VATIS UPDATE

Waste Management

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Apprise yourself with the latest technological innovations

Highlights

- Nepal generates power from waste
- Making bioplastics and biofuel
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- Turning CO_2 to stone

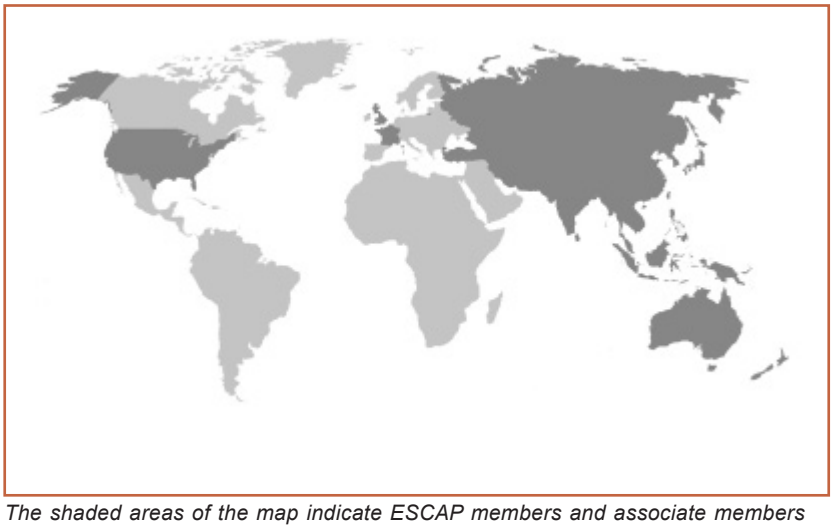
APCTT
Asian and Pacific Centre for Transfer of Technology

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

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

Mexican entrepreneurs from Rennueva designed a machine capable of recycling Styrofoam (expanded polystyrene)

(Credit: http://www.phys.org)

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Nepal generates power from waste

After years of continuous effort, the Kathmandu Metropolitan City (KMC) has finally succeeded in generating electricity from waste for the first time in Nepal. The first test conducted at Teku transfer station to generate electricity from waste has been successful. Though the technical team had already produced biogas from waste before Dashain, electricity production took two more weeks. "Our project has become a success. Now all that remains is the official inauguration of the project," said Gyanendra Karki, at the KMC office.

According to the KMC office, the three machines cost Rs 18.20 million. The KMC plans to replicate the project in other municipalities if the one-year pilot project succeeds. KMC hopes the waste-to-energy project will make waste management in Kathmandu Valley easier. Besides generating power, the KMC plans to produce 96 kg gas, 300 kg bio-organic fertiliser, and 13,500 litres of purified water daily from the garbage collected at the Teku transfer station. A total of 450 tonnes of garbage is produced in Kathmandu Valley every day. Nearly 63% of garbage is organic waste.

A study by Alternative Energy Promotion Centre said Kathmandu Metropolitan City, Lalitpur Sub-Metropolitan City, Bhaktapur Municipality, Madhyapur Thimi Municipality, Kirtipur Municipality and Kalimati fruit and vegetable market alone produce 331 tonnes urban waste daily. KMC had been facing a tough time managing household waste due to lack of resources and technology. The project is expected to assist the KMC in tackling problems created by household waste.

Source: http://www.thehimalayantimes.com

Industrial wastewater treatment in China

Mechanical and electrical equipment manufacturer Shanghai Electric, China, has commissioned water technology company Gradient to develop six brine concentration projects in China, two of which are in final stages of negotiation. Gradiant's Carrier Gas Extraction (CGE™) process will be used to produce fresh water from high-TDS (total dissolved solids) wastewater. Power plant flue gas desulfurization (FGD) wastewaters and oilfield produced water will be treated with distillate capacities ranging from 500 to 36,000 m^3/day.

Developed at the Massachusetts Institute of Technology (MIT), the United States, by the company's founders, Gradiant's proprietary CGE technology uses air as a carrier gas operating in a closed loop to extract water from high-TDS wastewater. Water is separated from the impurities by using it to humidify the carrier gas stream. Purified water is then recovered from the gas in a subsequent dehumidification process, which employs a unique bubble column heat and mass exchanger.

Gradiant is working with Shanghai Electric on a non-exclusive basis. The CGE systems will continue to be manufactured in the US but the company said it will work with its Chinese partners to determine if they could be manufactured in China. "In addition to power equipment, Shanghai Electric has a sizable desalination business as well as a strong understanding of water needs in China's industrial sectors. They invested in Gradiant after determining the huge market potential of our desalination technologies in the region," Anurag Bajpayee at Gradiant.

Source: http://www.waterworld.com

Door-to-door recycling in Viet Nam

Viet Nam Recycles will kick off its Household Collection campaign, which will see 12 volunteers going door-to-door around 5 wards in both Ho Chi Minh City and Hanoi, collecting recyclable electrical and electronic materials and discussing the importance of recycling with householders. Viet Nam Recycles is a take-back and recycling program run by leading manufacturers of electronic equipment to assure their responsible and safe recycling. Just lately, Microsoft Mobile Viet Nam joined the alliance.

The Viet Nam government, through Decree 16 which became effective in July this year, has drawn attention to the role of manufacturers in the safe disposal of electronic waste. Accordingly, the Decree obliges manufacturers to provide a take-back solution for their end-of-life products. The program, which will run over three months between September and November, is organized in conjunction with the various Ward People's Committees, who will accompany volunteers and Viet Nam Recycles team members to visit their constituents.

The program further has the support of the Department of Natural Resources and Environment. "The Household Collection program seeks to raise further awareness on our program because so far, we're still not receiving much equipment at our collection points. By coming to their houses and collect the equipment right away, we make the first use of our program easy and hope people will continue using our program and bring their devices to our collection points afterwards," said Ms.

Miriam Lassernig, at Viet Nam Recycles.

Source: http://www.vietnamrecycles.com

Viet Nam to introduce environmental incentives

Viet Nam is set to extend export tax relief to a number of goods including products and machinery used in the treatment of waste, as well as goods registered under Viet Nam's emerging Green Label certification. Viet Nam has recently released an optional environmental certification for enterprises with hopes of emphasizing its commitment to environmental protection and as a means of incentivizing investors to comply with a more stringent set of standards within its boarders.

Pursuant to Circular 128/2016/TT-BTC, goods that have achieved compliance with standards set out under Viet Nam's Green Label program will soon be eligible for a complete exemption from all export taxation outlined under MOF Circular 182/2015/TT-BTC. Viet Nam's Green Label program conforms with the International Standards Organization (ISO) and is administered at the national level by the Ministry of Natural Resources and Environment.

To obtain Green Label certification, specific procedures and protocols must be followed dependent on the good in question. The structure of the application process is broadly outlined in Circular 41/2013/TT-BTNMT while criteria for individual goods is regularly updated online.

In addition to exemptions offered to goods with Viet Nam's Green Label, export of specific goods relating to recycling activities, waste treatment and disposal will also be eligible for 50% reduction on applicable export tariffs.

Source: http://www.vietnam-briefing.com

Recycling gives new life to e-waste

The Malaysian Communications and Multimedia Commission (MCMC) has launched a programme for recycling electronic waste (e-waste) in a way that helps to protect the environment. Introduced in August last year, the programme has seen 72 collection bins for e-waste set up across the country. After collecting their old mobile devices and accessories, all the public need to do is drop them in any of the collections bins.

Recyclers will gather the waste and transport them to a facility in Penang, where urban mining will take place. The recovered materials will be used to create new products. The recovered metals can be used by several different industries such as jewellery, plating, electronics, plumbing, automotive and art foundries to create products like automotive catalytic converters, plumbing faucets and piping, and gold or silver jewellery.

The plastics can be recycled into new products such as garden furniture, licence plate frames, non-food containers and replacement automotive parts. "This included cellular phones, smartphones, tablets, phablets along with accessories and chargers. Other types of e-waste that can fit into the collection box such as MP3 players, iPods, pen drives and portable hard disks are also accepted," said Badaruzzaman Mat Nor, at MCMC.

Source: http://www.themalaymailonline.com

Car recycling programme in Kazakhstan

A new recycling initiative for end-of-life vehicles is to reduce the number polluting and unsafe cars in Kazakhstan. Initiated by the government together with the association of Kazakhstan car businesses and automobile manufacturers, the programme aims to collect some 10 000 cars by the end of 2016, according to local media.

A car must not exceed 3.5 tonnes or seven seats. The owner will receive financial compensation between US$ 140 and US$ 450, depending on the condition of the vehicle. In addition to reducing the number of unsafe and polluting vehicles, the initiators aim to promote entrepreneurship and create new jobs.

Source: http://www.recyclinginternational.com

Indian initiative for greening leather industry

The Council for Scientific and Industrial Research (CSIR) has come out with a Game changing technology for enabling the Indian leather sector achieve the set target of USD 27 billion by 2020 by making leather processing environmentally sustainable. This Waterless chrome tanning technology is a first of its kind technology to reduce chromium pollution load. "This was a unique institute which from the very start had a strong academic and industrial linkage," said Union Minister for Science and Technology and Earth Sciences and Vice President CSIR, Dr. Harsh Vardhan.

A tripartite arrangement of industry-academy-research is a first of its

kind, which is a role model for other sectors to emulate. The Institute represents the leather sector in all its planning and policy development. Over the years, the Institute is the global hub for transformation of a tradition bound industry into an innovation driven one. Technologies for bio-processing of leather, zero waste water discharge, value added materials from leather and indigenous chemicals for processing, are some of the highlighting features of this institute.

Through the Institute, Indian leather sector strives to achieve economic and environmental sustainability, leading to more than doubling of the annual turnover from the present in about 4 years. CSIR has been hand holding the industry since its establishment and has taken the export turnover of Rs. 40 crores in 1960s to Rs.40,000 crores in 2015 through technological interventions, training and service. The re-enabling of the tanneries in Tamil Nadu in 1996 stands a strong testimony to the contributions of this organisation.

Source: http://www.business-standard.com

Mobile e-waste recycling in Malaysia

The Malaysian Communications and Multimedia Commission (MCMC) initiative at ensuring unwanted electronics, particularly mobile phones and their related devices, are disposed of safely goes beyond just spreading the message or collecting the electronic waste (e-waste). The commission has also ensured that the discarded products collected under its mobile e-waste programme themed "Old Phone, New Life" are safely recycled or disposed of using technology and systems that are environmentally sound and in accordance with standards.

It is for this reason that MCMC has partnered with Shan Poornam Metals Sdn Bhd, which is among the pioneers in recycling e-waste in the country. The company's plant at Penang, utilises advanced technology that meets international standards with certification such as the ISO 14001:2004, OHSAS 18001:2007 and ISO 9001:2008 from Afnor Certification, based in the United Kingdom. "E-waste haphazardly disposed of could have an adverse impact on human health and the environment," said S. Selvakumar, at Shan Poornam.

The mobile e-waste is collected and sent to the plant. The discarded phones are manually screened and the units that can be saved are refurbished and sent back to the counters for sale, after the devices undergo the data wiping process. For those that cannot be refurbished, Shan Poornam will ensure proper disposal and recovery of useable materials. The mobile e-waste recycling process contributed to 350,000 metric tonnes of e-waste recycled, converting them to environmentally safe products such as secondary aluminium, alloy ingots, platinum, gold, palladium and silver.

Source: http://www.themalaymailonline.com

China's plan to standardize battery recycling

China's State Council has introduced the Extended Producer Responsibility (EPR) Plan recently. EPR is to require manufacturer to be responsible for the entire lifecycle of the product, including design, consumption, recycling and waste disposal. The plan will first be introduced to electronics, automobiles, lead-acid batteries and packaging products. The details of EPR for lead-acid battery are as followed, according to the plan.

First, domestic lead-acid battery producers are encouraged to build a whole life traceability system for products and to recycle scrap batteries, including autonomic, allied and authorized recycling pattern, through producers' own marketing channel or other professional firms' recycling network. Second, scrap standby and energy storage batteries should be disposed by professional firms. Third, battery producers should research and improve recycling technology and cross-regional transport method. Fourth, Shanghai will be the first city to establish recycling system for lead-acid batteries and to recycle scrap lead-acid battery through "sell one battery and recycle one scrap battery" pattern as required.

Source: https://news.metal.com

China to levy taxes to fight pollution

China's parliament passed a law that will levy specific environmental protection taxes on industry for the first time from 2018, as part of a renewed focus on fighting the country's pollution woes. "Tax revenue is an important economic means to promote environmental protection," the Finance Ministry said in a statement.

The tax rate will be 1.2 yuan ($0.17) per unit of atmospheric pollution, 1.4 yuan per unit of water pollution, 5 yuan per tonne of coal waste and 1,000 yuan per tonne of "hazardous waste". Industrial noise polluters will also be levied 350 yuan per month if they exceed limits by 1-3 decibels, 700 yuan for 4-6 decibels and 11,200 yuan per month for 16 decibels and more.

Source: http://www.financialexpress.com

Making bioplastics and biofuel

A team of researchers from KTH Royal Institute of Technology, Sweden, and the Karolinska Institute, Sweden, has developed an efficient, accurate and non-destructive way to detect the occurrence and purity of cellulose. The technique can be applied in mixtures of biopolymers, as well. "The ability to bottom-up assess and understand the lignocellulosic biomass composition is a key enabling technology in the emerging biorefinery sector," said Ulrica Edlund, at KTH.

The problem with cellulose is that it is rarely found in a pure form. What's more, the quality of isolated cellulose varies when industrial techniques are used to fractionate it, that is to deconstruct the matter and sort it out according to structural characteristics such molecular structure and molecular weight. Not being able to accurately assess the quality and purity is making recycling and manufacturing processes more difficult and less efficient.

This leads to unnecessary waste in recycling – which is costly and damaging to the environment. It also means that it is difficult to monitor the quality of the breakdown of cellulose to biogas. The researchers have synthesized a non-toxic molecule that can be easily applied to different forms of cellulose and provide a simple, optical readout of the quality. This could be used routinely and safely at any part of the cellulose-processing pipeline, giving multiple options for deployment and optimization.

Source: http://www.biomassmagazine.com

Plastic film identification and removal system

Optical sorting equipment manufacturer, NRT (a part of Eugene), Oregon based Bulk Handling Systems (BHS), the United States, has developed a plastic film identification and removal system, utilising its FiberPure™ Optical Sorter. The system also has the option of a pneumatic extraction system from Dutch firm Nihot, also a part of BHS. The combination of the NRT FiberPure Optical Sorter and Nihot air extraction system is said to create a one-step approach, enabling operators to better capitalise on the evolving mix of fiber and film than with standalone air or optical equipment.

It is also claimed to significantly lower labour costs and maximise the purity and recovery of both fiber and plastic film. BHS explained that the combination of the NRT FiberPure Optical Sorter and Nihot air extraction system was designed to fill a gap in the market for a technology solution to separate plastic film from high volumes of fiber with high purity rates on both fiber and film. In this application a standalone NRT optical sorter is capable of detecting and ejecting on film or fiber and creates a high quality split between these materials.

However, when the integrated Nihot air extraction system is installed it will also upgrade the ejected materials with a density split creating an even more pure fiber and film fraction. The combination is said to allow operators to use their existing sorting process for two- or three-dimensional sorting as it is easy to retrofit, the Nihot air extraction system can also transport materials to any desired position in the process, making this automated solution an easy retrofit with a fast return on investment.

Source: https://www.waste-management-world.com

Bacteria could help solve plastic problem

A students' research team at Ben-Gurion University, Israel, has developed a genetic engineering technology, called Plasticure, to target polyethylene terephthalate, the most common thermoplastic polymer resin used in fibers for clothing, bottles and food containers. The team has been working in the past month on developing a solution for the accumulation of plastic waste with the help of a germ called pseudomonas putida.

Segal is one of 13 undergraduate students at Ben-Gurion studying biology, engineering and other disciplines. The team's mentors are Professor Lital Alfonta, Dr. Ramon Birnbaum and Dr. Idit Dahan. "The goal is to completely biodegrade the plastic molecule," said Alfonta. In their search for bacteria that can decompose plastic efficiently the students tried to streamline the activity of a protein that breaks down the primary connections of plastic molecules. They also added genes to the pseudomanas putida to help it break down the plastic completely.

The streamlined protein was inserted into another germ – e.coli – and excreted to aid the putida's action. The biological system they built combines the two bacteria for a better breakdown of the plastic. Although the system still doesn't decompose the plastic completely, the team is in the process of developing germs that may increase the process' efficiency. According to their vision, the bacterium will be

used in facilities for breaking down large quantities of plastic waste.

Source: http://www.haaretz.com

Single-stream materials recovery

A new research from Resource Recycling Systems (RSS), the United States, shows flexible packaging can be captured in single-stream materials recovery facilities (MRF) with automated sorting technologies in use today. This could create a new stream of recovered materials while improving the quality of other recycling streams. The research was commissioned by Materials Recovery for the Future (MRFF), a collaborative of brand owners, manufacturers and packaging industry organizations that want to improve recycling and increase recovery rates for flexible film and packaging options.

"Flexible packaging has many positive attributes – highly efficient, great product protection, and low environmental impact. However, recovery has been one of its weak points. This study is shedding light on pathways that can be deployed to improve flexible packaging end-of-life options," said Brad Rodgers, at PepsiCo. This first phase of the MRFF research program included baseline testing, equipment testing, and a series of recovery facility trials to test existing sortation technologies commonly used in MRFs, such as screens and optical scanners. RRS developed the test methodology and conducted the research trials.

Source: http://www.environmentalleader.com

Plastic waste into construction blocks

Byfusion, New Zealand, has developed a technology that turns plastic waste into building blocks. This is a proprietary technology specifically designed to upcycle waste plastic. It uses water held under pressure at very high temperatures ranging from 100°C and 374°C, and compression, but it does not melt or otherwise degrade the polymers in the plastic. ByFusion's machine turns the waste plastic into an alternative building material which it calls RePlast.

The bricks can help improve the eco-friendly status of building projects and contribute to LEED certification. Needing no glue or adhesives, RePlast blocks could represent the next wave of sustainable construction, since they are completely recycled from collected waste plastic (with no discrimination for plastic type) and have 95-percent lower greenhouse gas emissions than traditional concrete block. Due to the nature of plastic debris, the blocks are a lot more colorful, too. The blocks have undergone testing to ensure that they comply with various building requirements related to compression and shear strength.

ByFusion is working hard to make sure that their blocks comply with international requirements. In New Zealand and California these blocks have been used to construct retaining walls without showing signs of degradation. In areas prone to earthquakes these blocks may even be more suitable than concrete blocks, because they are flexible. The ByFusion process works with pretty much any type of plastic, with the exception of foamed plastics such as polystyrene as these materials lack the structural integrity required for upcycling into building blocks. But coming up with a way to upcycle waste plastic is only a small part of the story.

Source: https://www.fespa.com

Bio-recycling process for plastic waste

Green chemistry company Carbois in France has announced that its innovative enzymatic bio-recycling process of polyesters is also applicable to crystalline polyethylene terephthalate (PET). 'This means it can treat all kind of plastic waste containing PET, namely bottles, packaging and films,' the firm says. Carbois had previously managed to successfully depolymerise 100% amorphous PET based commercial products into its original monomers, terephthalic acid and mono ethylene glycol. This new step is a 'world premiere' that is said to offer the opportunity of an 'infinite bio-recycling' of plastic products made out of amorphous and/or crystalline PET, which enables Carbois to access a market estimated to be worth more than US$ 31 billion per year.

The patented depolymerisation process enables the regeneration of monomers 'with no loss in quality', Carbois says. After separation and purification, these monomers could then be used for the synthesis of virgin PET coming at 100% from Carbois enzymatic bio-recycling process. The competitive pre-treatment process of crystalline PET will likely move swiftly into an industrial pilot development stage, so says Carbois and its project partners the LISBP laboratory and the CRITT Bio-Industries from INSA Toulouse.

The exceptional properties of thermoplastic material make it the most favoured polyester for manufacturing plastic bottles (69% of PET plastics), films (14%), packaging (10%) and other applications (7%).

Source: http://www.recyclinginternational.com

Eco-friendly metal extraction technology

Leading e-waste recycler and metal extraction company, Attero, India, has developed a low-cost metal extraction technology for e-waste. With an integrated recycling and refurbishing facility and proprietary metallurgical processes (patent pending), company officials informed that their unique metal extraction technology for e-waste extracts pure precious and semi-precious metals as a substitute for metals from virgin mines.

Attero's disruptive recycling technology ensures that e-waste is processed in an environmentally friendly manner, with high efficiency and lowered carbon footprint, at a fraction of the costs involved with setting multi-billion dollar smelting facilities. This solves a lot of issues like e-waste moving to just a handful of smelters. Its technology is disruptive because going forward most of the demand for metals could be met by recycling and extracting pure metals from e-waste.

According to a joint study by Assocham-KPMG, India has emerged as the second largest mobile market with 1.03 billion subscribers, but also the fifth largest producer of e-waste in the world, discarding roughly 18.5 lakh metric tonne of electronic waste each year, with telecom equipment alone accounting for 12% of the e-waste.

Source: http://www.financialexpress.com

Microfactories to turn unwanted electronics

University of New South Wales (UNSW), Australia, is soon going to unveil a pilot micro-factory that safely transforms toxic electronic waste (e-waste) into high value metal alloys, offering a unique low-cost solution to one of the world's fastest-growing waste burdens. The breakthrough new process, invented by UNSW Professor Veena Sahajwalla, recovers the considerable wealth of resources embedded in e-waste while overcoming the challenges of toxicity and the often prohibitively high costs of conventional industrial-scale recycling.

Professor Sahajwalla's solution will enable the safe, cost-effective 'mining' of e-waste stockpiles locally, anywhere in the world. Professor Sahajwalla uses precisely controlled high-temperature reactions to produce copper and tin-based alloys from waste printed circuit boards (PCBs), while simultaneously destroying toxins. A programmed drone is able to identify PCBs from within crushed e-waste, and a simple robot is used to extract them, overcoming the risks of contamination, before the PCBs are fed into the furnace.

"A tonne of mobile phones (about 6,000 handsets), for example, contains about 130kg of copper, 3.5kg of silver, 340 grams of gold and 140 grams of palladium, worth tens of thousands of dollars," said Sahajwalla. The new microfactories are suitable for mobile use: they can be set up in containers and transported to waste sites, avoiding the huge costs and emissions of trucking or shipping e-waste over long distances. Likewise, they promise a safe new way for poor communities in developing nations to generate an income from the production of metal alloys.

Source: http://www.international.unsw.edu.au

New e-cycling method

The Central Scientific Instruments Organisation (CSIO), India, has developed a technology to recover metal from discarded electronics in an environmentally-friendly way. This new approach is said to involve safer chemical steps, converting zinc waste into a high-value zinc salt using simple leaching and hydrothermal stages. The commercial price of the recovered product is currently around Rs 800,000 per kg (US$ 11,940) and so the economic benefits of this new process are 'significant' for the recycling industries.

A recent study by Assocham-cKinetics suggests that India will generate annually some 5.2 million tonnes of e-scrap by 2020 compared to current levels of 180 000 tonnes, equivalent to an annual compound growth rate of around 30%. Researchers hope this latest breakthrough will boost India's e-cycling rate currently standing at just 1.5%. Discarded electronics account for up to 40% of lead and 70% of heavy metals dumped in landfills by the countless players in India's informal recycling sector.

Source: http://www.recyclinginternational.com

Fungi method extracts metals from batteries

According to the researchers at the University of South Florida, the United States, it may be essential to establish an eco-friendly recycling process to extract cobalt and lithium from tons of waste batteries. The unusual project has seen the research team dismantle the batteries and pulverise the cathodes before exposing the remaining pulp to the fungus. 'Fungi naturally generate organic acids, and the acids work to leach out the metals,' explained Jeffrey Cunningham, who supervised the work.

Results to date show that up to 85% of the lithium and up to 48% of the cobalt can be extracted using the fungi's oxalic and citric acids.

The strains of fungi used in the project are Aspergillus niger, Penicillium simplicissimum and Penicillium chrysogenum. After 'fungal exposure', the metals remain in a liquid acidic medium, says Cunningham. The research team is trying to figure out the best way to retrieve the two elements from the liquid.

Source: http://www.recyclinginternational.com

Precious metals from e-waste

Mineral processing company Mineworx, Canada, has developed a nontoxic leach formula that extracts precious metals from ores and e-waste that is safer for the environment than existing cyanide-based formulas. Mineworx's parent company, Iberian Minerals, Canada, has created a new subsidiary, HMX Solutions, to pursue commercial opportunities for the HM X-leach formula.

Mineworx's formula is made of food-grade, organic ingredients and is recyclable.

In a test performed on e-waste scrap, HMX-leach accumulated 2,600 parts per million of gold in the solution in less than an hour of soaking. Cyanide is the dominant leaching agent used in gold processing. But it creates toxic wastewater and is a relatively slow in recovering the precious metal and has been banned in some US states, European countries and South American countries. While other chemicals have been tested to leach gold, none have been more cost-effective and productive than cyanide until now.

The HM X-leach solution recovers gold and other precious metals through several extraction methods including electrowinning, carbon absorption and precipitation. "We are very excited with the results of the HM X-leach formula. It has been proven by independent analysis to be non-toxic and faster than typical cyanide solutions on a number of different ores, concentrates and tailings. The HM X-leach is safer to use, offers faster dissolution rates and offers much broader operational parameters," said Mineworx CEO Duane Nelson.

Source: http://www.environmentalleader.com

Recycling method for e-waste, smartphones

IBM Research scientists at its research facility in San Jose, the United States, have discovered a new, one-step chemical process to convert discarded electronic waste including smartphones and CDs into non-toxic and high-strength plastics. Researchers have discovered a new, one-step chemical process to convert converts polycarbonates into plastics safe for water purification, fiber optics and medical equipment.

"Polycarbonates are common plastics in our society – especially in consumer electronics in the form of LED screens, smartphones and Blu-rays, as well as everyday eyeglass lenses, kitchen utensils and household storage gear," said Gavin O Jones, at IBM Research. Jones said that the researchers have found a new way of recycling to improve how this prominent substance impacts the world's health and environment.

IBM Researchers added a fluoride reactant, a base (similar to baking powder) and heat to old CDs to produce a new plastic with temperature and chemical resistance superior to the original substance, the technology giant said. In this study, researchers used a combination of predictive modeling and experimental lab work to make the discovery, and according to the research company, the learning from research efforts will also used to advance cognitive systems to help accelerate the materials discovery process.

Source: http://www.telecom.economictimes.indiatimes.com

Gold from old gadgets

Scientists at the University of Edinburgh, Scotland, have developed a new method for recovering gold from old gadgets such as mobile phones, TV's and computers, which not only doesn't require the use of toxic chemicals, such as cyanide, but it is also said to be more effective than current techniques. According to the researchers, their extraction method could help recover about 300 tonnes of the precious metal used in electronics each year.

They estimate that electrical waste contains as much as 7% of all the world's gold as the precious metal is a key component of the printed circuit boards found inside most modern devices. The team's proposed technique involves submerging printed circuit boards in a mild acid to dissolve the metal parts, before adding an oily liquid containing the team's chemical compound. The solution then helps extract gold selectively from the complex mixture of other metals.

The findings could aid the development of methods for large-scale recovery of gold and other precious metals from waste electronics, the team said. "We are very excited about this discovery. We have shown that our fundamental chemical studies on the recovery of valuable metals from electronic waste could have potential economic and societal benefits," said lead researcher Jason Love.

Source: http://www.mining.com

Wastewater turned into energy storage cells

Researchers from University of Colorado Boulder (UC Boulder), the United States, have developed a manufacturing process that uses a biological organism cultivated in brewery wastewater to create the carbon-based materials needed to make energy storage cells. The scientists believe that this unique pairing of breweries and batteries could set up a win-win opportunity by reducing expensive wastewater treatment costs for beer makers while providing manufacturers with a more cost-effective means of creating renewable, naturally-derived fuel cell technologies.

The process of converting biological materials, or biomass, such as timber into carbon-based battery electrodes is currently used in some energy industry sectors. But naturally-occurring biomass is inherently limited by its short supply, impact during extraction and intrinsic chemical makeup, rendering it expensive and difficult to optimise. The researchers in this study utilised the efficiency of biological systems to produce sophisticated structures and unique chemistries by cultivating a fast-growing fungus, *Neurospora crassa*, in the sugar-rich wastewater produced by breweries.

Source: http://www.indialivetoday.com

Cost-effective water treatment technologies

Dr. Yongheng Huang, at Texas A&M University, the United States, is working to develop cost-effective water treatment technologies to meet industrial, agricultural and domestic needs. "We focus on discovering and using iron chemistry to immobilize and secure heavy metals and to remove nutrients and other undesired impurities from various impaired liquid streams," said Huang. Huang's research led to the invention of the Activated Iron Technology that has been exclusively licensed by the Texas A&M University System and Texas A&M AgriLife Research to Evoqua Water Technologies, LLC.

"The new technology has been commercialized as a cornerstone for Evoqua for water and wastewater treatment, including electric power, mining, refinery and other industries as well as for environmental remediation and municipal drinking water applications," Huang said. The invention was accomplished after a series of breakthroughs in iron chemistry to help sustain iron corrosion reactivity. These breakthroughs have solved the issue related to the formation of passive iron oxide coatings on iron surface that could stop iron corrosion reaction, often referred to as iron passivation, which has troubled scientists and the industry for many years.

The new technology is robust and versatile, capable of removing a broad spectrum of toxic materials from some of the most challenging and complex wastewaters. The materials removed include metals such as selenium, mercury, arsenic, chromium, cadmium, vanadium and lead. If these metals were left untreated in the wastewater and discharged into the receiving water bodies, they could hurt the health of the environment, disrupting the ecosystem, and in many cases, pose an immediate or long-term threat to human health.

Source: http://www.phys.org

Technology to clean refinery wastewater

The Co-op Refinery Complex (CRC) in Saskatchewan, Canada, has nearly reached its goal of cleaning over two million gallons of wastewater every day. When the Wastewater Improvement Project becomes fully operational, CRC will be the only North American refinery recycling all of its wastewater, with two-thirds of it going into steam production.

A special blend of live bacteria eats the impurities in the wastewater ponds. Spaghetti-like, hollow strands of "Zee Weed" filter wastewater to remove suspended solids. The system then employs high-efficiency reverse osmosis to clean wastewater for steam production, using GE technology.

Sixty-five per cent of the recycled water goes into steam production, with the remaining recycled water being reused in other processes such as cooling and hydrogen production. After being recycled multiple times, water that can no longer be recycled is disposed of in deep wells, including any excess brine. The overall result is a significant reduction in both water usage and emissions from volatile organic compounds, which has the added benefit of reducing odours.

Source: http://www.canadianfuels.ca

Method to convert sewage into biofuel

According to a new research at the US Department of Energy's Pacific Northwest National Laboratory (PNNL), wastewater treatment plants may one day turn ordinary sewage into biocrude oil. "There is plenty of carbon in municipal waste water sludge and interestingly, there are also fats.

The fats or lipids appear to facilitate the conversion of other materials in the wastewater such as toilet paper, keep the sludge moving through the reactor, and produce a very high quality biocrude that, when refined, yields fuels such as gasoline, diesel and jet fuels," said Corinne Drennan, at PNNL.

The technology, hydrothermal liquefaction, mimics the geological conditions Earth uses to create crude oil. It uses high pressure and temperature to achieve in minutes something that takes Mother Nature millions of years. The resulting material is similar to petroleum pumped out of the ground, with a small amount of water and oxygen mixed in. This biocrude can then be refined using conventional petroleum refining operations, the researchers said. With this technology, a single person could generate two to three gallons of biocrude per year, according to an estimate by PNNL.

Sewage, or more specifically sewage sludge, has long been viewed as a poor ingredient for producing biofuel because it's too wet. The approach being studied by PNNL eliminates the need for drying required in a majority of current thermal technologies which historically has made wastewater to fuel conversion too energy intensive and expensive. Hydrothermal liquefaction may also be used to make fuel from other types of wet organic feedstock, such as agricultural waste, according to the researchers.

Source: http://www.economictimes.indiatimes.com

Osmosis technology for wastewater treatment

Aquaporin Asia, Singapore, and Berghof Membranes, the Netherlands, have announced the joint development of a forward osmosis waste water treatment technology based on Aquaporin's Inside membrane coating and Berghof's tubular polymeric membranes. The two companies believe that they will be able to provide a cheaper solution for treating industrial process streams and waste water.

Tubular polymeric membranes as produced by Berghof Membranes are particularly suitable for treatment of effluents presenting a high contaminants load.This accounts of the fact that the filtering channel is completely open, making it possible to handle a large quantity of suspended solids. Filtration occurs from the inside to the outside of the channel and it is possible to perform backwash operations.

The Aquaporin Inside technology is a thin film coating that hosts proteins in an environment that retains the molecules' natural activity of moving water molecules. The coating can be applied to both flat-sheet membranes and hollow fiber modules. The protein is selective for transporting pure water molecules because of the hydrophobic nature of the aquaporin's water channel. The end goal of the project is to demonstrate the cost saving potential of Aquaporin's coating Inside forward osmosis technology through industrial test bedding.

Source: http://www.dutchwatersector.com

Method to create biocrude oil

Researchers at the Department of Energy's Pacific Northwest National Laboratory (PNNL), the United States, have created a method to turn ordinary sewage and other organic waste into biocrude oil. The researchers have developed a novel process, which they call hydrothermal liquefaction, that mimics the geological conditions involved in creating crude oil. Using high pressures and temperatures, they only need a few minutes and the stuff we flush down our toilets to create a liquid that takes millions of years to form in nature.

Organic matter is pressurized to 3,000 pounds per square inch (about 100 times the pressure in a car tire), then fed into a reactor system which cooks it to 660 °F (350 °C). These extreme conditions break the matter down to its simple chemical compounds – the cells in the material rip apart, forming biocrude and an aqueous-liquid phase. "There is plenty of carbon in municipal waste water sludge and interestingly, there are also fats," said Corinne Drennan, at PNNL.

The method may also be used to make fuel from other types of wet organic feedstock, such as agricultural waste. In addition to the biocrude, the liquid phase can be treated to create other fuels and chemical products. A small amount of solid material is also generated, which contains important nutrients. For example, early efforts have demonstrated the ability to recover phosphorus, which can replace phosphorus ore used in fertilizer production.

Source: http://www.zmescience.com

Global Cleantech Innovation Programme for SMEs

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http://www2.cleantechopen.org

Patent for *in situ* pH adjustment method

Solutions-IES, Inc. (SIES), the United States, has recently obtained US Patent. The invention provides a safe, low-cost, effective method for the remediation of contaminated subsurface environmental media that require increasing or maintaining pH to improve the performance of *in situ* treatment processes. Many contaminated sites across the southeast experience naturally low pH conditions in the soil and groundwater. During remediation this can present a challenge in reaching site closure for some remedial methods such as bioremediation which require specific pH ranges.

Many practitioners and site managers try to adjust aquifer pH with common industrial chemicals such as caustic or buffers. While these can work, they are short-lived and sometimes dangerous to handle. Solutions-IES, Inc. patent covers the composition and method of using an alkaline suspension injected into the subsurface treatment zone to adjust, optimize and maintain the pH and effectively enhances the remediation process. "Today's patent protects an effective way to enhance *in situ* treatment of contaminated materials," said Ann Borden, at SIES.

After several years of research, development, and field demonstration SIES developed the patented methods to modify alkaline suspensions enhancing their transport in the subsurface, providing effective distribution and long-lived adjustment of pH. CoBupH-Mg™, exclusively licensed by EOS Remediation, LLC, the United States, was developed using the patented process and has been successfully applied to dozens of sites across the US over the past 3 years. *Contact: Ed Alperin, Tel: +1-919-873-1060; E-mail: ealperin@solutions-ies.com.*

Source: http://www.solutions-ies.com

Fungi help in bioremediation

A recent study done by scientists from Harvard University, EMSL, Pacific Northwest National Laboratory, Smithsonian Institution, DOE Joint Genome Institute (JGI), Centre National de la Recherche Scientifique and Aix-Marseille Université, King Abdulaziz University, University of Minnesota, and Woods Hole Oceanographic Institution (WHOI) reveals different fungal species secrete a rich set of enzymes that share similar functions, despite species-specific differences in the amino acid sequences of these enzymes. The study enhances understanding of the role fungi play in processes occurring in soil.

The study could be used to engineer fungal enzymes for biofuel production and bioremediation efforts. Fungi secrete a diverse repertoire of enzymes that break down tenacious plant material. These powerful enzymes degrade plant cell wall components such as cellulose and lignin, resulting in the release of carbon dioxide (CO_2) from soils containing dead plant material into the atmosphere. As such, fungal enzymes are not only critical drivers of climate dynamics, but they also hold promise for cost-effective development of alternative transportation fuels from biomass.

Moreover, the manganese [Mn(II)]-oxidizing capacity of certain fungal species can be harnessed to remove toxic metals from contaminated soils and water. Researchers used liquid chromatography-tandem mass spectrometry (LC-MS/MS), genomic analyses, and bioinformatic analyses to characterize and compare enzymes secreted by four Mn(II)-oxidizing Ascomycetes species. These four species were isolated from coal mine drainage treatment systems and a freshwater lake contaminated with high concentrations of metals and are associated with varied environments and common in soil ecosystems worldwide.

Source: http://www.phys.org

Reducing toxic threat of pesticides

A new undergraduate-led company at the University of Virginia, the United States, has a solution for common pesticide problem in agriculture. "Agrospheres" is a bioengineering start-up that has created a solution that can be sprayed on pesticide-treated plants to safely and rapidly remove potentially harmful pesticide residue. The spray is created from "mini cells," microscopic biologic platforms that deliver pesticide-degrading enzymes. It makes plants safer for workers to handle and allows farmers more control over their harvest time.

"What we mean by a 'platform' is that the technology we're using is a spherical bio-particle we're attaching enzymes to. Essentially it's just a carrier that can be modified to work with different enzymes for different purposes, from degrading pesticides to breaking down other substances," fourth-year biomedical engineering major Ameer Shakeel said. Shakeel helped co-found Agrospheres with 2016 graduate Payam Pourtaheri while they were both still students in UVA's School of Engineering and Applied Science.

They began working with UVA pharmacology professor Mark Kester as their adviser and eventual co-founder as they considered applications for the mini cell platform. "The majority of that organism is going to divide into one identical organism and a tiny remaining percentage of the organism is going to divide into what we call the mini cell. The mini cell that we get is just a sack without the genetic material of the original organism. It's like a package, but in that package we've got the one enzyme we want expressed," said Kester.

Source: http://www.phys.org

Microbes to treat soil fouled by oil

A pilot facility at the Garfield County landfill at the base of the Roan Plateau near Rulison, the United States, is using microbes to clean petroleum-contaminated soil. The facility is the first of its kind in Colorado, and unique for a public facility in terms of the blend of technologies it incorporates. It can accept waste mainly coming from the oil and gas industry and clean it to a point that the landfill will be able to use the treated soil as a cover material over waste. That will prove to be a valuable byproduct of the process because soil is hard to come by at the facility.

The treatment concept arose during strategic solid waste management planning undertaken by the county in 2014. Petroleum-contaminated soil (PCS), consists of materials such as cuttings produced during well drilling, soil cleaned up in spills, and so-called "filter cakes" produced in gas-processing operations. "The treatment concept grew out of the fact that the state Air Pollution Control Division, stopped the use of untreated PCS as landfill cover," said Gary Webber, at Northwest Colorado Consultants, Inc., the United States.

One of the technologies is what's called a biopile, which involves mixing the contaminated soil with a bulking agent like wood chips, nutrients such as nitrogen and phosphorous, and sometimes a microbial "inoculum" such as manure. The mixture is kept moist and is piled on perforated pipes to allow aeration, and the microbes biodegrade the hydrocarbons in the soil. But biopiles are meant to be used in a onetime process in which the pile is removed once it's done and the project is considered done.

Source: http://www.gjsentinel.com

Oil clean-up properties of aquatic ferns

Scientists at Karlsruhe Institute of Technology's Institute of Microstructure Technology (IMT), Germany, together with researchers from the Nees Institute for Biodiversity of Plants at the University of Bonn, Germany, have been discovering what makes these plants so special. In their study, the team focused on a number of water plants including four species of *Salvinia* – an aquatic fern – which were selected for their hairy leaves. The results have been published in the journal *Bioinspiration & Biomimetics*.

The shape of these hairy outgrowths, known as trichomes, falls into four categories and the researchers fine-tuned their sample to get the maximum information on the correlation between trichome type and oil absorption. "From our results we now know that the shape of the hair ends is important in supporting the oil/air interface to ensure maximum oil absorption and retention capabilities," said Claudia Zeiger of IMT. IMT has developed a synthetic version of these hairy surfaces dubbed 'nanofur', which is produced by pressing a hot rough plate into a polymer foil.

Nanofur is superhydrophobic and superoleophilic and, like the aquatic ferns, can selectively absorb oil while repelling water. One of the original goals of the current study was to learn from the plants to identify ways to increase the absorption capacity of nanofur, but the results also suggest other opportunities. Using these structures as oil absorbers might potentially solve two problems at the same time – the removal of unwanted plants and the production of natural and selective oil sorbent material at low-cost.

Source: https://www.sciencedaily.com

The StEP Initiative

The Solving the E-waste Problem (StEP) Initiative is a collaborative global initiative uniquely leading global thinking, knowledge, awareness and innovation in the management and development of environmentally, economically and ethically-sound e-waste resource recovery, re-use and prevention. StEP facilitates research, analysis and dialogue among its more than 65 members from business, international organizations, governments, NGOs and academic institutions around the world.

For more information, contact:

The StEP Initiative
E-mail: info@step-initiative.org
Web: http://www.step-initiative.org

Nano-spike catalyst converts CO_2 to ethanol

Scientists at the Department of Energy's Oak Ridge National Laboratory (ORNL), the United States, have developed an electrochemical process that uses tiny spikes of carbon and copper to turn carbon dioxide (CO_2), a greenhouse gas, into ethanol. Their finding, which involves nanofabrication and catalysis science, was serendipitous. "We discovered somewhat by accident that this material worked," said Adam Rondinone, at ORNL.

The team used a catalyst made of carbon, copper and nitrogen and applied voltage to trigger a complicated chemical reaction that essentially reverses the combustion process. With the help of the nanotechnology-based catalyst which contains multiple reaction sites, the solution of CO_2 dissolved in water turned into ethanol with a yield of 63 percent. Typically, this type of electrochemical reaction results in a mix of several different products in small amounts.

The catalyst's novelty lies in its nanoscale structure, consisting of copper nanoparticles embedded in carbon spikes. This nano-texturing approach avoids the use of expensive or rare metals such as platinum that limit the economic viability of many catalysts. "By using common materials, but arranging them with nanotechnology, we figured out how to limit the side reactions and end up with the one thing that we want," said Rondinone.

Source: https://www.sciencedaily.com

Turning CO_2 to stone

Scientists at Columbia University's Lamont-Doherty Earth Observatory, the United States, are developing way to prevent carbon dioxide (CO_2) produced by power plants and industries from ever entering the atmosphere, and they are exploring ways to take CO_2 out of the environment. In a study, scientists announced that, for the first time, CO_2 captured from a power plant in Iceland and pumped underground had mineralized into a white, chalky substance for permanent storage, and this conversion happened far faster than anyone expected.

Lamont scientists are now exploring similar possibilities with vastly greater storage potential beneath the oceans off the U.S. coasts, and they are experimenting with a type of rock found in abundance in Earth's mantle that could be used to go the next step and begin taking CO_2 out of the environment. "It's clear that, no matter what we may wish, we will not put the brakes on the carbon economy fast enough to avoid overshooting safe CO_2 limits in the air," said geologist Peter Kelemen, who is leading studies on mantle rocks and their potential for CO_2 removal.

Scaled up, the process of capturing CO_2 from power plants and factories and turning it into a solid could buy time as countries worldwide shift away from fossil fuel use and toward cleaner energy sources. Scientists used CO_2 captured at the power plant, and mixed it with water and hydrogen sulfide, creating soda-like carbonation, then injected the mixture into porous basalt rocks 400 to 800 meters underground. Basalt, which is created as lava cools, contains calcium, iron, and magnesium, which react naturally with CO_2 to form solid carbonate minerals.

Source: http://www.phys.org

CO_2 converted into fuel

Researchers at the University of Illinois at Chicago (UIC), the United States, have used an approach 'it's often smarter to borrow from nature than reinvent the wheel' for the eradication of carbon dioxide (CO_2) from the atmosphere, and its conversion into a resourceful, economical fuel. According to the researchers they have come up with an artificial leaf that converts CO_2 into fuel, costing equivalent to a gallon of gasoline that may make fossil fuel outdated.

The 'leaf' is among the increasing number of inventions imitating photosynthesis for the removal of excess carbon from the atmosphere, and transforming it into new, sustainable energy forms to provide energy to the world. "The new solar cell is not photovoltaic – it's photosynthetic. Instead of producing energy in an unsustainable one-way route from fossil fuels to greenhouse gas, we can now reverse the process and recycle atmospheric carbon into fuel using sunlight," said Amin Salehi-Khojin, at UIC.

The solar cells created by Dr. Salehi-Khojin and his team work like the leaves of a plant. The sole difference is the artificial leaf doesn't convert CO_2 into sugar, instead changes the gaseous compound into synthesis gas, hydrogen and carbon monoxide mixture. The idea of reduction reaction, which means CO_2 conversion into a burnable form of carbon, isn't new. The only thing is, in the past scientists were dependent on silver and other costly metals for the breakdown of gas into storable energy.

Source: http://www.norcal.news

Trial for NO_x emission control

Kawasaki Heavy Industries, Japan, has reported a successful sea trial of an arrangement employing a combination of exhaust gas recirculation and emulsion fuel to reach Tier III NOx emission levels with no fuel penalty. The Kawasaki Ecology & Economy System (K-ECOS) – employing EGR, emulsion fuel, water treatment, a turbocharger cut-out system and integrated controls – was installed on a Kawasaki-MAN B&W 7S60ME-C8.2 main engine driving Kawasaki Kisen Kaisha's pure car/truck carrier 'Drive Green Highway'.

After a successful sea trial before the vessel's entry into service early this year, the system will now be tested in service over a two-year period. Performance in shop tests, which were confirmed during the sea trial, showed that the system in 'NO_x Tier III mode' – employing the EGR and running on emulsion fuel – achieved NO_x emissions of 3.3 g/kWh, under the Tier III limit of 3.4g for low-speed engines. The scrubber successfully removed 97% of the fuel sulphur content from the exhaust.

Fuel consumption in NO_x Tier III mode – with the full K-EOCS system active and running on emulsion fuel – was greater than in basic mode with regular diesel fuel by 0.4-0.8g/kWh, but was still similar to the performance of the current engine. In 'auto turbocharger cut-out mode', which uses emulsion fuel and sequential turbocharger control but does not activate EGR, the fuel saving compared to basic mode reached a maximum of 4.8% at around 60% engine load.

Source: http://www.motorship.com

Solid capture of carbon dioxide

A team of researchers King Abdullah University of Science and Technology's Advanced Membranes and Porous Materials Research Center, Saudi Arabia, are developing porous solids called metal-organic frameworks (MOFs) for the selective removal of various gases from gas mixtures. Their latest breakthrough material can effectively take up carbon dioxide (CO_2) even when it is present at concentrations as low as 400 parts per million and opens possibilities for capturing CO_2 as it is generated.

MOFs contain metal ions or clusters that are held in place by organic molecules known as linkers. Altering the chemical composition and geometry of these two primary components can produce versions with varying and highly selective abilities to adsorb and store gases. "The discovery of this latest material for capturing CO_2 is the result of about four to five years of work on this unique MOF platform," said Professor Mohamed Eddaoudi.

Eddaoudi explained that the key challenge was to create something that could exceed the performance of existing options while also greatly reducing the energy requirements over the full cycle of operation. The researchers' response was to develop a fluorine-containing MOF in which square-grid layers encompassing Ni(II) metal centers and pyrazine linkers are bridged via pillars composed of niobium, oxygen and the fluorine atoms.

Source: http://www.internano.org

CO_2 injected into ancient lava

For the first time, scientists have injected carbon dioxide into ancient lava flows and watched it solidify, demonstrating that capturing carbon dioxide from the atmosphere or a power plant smokestack and safely storing it underground may be a realistic way to help reduce greenhouse gas emissions to tackle climate change, according to a published research. Scientists working at the Wallula Basalt Pilot Project in Washington State turned liquefied carbon dioxide into solid rock by injecting the gas into basalt formations. Over a span of about two years, the carbon dioxide solidified into a mineral called ankerite, according to the study conducted by Pacific Northwest National Laboratory researchers. The research was published in the journal Environmental Science and Technology.

"This study further supports the idea that one of the major rock types on the planet — basalts — can be used to store carbon dioxide permanently and safely," said study lead author Pete McGrail, a carbon dioxide and climate change researcher at PNNL. "Basalt storage is unique in the geologic sequestration of carbon dioxide because the principal trapping mechanism is a chemical reaction that locks the carbon dioxide away as a carbonate mineral that can never leak or return to the atmosphere," McGrail said.

The Wallula project is the first to show carbon dioxide could be solidified in the ancient basalts that are more common globally, said Paul Olsen, an earth and environmental sciences professor at the Lamont-Doherty Earth Observatory at Columbia University who is unaffiliated with either study. "The recent highly successful CarbFix project in Iceland showed that the conversion of carbon dioxide into limestone could be very fast, but that project used the much more recent lava flows of Iceland and it was not clear the process would

work on ancient lava flows such as those that are widespread in many places on land near major cities and their associated power plants," Olsen said. "It was also the first major test using liquefied carbon dioxide that is relatively easy to transport."

The Wallula project's success shows that commercial-scale carbon sequestration from electric power plants is possible, albeit more research needs to be done to show how the process could be scaled for use commercially around the world.

Source: http://www.climatecentral.org

CO_2 converted into useful chemicals

Belgian researchers from Ghent University have developed a new technique to turn carbon dioxide from exhaust fumes into useable chemicals. The chemical process, described in the latest issue of the journal *Science*, involves what the researchers call as a 'super-dry' reaction, meaning it doesn't require the use of water.

In the process, two types of greenhouse gas - methane and carbon dioxide - react, assisted by a nickel-based catalyst. Calcium oxide is used in the reaction to absorb carbon dioxide and iron oxide serves as a solid oxygen carrier. "With this process, we intensify the conversion of CO_2 by making maximal use of CH4 as reducing gas," said the study's lead author, Lukas Buelens of the Ghent University. "The generated CO can be used directly or combined with a green H2 source for the production of chemicals or fuels."

Previously, the so-called 'dry reforming' of methane has been used to break the greenhouse gas into CO and H2. In this reaction carbon monoxide reacts with water to re-form carbon dioxide. Eliminating water from these reactions has proved to be an active area of research.

In the current study, the team used calcium oxide as a CO_2 sorbent in which calcium carbonate is formed. This has several benefits that has allowed a higher carbon monoxide yield and an opportunity to remove water that is formed from the oxidation of methane. First, from an economic and practical standpoint, because CO_2 is removed in situ, the feed gas can be of lower stock quality. Secondly, the formation of calcium carbonate can be coupled with methane reformation and iron oxide reduction resulting in a more energetically favourable process.

Then, when calcium carbonate decomposes into CO_2 and CaO, the carbon dioxide is reduced to CO over the iron oxide oxygen carrier. According to the authors, it is at this point that the feed is switched to inert gas to regenerate the system. They obtained a 45 per cent higher CO yield, but this yield could be even higher by optimising conditions.

Importantly, their two-flow reaction set-up seems to have some versatility that prior dry-reforming reactions lacked, either by changing the gas feedstock ratios or by changing to a multi-reactor configuration. Additionally, their initial flow system uses a less expensive nickel catalyst because carbon deposition has been eliminated. Their system is more efficient for CO_2 utilisation than prior dry-reforming reactions and may serve as a model for optimised CO_2 conversion.

Source: https://eandt.theiet.org

Waste gas into diesel fuel

A new study, led by Professor Jae Sung Lee of Energy and Chemical Engineering at Ulsan National Institute of Science and Technology (UNIST), Republic of Korea uncovers new ways to make biofuel from carbon dioxide (CO_2), the most troublesome greenhouse gas. In their paper published in the journal Applied Catalysis B: Environmental, the team presented direct CO_2 conversion to liquid transportation fuels by reacting with renewable hydrogen (H2) generated by solar water splitting.

The currently existing catalysts, used for the reactions of H2 with CO_2 are limited mostly to low molecular weight substances, such as methane or methanol. Besides, due to the low value of these catalysts, the reduction effects of CO_2 is generally low. However, the new delafossite-based catalyst, presented by UNIST research team converts CO_2 into liquid hydrocarbon-based fuels (e.g., diesel fuel) in one single step. These fuel samples can be, then, used by existing diesel vehicles, like trucks and buses. This new delafossite-based catalyst, composed of inexpensive, earth-abundant copper and steel is used in a reaction between CO_2 emissions of industrial plants and H2 generated from solar hydrogen plant to produce diesel.

This direct CO_2-FT synthesis is different from the German car maker Audi's CO_2-to-dielsel conversion process, which actually involves two steps - reverse water gas shift (RWGS) reaction to CO followed by CO Fisher-Tropsch (FT) synthesis. The benefits are two-fold: The process removes harmful CO_2 from the atmosphere, and the diesel can be used as an alternative fuel to gasoline. The research team expects that this breakthrough holds a potential to revolutionize the automobile industry, thereby bringing us a step closer to eliminating greenhouse gas.

Source: http://phys.org

RECENT PUBLICATIONS

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