due to the filter effect of its inlets. HOE successfully delivered its first commercial supply (16 kW in total) of WECs (Drakoo-B0004) to Jurong Shipyard Pte. Ltd. The Drakoo-B0004 module is the world's first WEC that works under very small

wave conditions (0.2-0.6 m). HOE is collaborating with Singapore's Nanyang Technological University (NTU) to assess the wave energy resource along the nation's coasts. Contact: Hann-Ocean Technology Pte. Ltd., 7030, Ang Mo Kio Avenue 5, #09-61 Northstar@AMK, Singapore 569880. Tel: +65 67787980; Fax: +65 65709206.

Source: www.hann-ocean.com

Practical, affordable wave energy

AWS Ocean Energy Ltd., the United Kingdom, has developed AWS-III, a multi-cell array of flexible membrane absorbers that convert wave power to pneumatic power through compression of air within each cell. The cells are inter-connected, thus allowing interchange of air between cells in anti-phase. Turbine generator sets are provided to convert the pneumatic power into electricity. A typical device comprises an array of 12 cells, each measuring around 16 m (w) × 8 m (d), arranged around a circular structure with an overall diameter of 60 m. Such a device is capable of producing an average of 2.5 MW from a rough sea, while having a structural steel weight of less than 1,300 t. AWS-III is slack-moored in water depths of around 100 m employing standard mooring spreads. Devices will be arranged in arrays with a total rating of up to several hundred megawatts. Each AWS-III will be linked to a central offshore sub-station through a high-voltage umbilical connection.

The AWS-III is designed for practical operation and maintenance by utility power generators. The large, stable vessel structure provides a safe environment for on-board maintenance of generation equipment and ancillaries, while the company's patented system for cell maintenance allows rapid exchange of the

flexible wave absorber cells. AWS-III sports a power-to-weight ratio double that of any other offshore wave energy device. It has no exposed moving parts and employs simple, proven power take-off technology and is designed for practical maintenance – key factors for high availability. Device scale ensures that fixed costs such as moorings and power umbilicals are lower per installed megawatt. These features, the company believes, will make AWS-III arrays or farms an attractive investable proposition for utilities under the current 5-ROC wave energy tariff for projects in Scottish waters. Contact: AWS Ocean Energy Ltd., 12-14 Seafield Road, Inverness IV1 1SG, The United Kingdom. Tel: +44 (1463) 725 410; Fax: +44 (1463) 725 419; E-mail: info@awsocan.com.

Source: www.awsocan.com

Mobile wave energy generator

OceanRusEnergy, a Russia-based transnational company, has developed a mobile wave energy generator in the form of capsules that float on the sea surface. Inside the floating capsule, pendulum motor and electronic devices are installed. Each capsule is attached to a stationary object and the capsules can communicate with each other. This enables the use of generator units as elements and wave power, and hybrid (e.g. one in which both wave and wind are converted). The Ural generator can start to work with waves up to 30 cm. The modular design gives it mobility, ease of use and affordability. The total capacity of the unit is 160 W. The company plans to present a modified version of the generator, called Ocean 600, capable of producing an electrical power output of 600 W.

Source: www.offshorewind.biz

Water-powered fuel cell for consumer electronics



MyFC PowerTrek, the fuel cell that runs on water

A fuel cell that uses ordinary water to provide up to 3 W to battery powered products has been developed at KTH Royal Institute of Technology, Sweden. MyFC PowerTrek, as the device is called, is based on micro fuel cell technology. According to Mr. Anders Lundblad, KTH researcher and founder of MyFC, the charger is the first step towards building fuel cells in laptops. "The launch of our charger is a strategic move to gain wide acceptance of fuel cells throughout society." When water is poured onto a small disposable metal disc inside the unit, hydrogen is released and this combines with oxygen to generate electrical energy. The resulting charge is said to be enough to power an Apple iPhone to 25-100 per cent of its battery capacity. The device can also function as a portable battery.

Source: www.newelectronics.co.uk

Fuel cell purifies and uses wastewater to generate power

The City University of Hong Kong (CityU), China, has developed a membraneless photocatalytic fuel cell that offers dual benefits: uses wastewater to generate power and at the same time purifies the wastewater. By operating without a membrane, the cell reduces production

costs by 50 per cent, making it more feasible to turn fuel cells into commercial applications. Dr. Michael Leung Kwok-hi, Associate Professor and Associate Dean of CityU School of Energy and Environment, and his team have developed successfully a fuel cell that not only costs about 50 per cent less to produce but also purifies wastewater during the operation.

Dr. Leung, who is also the Director of CityU's Ability R&D Energy Research Centre, used microfluidics technology based on microelectronic, micromechanical, bioengineering and nano technologies for the membraneless fuel cell. The technology can be used to control fluids in micro volumes (e.g. microlitre or nanolitre) to perform specific operations. Dr. Leung's team has added a nano photocatalytic coating to the fuel cell, making it possible to start a photoelectric chemical process when it is placed under sunlight. This has enabled the fuel cell not only to utilize wastewater that contains organic compounds as fuel to generate power, but also to simultaneously purify the wastewater. *Contact: Mr. Mirror Fung, Communications & Public Relations Office, City University of Hong Kong, Hong Kong, China. Tel: +852 3442 6808, 6183 0853.*

Source: www.waterworld.com

Fuel cell power density increased

A research project involving several of the United Kingdom's leading technology companies has delivered a breakthrough in the development of fuel cell systems, raising the prospect of significant improvements in the power and performance of zero-emission vehicles. Led by Intelligent Energy and supported by Dyson Technology, engineering firm Ricardo, consultancy firm TRW

Conekt, logistics giant DHL and the government and industry-backed Technology Strategy Board, the Enhanced Fuel Cell Systems project announced that it has successfully demonstrated a new fuel cell design with a power density improvement of more than 30 per cent on previous systems. The group said the system had achieved reliable cold-start performance in temperatures as low as -20°C, overcoming a technical hurdle commonly faced by fuel cell systems. Intelligent Energy said that the project had resulted in a new 40 kW test cell that boasted the same system size and mass as previous 30 kW systems. Moreover, the new system had been designed to meet automotive specifications and has already passed vibration and environmental testing.

Source: www.businessgreen.com

A cheaper, easier way to build electrolyser

Scientists at the University of Calgary, Canada, have found a much easier and cheaper way to build an electrolyser, which uses electricity to break up water into hydrogen and oxygen, the basic requirements of fuel cells, which generate energy by recombining them. The method developed by Mr. Chris Berlinguette and Mr. Simon Trudel uses metals as common as rust – in place of the usual rare, costly and sometimes toxic metals – to deliver results that compare to current techniques, but costs about 1,000 times less. Current methods depend on the use of expensive rare earth metals in precise crystalline arrangements to catalyse the reaction. The Canadian researchers found a way to build catalysers using common metals that do not need a crystal structure. The implications of the invention are potentially enormous.

Source: www.vancouversun.com

“Artificial leaf” makes clean energy from dirty water

In the United States, researchers at the US Air Force, and other federal agencies, have been pursuing the development of an “artificial leaf”, a low-cost solar-powered device that splits water into hydrogen and oxygen, for powering fuel cells. The device, which really is about the size of a playing card, consists of a slim wafer of silicon coated with catalysts that break water molecules into hydrogen and oxygen gases, which can then be stored in tanks and used as fuel in hydrogen fuel cells. The initial research resulted in a “practical artificial leaf” with commercial potential, but it needed purified water. Otherwise, naturally occurring bacteria create a film on the wafer, which interferes with its efficiency and eventually prevents it from working altogether. In the latest avatar, the lead researcher Prof. Daniel G. Nocera at Harvard University revealed a new iteration of the device that has the ability to keep chugging along in contaminated water. The device can generate about 100 W of electricity 24 hours a day.

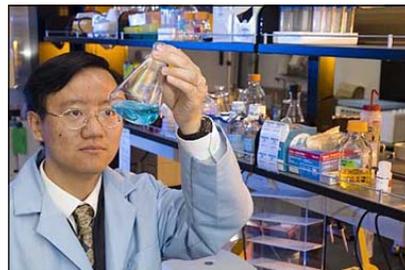
The trick was to “tweak” the catalyst to present a rough surface to prevent biofilm from forming. While that involves making a part of the catalyst fall apart, it also has the capability to heal and reassemble itself. The artificial leaf is not yet particularly efficient, but the driving force behind Prof. Nocera’s research is not to create the most efficient device. The aim is to develop a durable and simple device that could help provide affordable, renewable energy to the billions of people who currently don’t have reliable access to energy grid and clean water.

Source: cleantechnica.com

Breakthrough in hydrogen fuel production

In the United States, a team of researchers at Virginia Polytechnic Institute and State University (Virginia Tech) has discovered a way to extract large quantities of hydrogen from any plant – a breakthrough that could bring a low-cost, environmentally friendly fuel source to the world. “Our new process could help end our dependence on fossil fuels,” states Mr. Y.H. Percival Zhang, an Associate Professor of biological systems engineering in the Virginia Tech College of Agriculture and Life Sciences and the College of Engineering. Mr. Zhang’s team has succeeded in using xylose, the most abundant simple plant sugar, to produce a large quantity of hydrogen that previously was attainable only in theory. Mr. Zhang’s method can be performed using any source of biomass. The new process utilizes renewable natural resources, does not require costly or heavy metals, and releases almost no greenhouse gases. Earlier methods to produce hydrogen were expensive and created greenhouse gases.

Mr. Jonathan R. Mielenz, group leader of Bioscience and Technology Division at the Oak Ridge National Laboratory, says that the key to the development is the use of the second most prevalent sugar in plants to produce hydrogen. This reduces the overall cost of producing hydrogen from biomass. Obstacles to commercial production of hydrogen gas from biomass previously included the high cost of the processes used and the relatively low quantity of the end product. For seven years, Mr. Zhang’s team has been focused on finding non-traditional ways to produce high-yield hydrogen at low cost, specifically looking for enzyme combinations, discovering novel



Mr. Percival Zhang in his laboratory

enzymes and engineering enzymes with desirable properties. The process liberates high-purity hydrogen under mild reaction conditions and normal atmospheric pressure. The biocatalysts employed are a group of enzymes artificially isolated from different microbes that thrive at extreme temperatures, some of which could grow at around 100°C. The researchers chose to use xylose, which consists of as much as 30 per cent of plant cell walls. The natural or engineered micro-organisms that most scientists use in their experiments cannot produce hydrogen in high yield because they grow and reproduce instead of splitting water molecules to yield pure hydrogen. To liberate the hydrogen, Virginia Tech scientists separated a number of enzymes from native micro-organisms to create a customized enzyme cocktail. When combined with xylose and a polyphosphate, this enzyme cocktail liberates an unprecedentedly high volume of hydrogen from xylose – about three times as much hydrogen as other hydrogen-producing microbes. The energy stored in xylose splits water molecules, yielding high-purity hydrogen that can be directly used by proton exchange membrane fuel cells.

In addition, this reaction occurs at low temperatures, generating hydrogen energy that is greater than the chemical energy stored in xylose and the polyphosphate – resulting in an energy efficiency of more than 100 per cent (a net energy gain).

This means that low-temperature waste heat can be used to produce high-quality hydrogen for the first time. Other processes that convert sugar into biofuels such as ethanol and butanol always have energy efficiencies of less than 100 per cent, resulting in an energy penalty.

Source: www.vtnews.vt.edu

A hydrogen-based energy source

In a two-pronged approach aimed at solving India's energy and water problems, scientists of the Indian Association for the Cultivation of Science (IACS) have achieved a breakthrough in developing an efficient and bankable hydrogen-based energy source. "These results are breakthroughs that help pave the way for hydrogen-based power generation," states Mr. Abhishek Dey from IACS. The scientists hope that hydrogen could be used as a clean and sustainable fuel to meet ever-increasing global energy needs. Mr. Dey and his team at the IACS Department of Inorganic Chemistry have shown in two different studies that hydrogen can be generated from water in a considerable amount, utilizing two different metals, cobalt and iron, to speed up the reaction. Hydrogen can be produced from natural gas, alcohol, biomass and other non-renewable material. The splitting of water into oxygen and hydrogen currently remains the core method of hydrogen generation, but has been hindered by affordability and efficiency of the catalyst. The conventionally used platinum is efficient, but is also very expensive.

For the first study, the IACS team, in collaboration with a group of researchers in Israel led by Mr. Zeev Gross, came up with a new cobalt-based catalyst to boost the reaction. This cobalt catalyst proved to be highly efficient; by immobilizing

it on a cheap graphite platform, one could use it to yield hydrogen in a water-based environment. "We have shown that the cobalt catalyst immobilized on graphite electrode can catalyse the reaction very efficiently, from water obtained from local sources without requiring pretreatment, and even in the presence of oxygen," Mr. Dey stated.

Encouraged by the results of the cobalt-based study, the team also studied a catalytic system based on iron (1,000 times more abundant than cobalt). The projected output when using the iron catalyst is around 80 L of hydrogen per second per gram of the catalyst, a figure so far not reported in any study. "To the best of our knowledge this is possibly the highest electrocatalytic hydrogen generation rate reported so far," stated Mr. Dey, with regard to the second study. Furthermore, the research could also prove to be a tool to tackle water crisis as pure hydrogen generated using these catalysts, from sea or river water, when used in a fuel cell or a combustion engine, will produce pure water.

Source: zeenews.india.com

Ash: a source of hydrogen fuel

Researchers from the Lund University, Sweden, believe that ash could be used to produce hydrogen fuel. The researchers, who have developed a method to do this, say that using ash to generate hydrogen gas could produce more than 20 billion litres of hydrogen annually, equivalent to 56 GWh of electrical power. Mr. Aamir Ilyas, developer of the process, suggests that the world's current ash deposits are like a goldmine when it comes to hydrogen fuel production. Mr. Ilyas' process involves depositing ash into an oxygen-free environment and introducing

water. When water and ash mix, hydrogen gas is produced. The gas is then removed from the environment and placed into holding tanks for future use. If the process can be scaled up, it could serve as an adequate solution to the problems that face hydrogen fuel production. Using water and ash to create hydrogen gas is, currently, one of the most efficient and least expensive methods to generate this fuel. Most conventional hydrogen fuel production processes involve the use of fossil fuels and require a significant amount of energy themselves to complete the task of hydrogen generation.

Each year, millions of tonnes of ash are produced throughout the world. Much of this ash is deposited in landfills or, in some cases, used as construction material. A large portion of this ash comes from incinerating garbage. Therefore, using ash as a hydrogen source will also help alleviate garbage problem.

Source: www.hydrogenfuelnews.com

Asia Regional Capacity Building on Using Renewable Energy Resource Assessment Data and Geospatial Analysis

The United States Government's Enhancing Capacity for Low Emission Development Strategies (EC-LEDS) initiative is launching a regional training in Asia to develop a community of practitioners to use tools and data to assess clean energy resources to more effectively develop and implement a LEDS. For more information, contact:

*Low Emissions Asian
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ICF International
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Road*

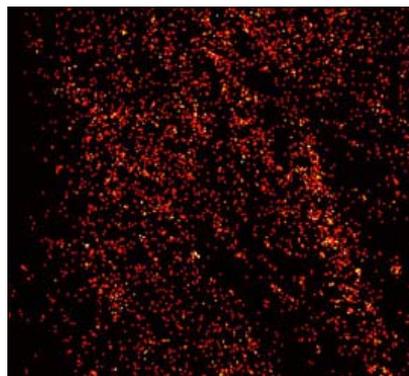
*M Thai Tower, 9th Floor
Bangkok 10330, Thailand
Tel: +66 2-655-8311/2*

Website: lowemissionsasia.org

Researchers catalyse more sugars from biomass

In the United States, researchers at the Lawrence Berkeley National Laboratory through support from the Energy Biosciences Institute have literally shed new light on cellulase catalysis. Using Photo-Activated Localization Microscopy (PALM) – an ultra high-precision visible light microscopy technique – the Berkeley researchers have found a way to improve the collective catalytic activity of enzyme cocktails that can boost the yields of sugars for making fuels. Increasing the sugar yields from cellulosic biomass to help bring down biofuel production costs is essential for the widespread commercial adoption of these fuels. According to chemical engineer Mr. Harvey Blanch, one of the leaders of this research, “The enzymatic breakdown of cellulosic biomass into fermentable sugars has been the Achilles heel of biofuels, a key economic bottleneck. Our research provides a new understanding of how multiple cellulase enzymes attack solid cellulose by working in concert, an action known as enzyme synergy, and explains why certain mixtures of cellulase enzymes work better together than each works individually.”

Unlike the simple glucose sugars in corn and other grains, the sugars in cellulosic biomass are complex polysaccharides that must be extricated from a tough polymer called lignin and then broken down into fermentable glucose, a process called saccharification. Because individual cellulases interact preferentially with cellulose structures based on distinct structural motifs, saccharification is carried out with enzyme cocktails. PALM is a technique in which target proteins are labelled with tags that fluoresce when acti-



A zoomed PALM image

vated by weak ultraviolet (UV) light. The intensity of the UV light can be kept sufficiently low to photoactivate individual proteins to image them and determine their location. Working with cotton, a well-defined cellulosic material, as their model system, the researchers applied PALM imaging in combination with a mathematical analysis they devised.

Results have shown that cellulases show specificities for cellulose structures that have many different levels of organization – ranging from the highly ordered to the highly disordered. The scientists also developed a metric to show that combinations of cellulases designed to bind to cellulose structural organizations that are similar but not identical can generate valuable synergistic activity. The PALM-based technique helps enzyme cocktails to be optimally matched to the structural organizations of particular biomass substrates, such as grass or wood, so that enzyme synergies could be fully exploited. This would increase saccharification efficiencies, which in turn would help reduce biofuel production costs.

Source: www.ethanolproducer.com

E. coli bacteria can produce biofuel

Researchers in the United Kingdom report to have genetically modified

(GM) *Escherichia coli* bacteria to convert sugar into an oil that is almost identical to conventional diesel. If the process could be scaled up, this synthetic fuel could be a viable alternative to fossil fuel. According to Prof. John Love, a synthetic biologist from the University of Exeter, rather than making a replacement fuel like some biofuels, they have made a substitute fossil fuel. “The idea is that car manufacturers, consumers and fuel retailers wouldn’t even notice the difference – it would just become another part of the fuel production chain,” says Prof. Love.

Most forms of biodiesel and bioethanol that are currently used are not fully compatible with modern engines. Fractions of the substances (5-10 per cent) need to be blended with petroleum before they can be used in most engines. However, the fuel produced by the GM *E. coli* is very different. Prof. Love says that the fuels produced are exactly of the chain length required for the modern engine in exactly the composition that is required. He calls them “bio-fossil fuels”.

To create the fuel, the researchers used a strain of *E. coli* that usually takes in sugar and then turns it into fat. Using synthetic biology, they altered the bacteria’s cell mechanisms so that the sugar was converted into synthetic fuel molecules instead. By altering the bacteria’s genes, they were able to transform the bugs into fuel-producing factories. However, the *E. coli* did not make much of the alkane fuel. Prof. Love said it would take about 100 L of bacteria to produce a single teaspoon of the fuel. “Our challenge is to increase the yield before we can go into any form of industrial production,” Prof. Love stated. “We have got a time-frame of about three to five years to do that and see if it is worth going ahead with it.” The

team is also looking to see if the bacteria can convert any other products into fuel, such as human or animal waste.

Source: www.bbc.co.uk

Sugarcane fibre could boost biofuel development

A doctorate study undertaken by Mr. Yuda Benjamin, a student at the Department of Process Engineering of Stellenbosch University, South Africa, has found that the fibres of some varieties of sugarcane have the potential to boost the production of ethanol at a reduced cost. According to Mr. Benjamin, a new method developed as part his research in process engineering will help the agricultural and biofuels sectors in identifying the most cost-effective sugarcane varieties for the production of ethanol. Ethanol produced from high-cost sugars, such as the sucrose found in sugarcane or the starch found in maize, is a promising alternative fuel that could one day replace petrol.

One of the largest challenges faced by the sector in processing sugarcane fibre for ethanol is cost reduction. However, the new method could enable the use of an entire crop for ethanol production. "Carbohydrates in sugarcane fibre can be used to increase ethanol production because of its availability and the fact that it does not have an impact on food production," explains Mr. Benjamin. "Almost 90 per cent of the carbohydrates could be extracted as simple sugars from the selected varieties, compared with 72 per cent obtained from sugarcane already existing in the market." The selected varieties also require less pretreatment and less enzymes during enzymatic hydrolysis.

Source: www.engineeringnews.co.za

Benefit of ethanol-to-butanol conversion

One drawback of adding ethanol to petrol to help oxygenate the fuel to limit pollution and stretch petroleum supplies is that ethanol reduces the energy content of petrol, resulting in fewer miles per litre when on the road. Chemists and chemical engineers working to find improved biofuels have decided that butanol is a better option than ethanol. They are now trying to settle on the best way to mass produce butanol to begin replacing ethanol. One solution offered by Mr. Duncan F. Wass and his research team at the University of Bristol, the United Kingdom, is a new family of ruthenium catalysts that convert ethanol to butanol.

Butanol with two additional carbons has about 30 per cent higher energy content per litre than ethanol, explains Mr. Wass. He noted that efforts are under way to retrofit some ethanol facilities to butanol production. With the new catalysts, however, ethanol facilities wouldn't need to be altered – the ethanol produced in the facilities could simply be upgraded to butanol in an additional condensation reaction step. "Our technology is an indirect path to butanol," notes Mr. Wass. "But it is flexible because it can upgrade ethanol made from either petroleum or biomass."

The ruthenium catalysts are very efficient, producing butanol with 95 per cent selectivity and ethanol conversion of better than 40 per cent. The ethanol-to-butanol catalytic process is complementary to the fermentation of sugars directly into butanol using engineered microbes, which is being developed by other scientists. Fermentation to butanol, however, has a few limitations, including low conversion of around 4-5 per cent because of the inherent toxicity of butanol to the microbes.

The new catalytic process has been patented, and Mr. Wass is working with scientists at BP Biofuels to further develop the technology.

Source: cen.acs.org

Turning crop residues into biofuel

In the United States, a corporate partnership Michigan State University (MSU) focused on turning crop residues into fuel and other products will receive support in the form of new federal funding. A US\$2.5 million United States Department of Energy (DOE) grant to MSU's bio-based technology affiliate MBI and partner Novozymes supports optimization of its enzyme technologies to cost-effectively extract fermentable sugars from processed corn stover – cornstalks and leaves. There are two major challenges in converting agricultural biomass into bio-based products, says Mr. Allen Julian, MBI Chief Business Officer. One is the challenge of handling, storing and hauling low-density biomass to the refinery. The other is how to break down the biomass cost-effectively into its constituent sugars.

MBI is scaling up a process called AFEX, which uses pressurized ammonia vapour to process biomass so that enzymes can more effectively break it down into fermentable sugars. AFEX process also enables the production of biomass pellets that can be economically stored, transported to a biorefinery where the pellets are fermented to make biofuels, chemicals and other products. MBI is currently completing the installation of a 1 t/d pilot AFEX reactor at its facility south of the MSU campus, scaling up technology developed by Mr. Bruce Dale, University Distinguished Professor of chemical engineering and materials science.

Source: msutoday.msu.edu

Optical Modelling and Simulation of Thin-Film Photovoltaic Devices

In photovoltaic (PV) devices, management of light is a crucial aspect of optimization since trapping sunlight in active parts of PV devices is essential for efficient energy conversions. Optical modelling and simulation enable efficient analysis and optimization of the optical situation in optoelectronic and PV devices. This book provides readers with a thorough guide to performing optical modelling and simulations of thin-film solar cells and PV modules. It offers insight on examples of existing optical models, demonstrates the applicability of optical modelling, and presents concrete directions and solutions for improving the devices. Along with giving practical hints, the book highlights significant R&D and production in the field. It covers numerous approaches of one-, two- and three-dimensional optical modelling. Many practical examples illustrate the use of simulations with developed models, helping readers better understand and develop their own models as well as appreciate innovative concepts in light management in thin-film PV devices.

Solar Power Generation: Technology, New Concepts and Policy

This book offers a global perspective of the current state of affairs in the field of solar power engineering. This well-researched volume is divided into four parts that inform about: (1) Established solar photovoltaic (PV) technologies; (2) Third-generation PV technologies based on new materials with potential for low-cost, large-scale production; (3) Solar cell technology based on new (third-generation) concepts, such as quantum dot solar cells and nanowire solar cells using silicon and compound semiconductors; and (4) Economic implications and effects, as well as policies and incentives in various countries of the world involved with solar energy implementation. In addition to discussing manufacturing facts and implementation issues, this publication emphasizes the implications of policy measures in countries with good PV activity. This book is intended as a reference for advanced students and R&D and industry professionals, as well as investors and policy-makers in the field of PV technology.

For the above books, contact: CRC Press, United Kingdom. Tel: +44 (1235) 400 524; Fax: +44 (1235) 400 525; E-mail: book.orders@tandf.co.uk.

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