Asia Centre Pipeline (CAC) which exports natural gas from Turkmenistan to Russia and the Gazprom. Then there is the Korpezhe-Kurt Kui Pipeline that transports natural gas to Iran. The Dowlatabad-Khangiran Pipeline also provides natural gas to Iran expanding the export portfolio of Turkmenistan. One of the popular pipelines in the recent era is TAPI (Turkmenistan–Afghanistan–Pakistan–India) which caters to the Asian demand of this natural resource. However, it still has not come into operation due to logistic issues. Currently, another pipeline that has been hogging headlines is the Trans-Caspian Gas Pipeline which explores an alternate route of transferring natural gas to Turkey.

The Trans-Caspian Gas Pipeline

It is said that the Caspian Sea section of Turkmenistan contains about 80.6 billion barrels of oil. After 2007, Turkmenistan has become one of the leading gas exporters in the Caspian and Central Asian region. Since its independence in 1991, leaders of the country have initiated the process of instituting diplomatic ties with Russia, Iran, China, Europe, and the United States of America in order to boost their economy by tapping gas reserves and developing pipeline systems. After all, a developing country needs the support and backing of partner nations to cultivate the much-required foundation for gas pipelines. Although the government is in talks with several countries for exporting natural gas, it still lacks the basic transportation infrastructure.

To give you a brief background, the Trans-Caspian Gas Pipeline project was introduced in 1997, with a plan to transmit natural gas from south-eastern Turkmenistan to central Turkey. A 750-mile pipeline, it aimed to share the gas reserves amicably to various partners in the Central Asian market, eventually extending its grasp in Europe. As Turkmenistan welcomed foreign investments in the late 1990s, this project was developed as a joint venture of GE Capital, Bechtel Corporation, and Shell and was expected to be delivered within three years at a cost of $2.4 billion. The companies were also expected to undertake the design, engineering, and construction of a channel extending from Turkmenistan, going into the Caspian, and ending at Baku in Azerbaijan. It will then move towards Turkey, passing from Georgia. The Trans-Caspian Gas Pipeline was established, legally, in a Framework Declaration signed by the leaders of Turkmenistan, Azerbaijan, Georgia, and Turkey in November 1999. The United States of America also took active participation, as a witness, in the signing of this agreement. The then US President, Bill Clinton, declared America's support and commitment towards the construction of this pipeline.

Trouble with the Project

The enthusiasm and fanfare with which the Trans-Caspian Gas Pipeline was initiated turned out to be nothing but a damp squib. Since the signing of the official contract, the pipeline has only stuck to paper and hasn't seen the light of day. The construction of this pipeline has faced many conflicting interests among the neighbouring nations of Turkmenistan. The major contenders, Russia and Iran, were not happy with the arrangement. Building the pipeline would not only make Turkmenistan self-reliant but would also lead to a decrease in their energy share. Apart from the Trans-Caspian Gas Pipeline, there were three other major gas systems which had already created a whole lot of waves in the Central Asian markets. They were considered not only economically progressive but also geographically and strategically well located in the area. This included the Blue Stream Pipeline, Shah Deniz Field, and the Iran–Turkey Pipeline. These pipelines were mainly built to fulfil the energy needs of Turkey with the assistance of Russia, Iran, and Azerbaijan and with some help from the United Kingdom.

The economics of the Trans-Caspian Gas Pipeline is quite contentious, as it involves several major energy-

centric countries. Experts feel that the construction, design, and maintenance of the pipeline mean a heavy shedding of its pockets by Turkmenistan. It is not only unaffordable but also impractical. The overall route of the pipeline is therefore financially very steep. On the other hand, the potential buyer of this gas would be solely Turkey as the rest of Central Asia receives its supplies from different established sources. Right from the beginning, Russia was strictly against the construction of this pipeline. Its reason was purely political as it threatened its economic hegemony over Central Asia. The existence and progress of other pipelines also endangered the creation of the Trans-Caspian Gas Pipeline. For instance, Azerbaijan was busy with providing gas to the Shah Deniz Field instead of working out the economics for the Trans-Caspian Gas Pipeline. Another obstacle facing Turkmenistan was the political and economic decisions taken by their then-President, Saparmurat Niyazov. He was more interested in selling oil and gas to Russia and Ukraine instead of investing in the pool of the Trans-Caspian Gas Pipeline. Many experts also felt that the rules and regulations of the pipeline were bizarre and unnecessary. There was a registration fee of $500 million, which the countries termed as nothing but unreasonable and irrational. Apart from that, there were certain economic issues between Turkmenistan and Azerbaijan which were never resolved, leading to further tension in the region and also stomping the Trans-Caspian Gas Pipeline project. These are certainly some issues that have gripped the Central Asian countries for a long period of time.

The Road Ahead

With fingers being pointed at the Trans-Caspian Gas Pipeline, it is time that Turkmenistan leadership began to chart out its way as far as energy exports are concerned. Though the pipeline has been criticized severely, it also holds certain advantages for the region. The country needs to realize that this pipeline can bring in millions worth of capital, if exploited and utilized intelligently. The potential

gas reserve for the Trans-Caspian Gas Pipeline was supposed to be derived from Shatlyk and Dowlatabad, located in eastern Turkmenistan which never materialized. If one studies the history and origin of this gas pipeline then it is evident that simply possessing enormous fields of gas reserves is not enough. One also needs to devise an amiable strategy to procure, exploit, produce, and serve this natural commodity to its customers, of course profitably. To begin with, the country has to attract some solid Foreign Direct Investment (FDI) in order to get its markets going. It also needs to lay down some strict regulatory and legal frameworks with the help of rule of law so as to counter attack the challenges of globalization.

Experts feel that the Trans-Caspian Gas Pipeline would not only be beneficial for Turkmenistan but also for other partner countries including Azerbaijan, Turkey, and Georgia. With a joint effort of these nations, it has been said that the actual cost of the natural gas would also come down leading to an equitable demand and supply graph. Even though Turkey was supposed to be the only buyer, experts have made it clear that Turkmenistan stands to profit substantially. The Trans-Caspian Gas Pipeline is definitely a practical and sustainable option to develop and maintain. The government must welcome private companies in its economic orbit to earn good returns on gas exports. This also means that Turkmenistan needs to tie-up with international petroleum companies to produce and transport gas, and as a result, create a transparent oil/gas sector. Even the United States of America and Europe find it hard to stay away from the gas game of the Trans-Caspian Pipeline. For instance, EU Energy Commissioner, Gunther Oettinger, has recently said that this pipeline is crucial for the development of the Southern Gas Corridor as it will reduce the dependence of European countries on Russian energy, also diversifying the energy market. The Southern Gas Corridor is aimed at linking the EU gas markets with the vast reserves of gas in the Caspian Sea.

Needless to say, there are various opinions about the Trans-Caspian Gas Pipeline project. However, the judicious usage of this gas pipeline as an alternate source of energy is something that the Turkmenistan needs to think deeply about. It goes without saying that with growing depletion of natural resources, conservation of energy has certainly becoming an essential issue. With a fading and decreasing economic structure, Turkmenistan has a long way to go before it establishes its hold on the oil/gas markets in the region. ■

The author is a research student and freelance writer based in New Delhi

BIOMASS POWER IN PUNJAB

The New Green Revolution?

As one of India's most famous states with a substantial agriculturally-inclined population, and with some of the most fertile land in the country, the state of Punjab is an ideal candidate for projects in bioenergy. With power shortages now rampant in the state, and with state and national governments unable to quickly bridge the gap between demand and supply for power, it is up to the private sector to respond to the challenge, and projects are underway to harness the potential for biomass power in Punjab. Energy Future's *Harish Alagappa* looks at a project in Ghanaur, outside Patiala, where Punjab Biomass Power Limited – a joint venture between the Bermaco Group and ILFS – is attempting to use the waste products left over from agricultural processes to fill the gap between demand and supply for electrical power.

Trouble in the 'Pind'

Deep in the heart of Punjab, on the outskirts of Patiala, is a landscape that was shaped and changed over fifty years ago by the pioneering efforts of Dr Norman Borlaug and the green revolution. While the practices of the corporations that have succeeded him are questionable, the success of the groundbreaking practices begun here by Dr Borlaug in the 1950s and 60s is responsible for India averting widespread famines that could have seen death tolls unlike anything witnessed before or since. Punjab is now India's grain basket, famously fed by five rivers with fertile land that has been mythologized in song as being covered in gold and sprouting pearls and diamonds. However, in the decades since the green revolution, there have been a new host of problems. Irrigation has helped make land more fertile, but water pumps need energy to run. Improved farming techniques have increased harvests, but modern farming techniques need modern equipment such as tractors, which need energy in the form of fuel and electricity. With the progress that many farmers and their families have seen throughout Punjab, there are now

houses that need power to run lights, fans, and in increasing numbers, air conditioners. At every stage from the planting of the seed to the harvesting of the crop to afterwards, processes are becoming more modern, which is a good thing as it would maximize the yield of every farm, but conversely require substantial energy investments. Mills need large quantities of electricity to run, and trucks need fuel to transport crops across the land. In a very strong sense then, the next major problem being faced in Punjab is that of energy. The struggle between food, water, and energy security, a recurring theme that is to shape the future of the world, is already dictating terms in Punjab.

Governments at both the national and the state level have been trying to take action on this topic, but there has been little concrete progress on bridging the ever-widening gap between power production and demand in the state. The coast, however, is clear for private players to try their hand at supplying cheap, plentiful, and most importantly, clean energy to the denizens of Punjab. There is no shortage of companies trying to invest in power, but the key question on everyone's lips is what kind of power? Coal, which powers most of India, is not a sustainable option any longer, either economically or environmentally, and with the technology behind harnessing sources such as solar and wind and other renewables not yet fully perfected, there is the need for an energy source that combines the advantages of conventional fuel sources such as coal, natural gas, or nuclear power; and renewables such as solar and wind. One proposed solution was damming rivers to produce hydroelectric power. However, damming a river would make the lands downstream that depend on


Photo: Harish Alagappa

the waters of the river for nourishment and for irrigating their fields to go dry, which would harm not only the farmers and their livelihoods, but would also have serious repercussions on the food security of the nation.

Answers do not grow out of the ground. Or do they?

Amidst a picturesque landscape of blue skies and fields of various hues of yellow and green, there is another green revolution at work. The question of providing energy to Punjab, and possibly the rest of Northern India, is dependent on finding an energy mix which has the benefits of conventional fossil fuel sources such as coal, oil, and natural gas, viz. dependability, reliable power output irrespective of outside conditions (overcast, no wind, night), easy storage, and variability in power supply; while also incorporating the advantages of renewable energy sources such as solar and wind in the sense of being clean sources of energy with minimal to no carbon emissions and an insubstantial impact on the environment in the sense of being renewable sources of energy, so that we do not end up in a situation similar to one we are in now where we are looking at exhausting global reserves of fossil fuels sometime in the next century. Finding such an energy source would normally be an extremely difficult task and would involve an exhausting search through whatever resources were abundant in that region to see how they can be used to build an energy economy. In Punjab, however, the answer stares you right in the face from the moment you leave Chandigarh and begin to look out into the seemingly never-ending expanse of farmland that stretches to the horizon. Punjab is known for producing much of the food that is eaten in places such as Delhi. However, agriculture is not a 100 per cent efficient process and not all parts of the crop are used. In fact, almost all agricultural processes produce large amounts of waste; this agricultural waste has no little to use, instead it occupies an unnecessarily large amount of space on farmlands and consequently is disposed of by farmers, usually by burning. India produced 98 million tonnes of paddy, 130 million tonnes of straw, and 30 million tonnes of cane trash, and while some of this waste was used

as fodder for farm animals, most of it was just burnt. It has been estimated that these agricultural wastes, if they were to be collected and judiciously used for power generation, would be capable of producing over 50,000MW of electricity.

The advantages of Bioenergy, especially in a place like Punjab, are numerous. The average farmer in Punjab works on a farm that is roughly five acres in area. This five-acre plot produces around 8 tonnes of paddy straw every year. When sold to a local power company (and I use the phrase local power company for a very specific reason), this otherwise useless waste can become a source of extra income for the farmer. Biomass power projects tend to be rather small, they usually generate between 10 to 25 MW of power. Thus, with the advancement of biomass power across Punjab and Northern India, we would see a series of biomass power plants scattered across the nation's rural farmland providing electricity to their local farmers from whom they would source their feedstock. This process of *quid pro quo* energy generation is an easily replicable model that can be adapted across the nation and would see greater efficiency in the grid as small power plants providing electricity to local consumers are usually not constrained by the kind of transmission and distribution losses that very large-scale electricity grids fed by massive coal-fired power plants are used to.

Ghanaur

Just outside Patiala, in the village of Ghanaur, is a glimpse of Punjab's and indeed India's clean and green energy future. The 12MW biomass power plant run by Punjab Biomass Power Limited does not dominate the landscape as much as it melts quietly into it, surrounded as it is by farmland, trees, and a canal that diverts water from the Bhakra River into the fields and farms of Ghanaur. Agriculture is India's backbone, it occupies over half the labour force and contributes a sixth of our GDP. India has the second highest agricultural output in the world. The power plant at Ghanaur is the first in a proposed series of biomass power plants across Punjab and the rest of North India that aims to leverage India's agricultural strength to provide the energy needed to take the nation into the twenty-first century. The plant produces power from paddy straw and not paddy husk, which is a common misconception. Paddy husk is already used widely as an expensive commercial fuel, but paddy straw is seen by farmers as a large agglomeration of waste that needs to be eliminated in the 6–8 weeks between the harvesting of the year's Kharif crop (where it is produced) and the sowing of the Rabi crop. The power plant in Ghanaur needs around 120,000 tonnes of paddy straw a year (or, roughly 350 tonnes a day); most of

Photo: Harish Alagappa

this paddy straw is stored in a series of warehouses distributed around the plant in the local community.

Punjab Biomass Power Limited is a joint venture between Bermaco Energy Systems and the Infrastructure Leasing and Finance Service Limited (ILFS). The plant in Ghanaur is the first glimpse into what could possibly be the future landscape of Northern India. The Bermaco Energy –ILFS consortium intends to open nine similar projects in Punjab, and six more in Haryana. In the next three years, Bermaco Energy expects to open close to twenty such biomass power plants, which would generate close to 240W of clean, green bioenergy across Punjab, Haryana, and other North Indian states. By 2019, Bermaco expects to set up about 1,000MW across nearly a hundred districts in India. The addition of this alternative fuel source into the nation's energy mix would involve utilizing a natural resource that is produced every year to generate electricity for people who are most commonly overlooked by the large-scale thermal or hydroelectric power projects. It is an example of the Indian farmer taking his energy future into his or her own hands.

Punjab Biomass Power Limited's plant in Ghanaur, Punjab is a large step in the right direction for India's fledgling bioenergy industry, and with Bermaco's expansion plans, the energy future of India's breadbasket looks very bright indeed. India's economic success story in the last two decades has seen many members of the urban elite migrate to an almost developed-world standard of living, but in rural India, little changed. The green revolution, which had saved farmers from starving, and as a consequence, saved the rest of the nation from famine, had been the last time Indian farmers had been so empowered. What Bermaco and Punjab Biomass Power Limited are attempting here is to foment a second green revolution; while the previous one had focussed on food security, this one is focussing on energy security. The beneficiaries of this next green revolution are the very people who will be providing — figuratively and literally — the fuel for the fire. ■

Photo: Harish Alagappa

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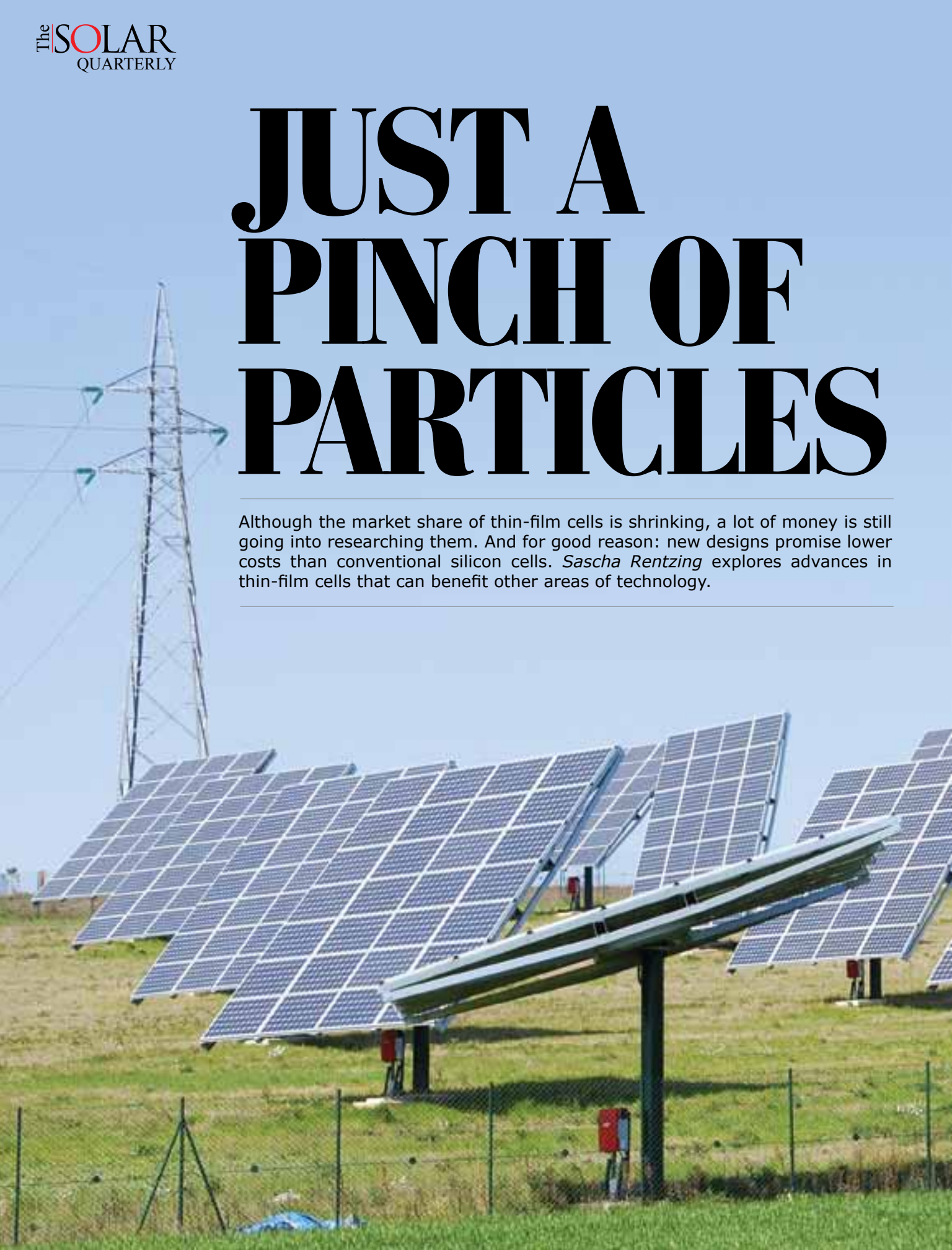
The SOLAR QUARTERLY

JUST A PINCH OF PARTICLES

Although the market share of thin-film cells is shrinking, a lot of money is still going into researching them. And for good reason: new designs promise lower costs than conventional silicon cells. *Sascha Rentzing* explores advances in thin-film cells that can benefit other areas of technology.



How far does a kilo of copper go when it comes to building a power plant? It is just enough for half an absorber plate in a solar thermal collector, or for a short length of cable in a wind turbine. A single offshore wind turbine currently uses about 30 tonnes of copper for its generator and cables.

By contrast, thin-film photovoltaics (PV) make do with much less material. ''A kilogram of copper, indium and gallium is enough to coat around 50 square meters and produce approximately six kilowatts (kW) of solar capacity," explains Christoph Adelhelm, project manager of Austrian materials supplier Plansee. In other words, a bar of metal the size of a packet of cigarettes can make enough PV cells to cover the roof of a large house.

The high yield is possible thanks to a special coating procedure known as sputter deposition. This involves using gas to blast particles out of the metal block and onto a substrate - glass or foil - where they form a wafer-thin layer. In industrially produced CIS cells (the initials stand for semiconducting compounds of copper, indium, gallium and selenium), this film, which is no thicker than two micrometres (µm), converts on average ten to twelve percent of the sun's energy into electricity.

It is the ability of just a few atomic layers of absorber material to effectively produce clean energy that has kept solar researchers and companies interested in thin-film technology since the early 1970s. But they don't confine themselves to CIS. US manufacturer First Solar, for instance, recently began enjoying great success with 'cadmium telluride (CdTe). Other producers use amorphous silicon on its own to deposit a thin film on a substrate, or they opt for micromorph technology by using both microcrystalline and amorphous silicon. There are also various coating methods, the most widespread after sputter deposition being thermal evaporation. This involves using electricity to heat the source material until it evaporates into a cloud that then condenses and forms a film on the substrate. Like sputter deposition, evaporation takes place in a protective vacuum to stop the semiconductor becoming contaminated.

Simpler than silicon

But regardless of the absorber and process used, the end result is always the same: photo active layers thinner than a human hair. "Thin-film technology is exciting because it needs very little material and it's cheap to produce. The panels are also flexible and lightweight, which means they're easy to transport and can be fitted anywhere," says Klaus Lips, a solar researcher at the Helmholtz Zenrrum Berlin. Another incentive for thin-film scientists to keep exploring is that the results of their research - new materials or improved coating processes - can also be used in other fields, such as electronics and optics.

Thin films protect and refine surfaces, they insulate products against heat and cold, they conduct and regulate electricity, and they help store energy and information.

Silicon cells, the market-leading PV technology, seem almost out-dated next to their thin-film cousins. They might well be the more efficient option - modern silicon cells convert 15 to 17 percent of the sun's energy into electricity - but at some 180 µm, they are almost a hundred times thicker. That means it takes significantly more material to produce them. "Silicon wafers are sawn from polycrystalline or monocrystalline blocks. This puts a limit on how thin we can make the wafers," explains Lips. Producing the blocks is also a laborious process. A monocrystalline bar, or ingot, is drawn out of slowly crystallising molten silicon. For an average diameter of 15 to 20 centimetres and a weight of up to 60 kilograms, the process takes around 36 hours. By comparison, sputtering copper, gallium and indium and then annealing the film in a selenium atmosphere takes mere minutes.

The only thing now standing between the technology and a decisive breakthrough is its efficiency. Excellent results have already been achieved in the lab, mainly due to the pioneering work done by US researchers. New York electronics company RCA designed the first amorphous silicon cell in 1975. Just eight years later, it achieved six-percent efficiency. United Solar then picked up the technology and increased its efficiency to 16.3 percent using triple-junction amorphous cells. The two other types of thinfilm were the preserve of the National Renewable Energy Laboratory (NREL), which spent years improving the efficiency of CdTe cells, taking them up to 16.7 percent - a record that CdTe market leader First Solar broke in August last year, when it announced that its cells had reached 17.3-percent efficiency. Meanwhile, NREL raised the efficiency of CIS cells in laboratory conditions from 12 to 19.9 percent over the course of a decade. In 2010, the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) went one better with a CIS cell boasting 20.3-percent efficiency.

But even though they are so close to their goal, thin-film companies seem to be running out of steam in the race to increase efficiency. Figures from GTM Research in Boston show that, instead of taking town and country by storm, the thin-film sector has seen its market share fall by half, to just ten percent since 2009. This is primarily due to a massive drop in the price of silicon panels. Overzealous Chinese manufacturers built too many factories on too grand a scale. To keep the lines running, they are now selling some of their products below cost. Sologico, a Berlin-based market research company, says that over the past 18 months this has cut the average price of Chinese silicon panels by half - to €0.66 per watt. Thin-film thus saw its competitive advantage (lower production costs thanks to minimal materials) melt away in next to no time. According to Sologico, all three varieties of thin-film are only marginally cheaper at around €0.60 per watt. At almost identical prices, it is not surprising that investors go for the more efficient option of silicon.

Moving from micro to nano

Nonetheless, researchers' faith in thinfilm remains unshaken. "We believe that thin-film will make a comeback - unlike crystalline technology, it still has plenty of scope for improvement", says Helmholtz researcher Lips. Experts in the German government clearly agree. They are continuing to provide thin-film with generous funding through the Photovoltaics Innovation Alliance. Despite its lower market share, thin-film is the focus of one third of the Alliance's projects. For instance, the CIGSfab project receives €6.5 million, enabling plant manufacturer Manz to develop turnkey production lines.

The EU is also pumping money into thin-film research. It recently approved €10 million for the Scalenano project, which brings together 13 European research groups and will run until 2015. The project's ambitious goal is to produce entirely new cells. To reduce costs quickly, researchers want to develop alternative, vacuum-free processes which will involve printing nanoparticles in a manner similar to ink. Printing is cheaper than sputtering or evaporating, as it can be done faster, has a higher throughput and uses less energy. The cooperative also wants to test a new kind of absorber: kesterites. Like the chalcopyrites used in CIS cells, kesterites belong to the mineral

class of sulphides and sulfosalts, and therefore share some of the same properties; however, rather than the rare and expensive indium, they are made from the cheaper materials zinc and tin.

One of the key players involved in researching the new cells is EMPA (Swiss Federal Laboratories for Materials Science and Technology). Its task is to develop innovative kesterite absorbers from copper zinc tin sulphide (CZTS) and more effective transparent conductive oxides (TCO) for use as electrical front contacts in thinfilm cells."In five to ten years we hope to be using nanostructured source materials to make kesterite cells that have 15 to 20 percent efficiency and are cheaper than silicon cells," says EMPA solar researcher Yaroslav Romanyuk. US firm IBM's latest success is encouraging. In June, the company used a roll-to-roll coating plant to produce the first kesterite cell with 9.6-percent efficiency. EMPA wants to make the results of its research available to other fields, such as batteries or intelligent windows. Romanyuk explains that window panes could use TCO nanoparticles to reflect infrared heat in the summer and absorb it in the winter.

The Helmholtz-Zentrum Berlin is also involved in the, search for the thinfilm cell of the future. As part of the Scalenano project, it is developing new analytical methods for characterising cells during production.

> "In five to ten years we hope to be using nanostructured source materials to make kesterite cells that have 15 to 20 percent efficiency and are cheaper than silicon cells."
>
> ***Yaroslav Romanyuk, EMPA***

The researchers plan to use the results to improve absorber quality and to increase yield and throughput. They will be able to analyse the layers accurately thanks to the new X-ray beamline Emil (Energy Materials In-situ Laboratory, Berlin), which will be connected to the particle accelerator Bessy II in 2013. Lips says that Emil, which is worth €19 million, will allow researchers to watch the layers as they grow and see exactly what processes are unfolding on their surface.

The Helmholtz-Zentrum also wants to use the new X-ray technology to develop catalytically active coatings. Catalysis triggers or speeds up chemical reactions due to the presence of particular materials catalysts - which are not consumed during the reaction process. Catalysts could help produce multifunctional thin-film cells that can convert electricity directly into storable hydrogen at their surface. The hydrogen can then be stored in the natural gas grid or used to power fuel cell vehicles. Perhaps the glory days of thin film technology are yet to come. ■

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High hopes for kesterite

A combination of zinc and tin could replace the expensive indium and gallium in thin-film solar cells.

The main way of reducing costs in thin-film photovoltaics is to use less material. Prime candidates for this are CIS cells, the most efficient form of thin-film technology. One approach is to replace the CIS absorber, which contains indium, with a cheaper kesterite absorber (CZTS) made from zinc and tin, and to apply as thin a layer as possible. Researchers also want to dispense with the buffer layer (which contains cadmium) between the semiconductor and the cathode. They want to replace it with a zinc oxide window which allows light to pass through it while efficiently collecting the charge carriers. The long-term plan is for this layer and the kesterite absorber to be printed like ink, in the form of tiny particles. If this can be done, thin-film will move from being a micro-technology to a nanotechnology. While current CIS absorbers are 0.002 mm 12 µm thick, the printing procedure would push the two back by as many as three decimal places.

Source: Helmholtz-Zentrum, own diagram

A Financial Perspective to Success of Solar Energy in India

Solar Energy has taken centre stage across the world as a viable alternative energy source, for power utilities at least. At the end of 2012, Germany led the world in terms of installed solar capacity, with 32.5 GW, followed by Italy, China, and the USA. China had an installed solar capacity of 3 GW in 2011, which increased to 8 GW in 2012. In India, to meet the challenges of supply constraint from fossil fuels and environmental degradation, solar as an alternate source of energy is gaining importance by way of government support through launch of Jawaharlal Nehru National Solar Mission (JNNSM) scheme in January 2010. *Dharmendra Makwani* and *Dr Chetan Singh* Solanki investigate.

Jawaharlal Nehru National Solar Mission (JNNSM)

The JNNSM is regulated by the Ministry of New and Renewable Energy (MNRE). The objective of this scheme is to promote gird connected as well as off-grid applications of solar energy. The scheme has brightened the days of solar industry in India;installed capacity of solar PV has gone up from 22MW in 2009 to over 1.1 GW in 2012. Rajasthan and Gujarat contribute 86 per cent of the installed capacity in India. The projects under the Gujarat solar policy and the National Solar Mission (NSM) accounted for 80 per cent of India's installed solar capacity until October 2012. A liberalized policy for the power sector and incentives from both central and state governments presents a good opportunity for the solar industry. The JNNSM scheme through NABARD is providing Capital Subsidy and Refinance Scheme to commercial banks and RRBs for promoting solar off-grid and decentralised solar applications.The banks can be financed by NABARD for the loan disbursed to the borrowers (solar companies).The two important financial component of this scheme are:

- Capital Subsidy: Capital Subsidy up to 30 per cent of benchmark cost indicated by MNRE on various solar applications is provided to companies registered with MNRE for the facilities.
- Interest Subsidy: Maximum loan up to 50 per cent of actual cost can be availed at subsidised interest rate of 5 per cent for tenure not exciding 5 years. No interest will, be charged on capital subsidy availed.

Finance Mix

Finance for a business entity can be in the form of either debt or equity. Debt is always a burden and liability for the entity while equity increases the value of the company. Debt is an obligation for providing fixed return committed to the investors. On the other hand, Equity does not impose any obligations on the issuer/company.

Debt

A. Commercial Banks

Commercial banks include banks from both the public and private sector. The JNNSM through NABARD and commercial banks provide capital and interest subsidies to the solar power industry. Banks have been wary to increase exposure in these industries due to increase in Non-Performing Assets (NPA). The total NPA as of now stands at 3.2 per cent. In first half of 2013, the NPA's of all commercial banks has gone up by 86 per cent. Banks' exposure to the power sector is at 7.2 per cent (i.e. ` 344,980 crores) of their total loan assets, 11 per cent of these loans have been restructured in FY'12. Credit growth to the power sector has dipped from 42 per cent in 2011 to 13.65 per cent in 2012. The culprit for slowdown in both credit and the growth of the industry has been higher interest rates in India. On average, commercial interest rates have been around 14 per cent. The banks have a ceiling on credit up to 40 per cent of the capital infused by the company. The banks provide credit:

- Term Loans: This is for the long-term loans, beyond one year and even 30 years. This is a bilateral loan, where one borrower and one lender are involved. This is to meet the fixed capital requirements of the companies. This interest rate on term loan is sensitive to the repurchase rate (repo rate) of the RBI, which is at 7.75 per cent. However, commercial banks rates vary from 11 per cent to 14.5 per cent depending on the rating and sector specificities of these banks.
- Working Capital Loans: This is required to meet daily needs of the company. Interest rates are lower than term loan rates and may vary based on money market rates. There are various instruments of which the most popular are Commercial Paper (CP), Bill of Exchange, and Letter of Credit (L/C); the CP maturing in a year of a company with the highest credit rating will have the same yield of 1 year (365 days) Treasury Bills or Government Securities.
- Syndicated Loans: In this more than one bank is involved in lending to a borrower. It is also called as consortium lending, where a group of banks come together to finance the lender. These deals involve large amounts and long tenures, and can be in either domestic or foreign currency. When, in foreign currency then the loan is benchmarked at LIBOR (London Inter-Bank Offer Rate) + commission. Current LIBOR rates, depending on maturity of the loan, range from 0.5 per cent to 3 per cent for periods from 1 to 30 years, while the commission, can range from 3 per cent to 6 per cent.
- Debentures/Bonds: These are debt instruments to meet long-term credit requirements of buyers. They are tradable on the exchanges and hence are liquid. It is less risky than equities as it gives a fixed coupon to the investor. The value is based on yield, which is a combination of the price, coupon, and maturity of the instrument. Yield is inversely proportional to the price. Higher yields are attractive to buy as the price is lower and vice versa when yields are lower. The yields movement are benchmarked against sovereign papers like GSecs.

Highest rated papers are at par with sovereign papers and lower rated papers have higher yields compared to GSecs. The difference in yields is called spreads.

B. Financial Institutions

Apart from commercial banks, major financial institutions such as NABARD, SIDBI, EXIM Bank and IIFCL are critical to the corporate lending system.

- NABARD has been appointed by the MNRE to provide refinance facilities to commercial banks for lending to solar companies under JNNSM scheme. It is thus, a facilitator in fulfilling the objective of MNRE in promoting off-grid applications of solar energy.
- SIDBI (Small Industries Development Bank of India) has been set up with the objective to support the MSME (Micro, Small, and Medium Enterprise) sectors to meet their borrowing needs. They have launched Energy Saving Scheme to promote solar applications at competitive interest rates ranging from 9.5 per cent to11 per cent. They also encourage new entrepreneurs in the industry.
- EXIM Bank of India has been to support credit facility in international trade with various products. It also provides export/ import services to gauge the knowhow of overseas markets in order to meet cross border competitive challenges.
- IIFCL (India Infrastructure Finance Company Ltd.) is the new crown in the FIs space, and aims to promote infrastructure in the country. This institution has helped alleviate bottlenecks in disbursing loans to companies. ADB (Asian Development Bank) had been supporting 50 per cent of its exposure risk. IIFCL is one of the major lenders to solar power industry to the tune of ₹570 crore. The recently, sanctioned $200 million by ADB will be available to solar companies at LIBOR + 300 bps. The Credit Enhancement scheme of the institutions encourages new entrepreneurs in the solar industry at easy and faster credit to meet the national objective set by NSM.

C. Foreign Institutions

- World Bank's exposure to power sector in India is at $3.4 billion since 2007. Solar PV and thermal accounted for 12 per cent of the total disbursement. World Bank has decided to increase their exposure in India's solar energy sector in India by $ 2 billion over next three years.
- IFC (International Finance Corporation), a body of World Bank, it has been supporting the solar industry and has investments worth $3.8 billion spread over 264 companies.
- Exim banks worldwide have been financing Indian companies. Exim Bank USA has exposure to the tune of $ 7 billion in India. Mahindra Surya Prakash and Solar Filed Energy Two have taken loans of about $23 and $34 million respectively. In the last two years, US Exim bank has disbursed about $330 million to the solar industry in India.
- ADB has taken 50 per cent exposure risk of IIFCL and provisioned credit of $ 200 million to solar industry at LIBOR+ rates to reduce cost of solar applications.

Equity

A Domestic capital market

Capital markets consist of both debt and equity instruments traded on the bourses. Equity capital has no fixed obligations and absorbs financial risks. The cost of raising capital is high in equities. It dilutes management control and risk of overtaking the management, if the company is new and with a small capital base.

B. Foreign capital markets

These are equity instruments issued by a company in another country to a depository in another country. The depository then issues shares to the investors and dividends received by investors are in US Dollar. If depository receipt is traded in the USA, it is called American Depository Receipts (ADR), and if it is traded in countries other than the USA, it is called Global Depository Receipts (GDR).

C. Strategic Investments

A hundred percent Foreign Direct Investment (FDI) in the power sector is allowed. FDI has grown at 6.4 per cent year-on-year, coming in at $31.54billion (₹1,70,237 crore) for 2011. Power MNCs that entered India through direct investments or through JVs include British Petroleum, Webel Energy, Wartsila, Sun Edison, Areva, SunTech, Siemens, and First Solar.

D. Foreign institutions and Private Equity (PE)

IFC has various strategic investments in private power companies by taking direct stake. PE investors are jittery of investing in India due to lower IRR (Internal Rate of Return). The rationale of receding PE investments has been higher interest rates, land acquisition hurdles, and longer gestation periods. ■

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"OUR THINKING IN THE RSPO IS HOW DO WE TRANSFORM MARKETS WITHOUT HARMING THE PEOPLE AND THE PLANET, AND STILL GENERATE PROFITS"

Darrel Webber joined the Roundtable on Sustainable Palm Oil (RSPO) as Secretary-General in January 2011. He has previously held positions with the World Wildlife Fund (WWF), Shell Malaysia, Permanis Sandilands, and Global Sustainability Associates. Prior to his appointment as Secretary-General, Mr. Webber was an Executive Board Member with the RSPO, representing stakeholders in the Environmental NGOs sector through his position with the WWF. Darrel Webber delivered the keynote address in the thematic track on Global Trends in the Sustainable Procurement and Production of Edible Oils at the Delhi Sustainable Development Summit (DSDS) 2013, where he was in conversation with Energy Future's *Harish Alagappa*.

If I can begin with your work for the RSPO, my understanding is that you represent a wide variety of stakeholders in the palm oil sector. Could you please give us an understanding of the kind of stakeholders you represent, their concerns, and the kind of work the RSPO is doing in sustainable development.

We at the RSPO cover the full length of the supply chain; this includes producers, buyers, retailers, manufacturers, processors, and traders. In addition, we also represent the financiers, banks, and investment organizations. Finally, we have the environment, represented by environmental NGOs and the social sector, represented by the social and development NGOs. In total, that's seven stakeholders. What worries them? To understand what worries them, we have to see where oil palm is grown. Oil palm is grown between

latitudes that are 10° north and 10° south of the equator. It is a tiny strip of the planet, a belt around the planet and within that strip, you'll see countries with the highest biodiversity in the world. Within this belt, you will see only developing countries or under-developed countries – with the exception of Singapore. Think about it, if you are to develop anything – mining or agriculture, any natural resource intensive industry – you are potentially going to come into conflict with environmental issues. As it is a poor or developing country, you are probably going to get into conflict with social and development issues as well. So these are the big concerns for all the stakeholders. The producers are worried about the NGOs and the NGOs are worried about the biodiversity loss or water quality issues, etc. The social NGOs are worried about land degradation and marginalizing of the local communities; remember when a large company buys, say of 10,000 hectares, it comes within an area of sparse population. But to manage 10,000 hectares, you will need a workforce of around 2,000 locals; we go and get the 2,000 locals from outside, and that marginalizes the local people. Consumers want to know what the products they buy and use contain. The buyers and traders are worried that consumer goods, famous brands like Unilever, Dove and Kit Kat, which have palm oil in them are being attacked. If a product has palm oil in it, it has come to mean killing of the Orangutan, destroying environment and biodiversity, and marginalizing local communities – therefore they are advised to avoid using such brands. Manufacturers and processors worry about traders and retailers who worry about consumers. So our stakeholders have a shared worry, which gives them a shared vision, which is transform problems into opportunities. Our thinking in the RSPO is how do we transform markets without harming the people and the planet, and still generate profits. That's the triple bottom-line we are looking for.

You touched upon the concerns that people have about palm oil when it comes to habitat destruction and biodiversity loss. What kind of work is the RSPO doing to alleviate these fears?

What we did is collaborate amongst stakeholders. These stakeholders are unlikely partners, unlikely collaborators; you rarely get businessmen negotiating at the same level and on the same table as NGOs, but that is what we did. We put everyone together on the round table to develop a standard definition of sustainable development for the commons. So we developed a standard

that specifies and that tells you how do you deal with the environment, how do you deal with people, how do you deal with profit issues. A good example from the standard is a directive that says you are not allowed to clear any primary forest or any areas of high conservation after 2012. Another important standard, I would say, is that before you develop an area, you must prove that you have free prior informed consent from the local communities who live near there. It goes beyond legal requirements; you may have all the legal requirements and permits, but you still have to prove that you have free prior informed consent from the local communities who live there, so we are asking for a social license as well.

My next question picks up from your point about how palm oil is grown largely in less developed countries. People tend have this idea that development has to occur through the existing process of industrialization like it happened in the West and this will have a negative impact on the environment; that you cannot have responsible, sustainable growth without harming the environment. How can we prove that green growth or sustainable growth is actually possible?

Well, that is why the RSPO has these seven different stakeholders as their members. When we discuss for example, important topics like RSPO standards or the commons, we give every one of our round table members, let them be corporations or NGOs, equal rights in terms of voice, in terms of inputs, and we try to develop everything based on consensus. For example if the standard is like green washing, it's so low that within seconds you can say, "This is green washing!", it will not be passed because the NGOs within the committee discussing standards will block it. And they all have veto; even if only one NGO decides to block it, nothing goes. And it works the other way round too. That is how we maintain a sense of credibility within the standards of the committee. And these NGOs that worked with our committee to formulate these standards will then go out and support the adoption of this, they will go out and say to the others, "Look these standards are fair and credible; I should know, I was there and helped develop it." It is not an easy thing to do, to come up with a guideline for sustainably developing a commodity, the RSPO was one of the first and we have inspired other commodity groups to have roundtables that discuss their sustainability issues. It is not easy, but it can be done provided you try to build consensus and ensure that there are equal rights for all stakeholders.

You speak extensively at seminars and conferences, such as DSDS 2012 and others, on the topic of Thought Leadership. How does one cultivate Thought Leadership?

Thought leadership is the output of someone's thinking process, but to have that output you must have lots of input, and you must be open to that input. The problem nowadays is that people think they do not have the time to read or to listen, and when you refuse to read or listen, you close your mind to so many opportunities. Secondly, many people avoid tough questions; you can come up with sustainable solutions if every day you asked yourself, "How can I make profits while being sustainable, while not harming the environment?" It is a tough question, but if you ask that yourself question every single day and try to come up with answers, you will have sustainable development. ■

WHY DO WE NEED RE

HOW TO APPROACH MARKETING RENEWABLES

In the over-saturated marketplace that is the modern global economy, the importance of effective marketing cannot be overstated. It is critical for corporations and start-ups alike to focus extensively on marketing their product effectively, which involves making their idea stand out from the crowd; a task that's compounded even further when one factors in that every other company is also trying to make their idea stand out from the crowd at the same time. Renewable energy (RE) is currently facing many challenges, and there are an equal number of opportunities on the horizon. As Victor Hugo famously said, "Nothing is as powerful as an idea whose time has come" and with the understanding that the world cannot and should not continue with the conventional energy economy we have been living in for the past century, renewable energy is such an idea. The problem is that most technological progress has been organic, controlled by vast socio-economic and historical trends that finally culminate in an inspired moment of invention. For example, computer technology as we know it today began with the invention of the transistor diode in 1947 which rendered large, energy-consuming vacuum tubes obsolete. Transistors were (and remain) essential for amplifying and switching electronic signals, an agglomeration of them together on an integrated circuit can be programmed to perform a variety of complex tasks, a job that had been performed earlier by vacuum tubes. As a consequence early computers, like the Electronic Numerical Integrator And Computer or ENIAC had to be stored in extremely large rooms, consumed vast quantities of electricity, and ultimately had less processing power than a modern day pocket calculator. While people were aware that vacuum tubes are an inefficient and cumbersome technology for over thirty years, the transistor could not be developed until 1947 not due to insufficient knowledge, but rather due to insufficient technological prowess. The tools we can develop are limited by the tools we use to make tools. The transistor could only be developed after it became possible for us to manufacture high-quality, precision semiconductors. And a similar problem plagues the arena of renewable energy, we have the technical know-how, what we lack are the technologies that would allows us to build the technologies needed for a cost-effective renewable energy based system. And the only way one can try and develop those technologies is by learning how to effectively and successfully market renewable energy. Once individuals, laboratories, research

institutions, and corporations are able to comprehend the future profitability and potential for limitless energy that can come about with the judicious application of renewable energy technology, it would set into motion a large amount of people working towards a goal from varied disciplines, which would ultimately generate such a massive amount of socio-economic momentum that the renewable energy sector, much like the computer industry after the 1970s, would witness extraordinary growth. Efforts are under way to try and accomplish this already, but there are drawbacks to be taken into account as well.

The two biggest opportunities in the favour of marketing renewable energy are the fact that the energy sources on which global civilization is currently dependent are depleting quickly and that RE technology has the potential to offer near limitless energy to everyone on Earth. Ironically, these are also the biggest challenges faced by the industry in effectively marketing itself. Many might think that renewable energy's cleanness, i.e. the fewer carbon emissions (and in some cases, complete lack of carbon emissions) that come about as a consequence of generating electricity from renewable energy technology such as solar power or wind power is also a potential marketing point, but that would be naïve. The key to marketing is not selling to a consumer base you already know are interested in your product, but rather it is in converting people sceptical of your product into consumers. Climate change denial is, unfortunately, a very pervasive ideology, particularly in the United States of America. Many climate change deniers are otherwise rational people who do not hold any other absurd views, as far conspiracy theories go. One of the issues with the current approach to marketing renewable energy has been the fact that it has been inexorably linked to climate change. This serves no purpose as people who are concerned about climate change do not need convincing about the necessity for investing in renewable energy. The people who do need convincing, the climate change deniers, have as a consequence migrated strongly towards conventional energy technologies, claiming that coal and oil should continue to power our energy future. However, there is an even greater consensus between scientists, administrators, and corporations on fossil fuel scarcity than there is on climate change. Companies and administrations that reject the evidence in favour of climate change are nevertheless in agreement when it comes to evidence in the favour of dwindling oil resources. In this situation, renewable energy needs to be marketed, not as clean technology per se, but rather as a long-term alternative to oil and coal. Climate change deniers cannot overlook the potential benefits of using energy from the sun to power our economy.

Nations have intimidated, invaded, fought, cajoled, and bribed other nations to gain access to oil and coal, but solar power is universal, every square inch of the planet has sunlight incident upon it. The argument that needs to be made is a very simple and rational one: the reason why we are asking you to invest in renewable energy technology is simply so that we can be in charge of our own energy future. It is a unifying message that will go down equally well among diverse groups of people as it appeals to the basic human tendency to want a secure future. The offer of limitless energy to fuel their nation's economy will supersede ideological differences and one would be able to see cooperation on a much larger scale than what is witnessed today. It is crucial, if we are to build a strong, resilient, and self-reliant economy on the foundations of renewable energy, to generate a large amount of socio-economic momentum to change the course of humanity's energy future. ■

CURRENT R&D SOLAR

Scientific production of renewable energies worldwide: An overview
Renewable and Sustainable Energy Reviews, Volume 18, February 2013, Pages 134-143
F Manzano-Agugliaro, A Alcayde, F G Montoya, A Zapata-Sierra, and C Gil

This paper reviews the scientific production of renewable energies, namely, solar, wind, biomass, hydropower and geothermal, from 1979 to 2009. The production of all the countries in the world is analysed, paying particular attention to renewable energies and research institutions. The production of scientific research for each type of energy is represented on world maps to show the degree of relationship between this research and the resources of these energies. It is observed that biomass is the most studied, both by number of publications, with 56 per cent of the publications on renewable energy, and by geographical distribution. The next in importance by number of publications is solar energy (26 per cent). The countries investigating solar energy, however, are not necessarily those with the greatest availability of this resource. Wind is the third positioned in publication (11 per cent). Wind is being investigated by countries that most have implemented this type of energy production. Hydro and geothermal energies are also investigated by countries with great abundance of this resource. It is observed that research on renewable energy is highly concentrated in a few countries (12 or 14, depending on the energy type), accounting for between 70 and 80 per cent of scientific production. The role of the USA as a leader in research in all renewable energies studies is emphasised. NASA is the leading institution for solar and wind energy, the Chinese Academy of Sciences leads in hydropower and biomass, and the U.S. Geological Survey leads in geothermal energy.

Iran's achievements in renewable energy during fourth development program in comparison with global trend
Renewable and Sustainable Energy Reviews, Volume 22, June 2013, Pages 561-570
Payam Nejat, Abdul Kasir Morsoni, Fatemeh Jomehzadeh, Hamid Behzad, Mohamad Saeed Vesali, M.Z.Abd. Majid

Since the beginning of the last century, energy affairs have always been taken into global consideration due to their effects on economies, policies, security, and the environment. Fossil fuels have been the first recourse for global energy supply needs (80 per cent of total energy consumption); nonetheless, owing to the production of greenhouse gases, they are gradually being replaced with renewable energy resources. In addition, renewable energy resources are perpetual, unlike fossil fuels, which may be exhausted in less than one century. From 2005 to 2010 (coinciding with Iran's fourth development program), renewable energy

resources enjoyed a double-digit global growth rate as a result of environmentally friendly perception and a reduction in equipment price. Some policies and strategies were globally adopted to support renewable energy resources (Feed-In-Tariff, subsidies, etc.). Iran began utilizing renewable resources from the early 1990s and set targets and policies for renewable energy resource utilization in the fourth development program. However, Iran's trend has not aligned with global trends, and it appears that its enormous fossil fuel reserves overshadow the growth of renewable energy resources in the country. In this paper, the status, achievements, and policies of Iran during the fourth development program will be discussed and compared with global trends.

An overview of renewable energy potential and utilization in Australia
Renewable and Sustainable Energy Reviews, Volume 21, May 2013, Pages 582-589
Alireza Bahadori, Chikezie Nwaoha, Sohrab Zendehboudi, and Gholamreza Zahedi

As concerns about rising fossil fuel prices, energy security, and climate change increase, renewable energy can play a key role in producing local, clean, and inexhaustible energy to supply Australia's growing demand for electricity, heat, and transportation fuel. Renewable energy is an essential part of Australia's low emissions energy mix and this energy is important to its energy security. Australia has some of the best renewable energy resources in the world. This paper will focus on the impact of these renewable energies in Australia. This study shows that Australia has the potential to secure its long-term energy future through focus and encouragement on increasing utilisation of renewable energy.

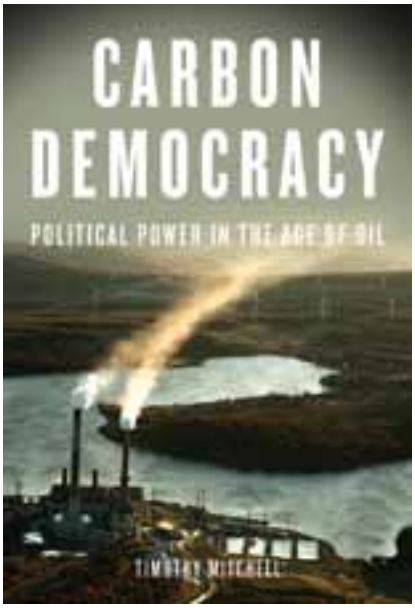
Overview of potential and utilization of renewable energy sources in Turkey
Renewable Energy, Volume 50, February 2013, Pages 456-463
E Toklu

The necessity of minimizing environmental impacts of energy use, particularly those with potentially worrisome global effects, is perhaps the greatest challenge resulting from the twentieth century's energy advances. The renewable energy technologies of wind, biofuels, solar thermal and photovoltaics are finally showing maturity and the ultimate promise of cost competitiveness. Turkey's demand for energy and electricity is increasing rapidly and heavily dependent on expensive imported fossil energy resources that place a big burden on the economy and environmental pollution is becoming an important concern in the country. With respect to global environmental issues, Turkey's carbon dioxide emissions have grown along with its energy consumption. States have played a leading role in protecting the environment by reducing emissions of greenhouse gases. In this regard, renewable energy resources appear to be the one of the most efficient and effective solutions for clean and sustainable energy development in Turkey. This study shows that there is huge potential for renewable energy in Turkey, especially hydropower, biomass, geothermal, solar and wind.

Forecasting job creation from renewable energy deployment through a value-chain approach
Renewable and Sustainable Energy Reviews, Volume 21, May 2013, Pages 262-271
E Llera, S Scarpellini, A Aranda, and I Zabalza

This paper introduces a new approach to the study of the socioeconomic impact of renewable technologies through the analysis of the reinforcing effects of the expansion of this industry and the specific characteristics of the employment along the value chain. The method proposed is based on the collection, critical analysis and presentation of the results obtained using primary information sources. The model design includes contributions extracted from a prior analysis of the existing assessment methods, to lessen the uncertainty of the job ratios often used in these types of analysis. One factor to be taken into account is the high degree of development in the sector and above all the maturity of the technology considered from the point of view of the industry fabric: the economy of scale and technological development actually influences the human resources needs, sometimes increasing the demand for professionals within the scope of R&D and sometimes reducing jobs in the manufacturing industry, which is gradually applying processes with a greater degree of automation. The influence of these experience curves is different for every single stage of the value chain. Trade balance of technologies is also crucial for local employment generation. An analytical model was developed based on the above assumptions and applied to the Spanish PV industry. This industry has been playing a leading role in the expansion of renewable energy and offers a high potential towards the short-term development of the smart grids in this country. This model represents the history of the Spanish PV industry, from the perspective of the evolution of jobs; and shows the foundation of a methodology for prospective studies in the social and economic impacts of renewables. ■

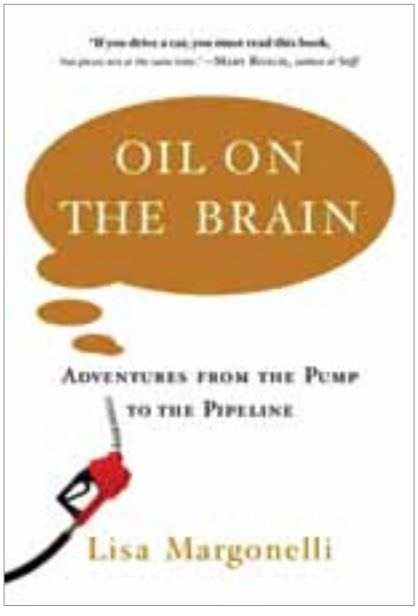
Carbon Democracy: Political Power in the Age of Oil



Dr Timothy Mitchell is a British-born author and political scientist and whose active interest in the politics of the Middle East has seen him helm the post of Professor of Politics at New York University and Professor of Middle Eastern Studies at Columbia University. His extensive studies and travels through the region offer him a unique insight, not only into the political world of the Middle East, but also into the common person's perception of the same. In this book, Dr Mitchell tries to describe the complex political relationship between the democratic west and the authoritarian regimes of the Middle East on whom the former are dependent for their primary energy source. The book describes how coal mining in the United Kingdom towards the end of the 18th and beginning of the 19th centuries during the industrial revolution led to a greater distribution in political power, which had earlier been vested in a powerful few. The creation of what the author describes as Carbon Democracies during the industrial revolution in places such as the UK, Europe, and the United States was followed by a worldwide addiction for fossil fuels amongst the most powerful economies in the world, which has only grown stronger in the last few decades. Numerous significant political and military decisions have as their epicentre, the oil-rich lands of the Middle East. As almost every modern country in the world still relies on oil and other fossil fuels for their basic energy requirements, Dr Timothy Mitchell argues in the book that political power in the world is a function of energy, and that all countries – whether they may produce, export, or import these fossil fuels – are profoundly affected by this. ■

Author: Dr Timothy Mitchell
Year: 2011
Pages: 288
Publisher: Verso

Oil on the Brain: Petroleum's Long, Strange Trip to Your Tank

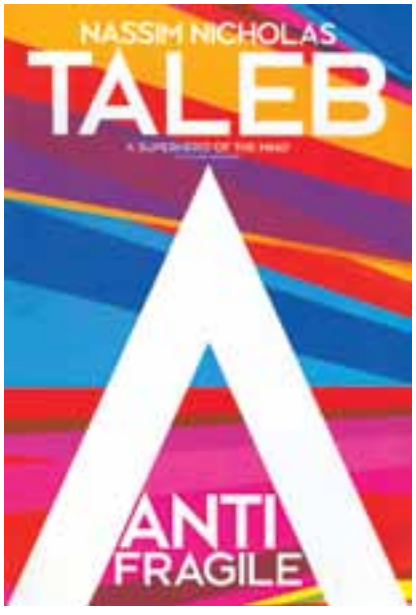


Authored by Oakland, California based writer and journalist, Lisa Margonelli, Oil on the Brain: Petroleum's Long, Strange Trip to Your Tank, is a fascinating account of the varied, highly complex inter-connected processes that are required to extract oil from more and more obscure and difficult locations in order to power society. Lisa Margonelli utilizes her vast experience writing for the San Francisco Chronicle, Wired, Business 2.0, and Discover to make the book engaging, exciting, and endearingly funny – this humorous approach separates it from the rest of the field in writing in energy. The book is a bestseller and can be regarded as a thinking person's Eat, Pray, Love, except it is a journey that leads to the discovery of significant truths about the global energy scenario rather than a journey leading to inward happiness. The book is told from the first-person point of view, with the author's personal journey punctuates the book as she travels from the United States to Venezuela to China and Chad in Africa, as well as Nigeria and Iran. The United States' dependence on oil is exposed in its entirety in this book as the consequences of such an addiction on citizens in diverse corners of the world are brought to the forefront. There is greed, stories that blur the line between funny and scary, and interviews that help one realize why Lisa Margonelli won an excellence in journalism award from the Northern California Society of Professional Journalists. In the end, Margonelli's journey ends with stark warnings about the energy security of the United States if it is to depend on countries that are not its strongest political or military allies for its oil supply. ■

Author: Lisa Margonelli
Year: 2008
Pages: 352
Publisher: Broadway

Antifragile: How To Live In A World We Don't Understand

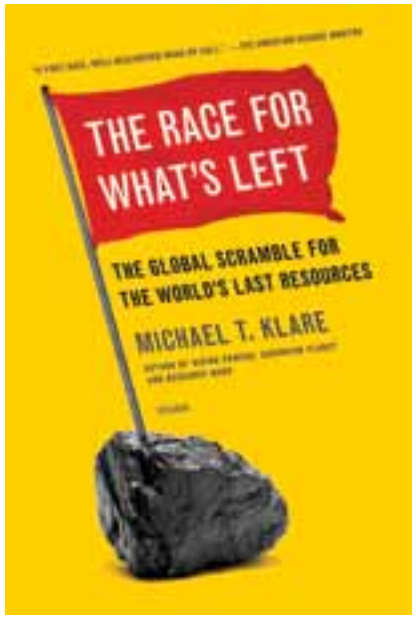
One of the world's foremost analytical thinkers, authors, and epistemologists, Nassim Nicholas Taleb's new book, Antifragile, can be perceived as a sequel to his bestselling 2007 book, The Black Swan. While Black Swan describes sudden, unexpected events that have far-reaching and profound consequences on humankind's collective epistemological approach to the world, this new book introduces ideas on how to survive and thrive in a world filled with black swans. Taleb introduces the concept of antifragility, a concept that, as the name implies, implies a construct either real or abstract that exhibits the ability to deal with shocks, stresses, and strains and emerge from the process unharmed and even stronger. Taleb remonstrates and demonstrates; he argues that as the property exhibited was hitherto nameless he coined the word antifragility, and uses the example of the human skeleton, stating, "Human bones get stronger when subjected to stress and tension". It is an idea that hits home immediately due to its simplicity and it is a concept that we are all familiar with, not from an academic exercise, but as a part of life. The book looks extensively at the nature of systems that are resilient to sudden shocks and black swans, which in the current global environment is an invaluable ability for individuals, institutions, and corporations alike. As the book jacket says, "Antifragile is a blueprint for living in a Black Swan world (…) Taleb's message is revolutionary: the antifragile, and only the antifragile, will make it". ■



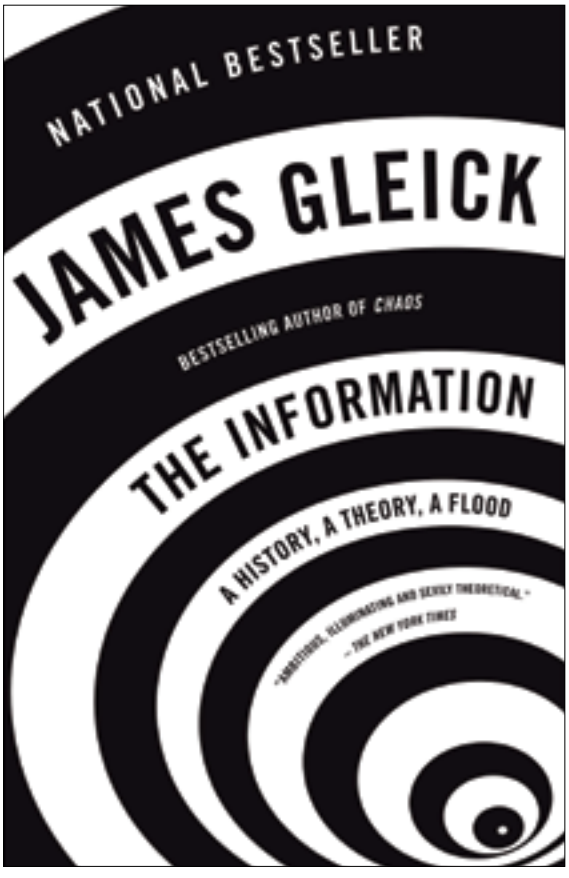
Author: Nassim Nicholas Taleb
Year: 2012
Pages: 471
Publisher: Penguin / Allen Lane

The Race for What's Left: The Global Scramble for the World's Last Resources

Resource security is an acute issue, it always has been the primary factor behind most significant events in politics and economics; but what is special and intimidating about the current resource scarcity is the sheer scale of the problem. There is a shortage in basic resources, food, water, energy, minerals, metals, at a global level and with no new resources or new regions to try and tap for resources there is, quite literally, no way out of this problem. Highlighting this issue and bringing into sharp relief the ways in which the damage can be minimized is this book, written by a veteran author of fourteen books, regular columnist, and director of the Five College Program in Peace and World Security Studies at Hampshire College, Michael T Klare. In this book, he describes in extensive detail, the issues being faced by the world. Apart from ones that have been popularized and are hence well known, such as climate change and resource scarcities, other significant problems that aren't discussed as much in the public forum such as global shortages in copper and cobalt, metals that are ubiquitous to modern civilization and finding ways to produce enough food for a population explosion that is spiralling out of control. Advocating a sensible tactic of lowered consumption along with greater efficiency in production and distribution of resources, Klare's proposed changes are a radical departure from the lifestyles that some parts of the world have become accustomed to, but are necessary to the future survival of global civilization. ■



Author: Michael T. Klare
Year: 2012
Pages: 320
Publisher: Picador



THE INFORMATION

A History, A Theory, A Flood

Author: James Gleick
Year: 2012
Pages: 544
Publisher: Vintage

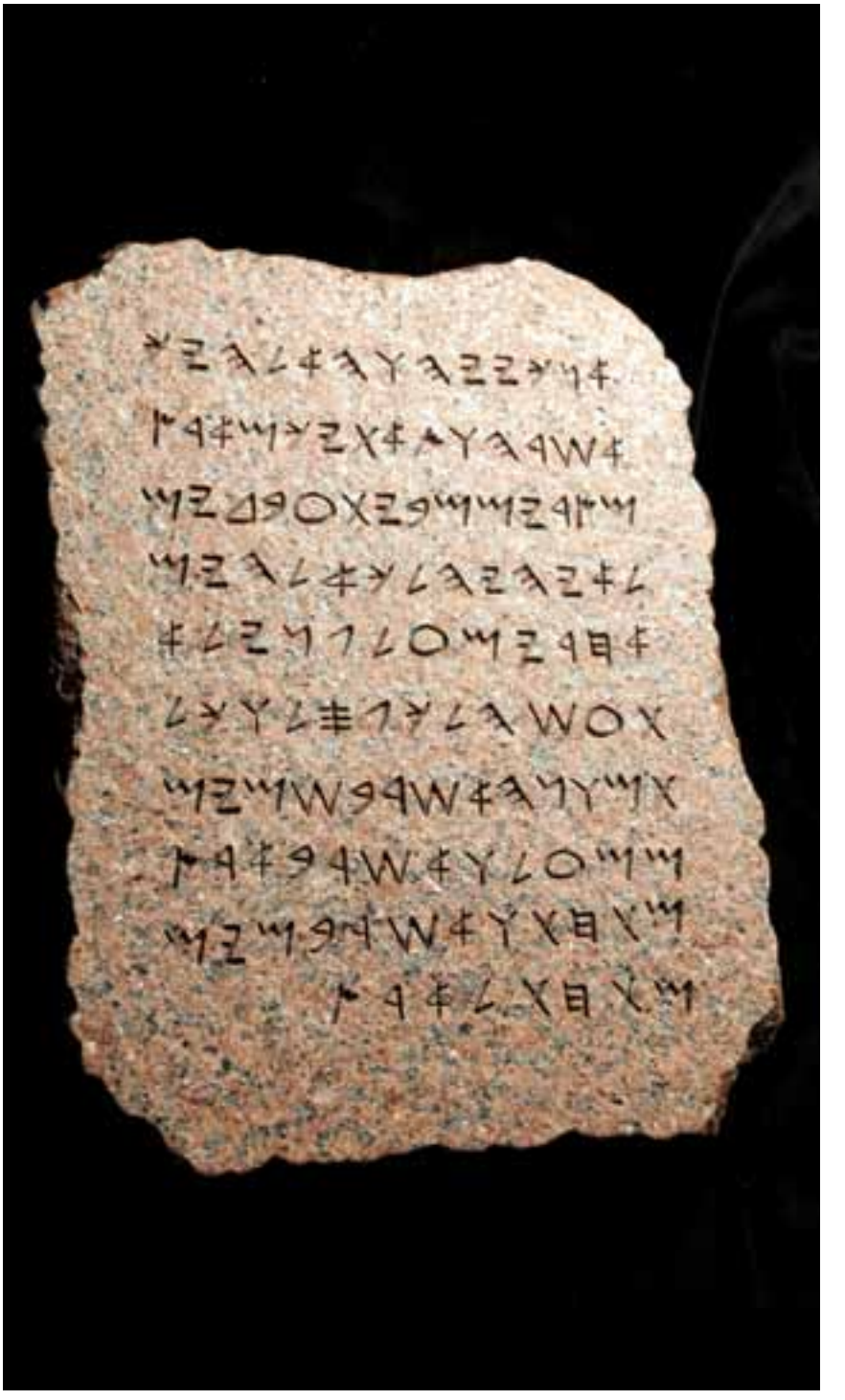
One of the foremost science writers and popularizers of the age, James Gleick's pedigree at explaining complex ideas in an understandable and engaging manner to the common person is evident from a cursory glance at his bibliography. In 1987, he authored the immensely popular and successful *Chaos: The Making of a New Science*, which brought the mathematical fringe subject of nonlinear dynamic theory (also known as Chaos Theory) into the limelight, and firmly embedded it into the popular consciousness. His other works include a comprehensively researched and well-written biography of one of the greatest minds of the 20th century, the Nobel Prize winning Physicist Richard P Feynman, and an equally in-depth biography of Sir Isaac Newton. His latest offering, however, has put his previous work in the shade in terms of the complexity of the task he undertook and the extraordinary nature of the result. *The Information: A History, A Theory, A Flood* can be explained very simply as a book that attempts to detail the history of information. Yet, as the repercussions of that deceptively simple premise start to flood in, one is left with a profound sense of foreboding, either this book is going to overload my brain with more data than I am capable of safely processing or it is going to be woefully short on anything more than the most cursory introduction to the topic. Gleick, however, knows what he is doing. The book marshals its facts into clearly organized sections and presents them to you with all the hurry of a valet asking you to consider this or that particular cocktail

As the book's title suggests, The Information is divided into three major sections that deal with the history of information, the rise of information theory, and how the world has suddenly and unexpectedly gone, within half a century, from an

era of not having a word to measure a basic unit of information (the word "bit" to measure information was coined in 1948 and was the first time someone had come up with a name to define a unit of information, even though the man who had devised the word himself was unsure of how that information should be measured) to a global society that is built around systems of easily accessing, storing, processing, and disseminating vast quantities of data on a daily basis. In lieu of discussions of information of complexity, one is treated to the breadth of Gleick's understanding of disparate fields of study. The book discusses linguistics and the role literacy has to play in fundamentally altering the way we think and view the world, as well as history and economics. Psychologists make frequent visits to explain how the human brain has changed from the repeated act of processing, understanding, and spreading all kinds of information — from messages passed through the beating of drums to writing to YouTube videos — and how that has altered and continues to alter our ideas about what it is to be human.

One of the most fascinating sections of the book detail the rise of Wikipedia, which the author analogises with the Biblical story of the tower of Babel, and describes the passionate edit wars that are fought behind the articles by common, everyday people who volunteer to write, edit, and maintain the online encyclopaedia's collection of over 4 million articles in English and 15 million articles in 270 other languages. With the sudden explosion of communications technology and subsequent flood of information during the last century, the impetus has shifted from gathering information to sifting through piles of it to find nuggets of useful knowledge. 'What good' says Gleick, 'are the precious books that cannot be found'?

James Gleick's The Information: A History, A Theory, A Flood is a highly enjoyable book that will leave you amazed and slightly out-of-breath at the span of time covered and the variety and complexity of ideas discussed. It is highly recommended for its accessible style of writing and the fascinating narrative that describes the evolution and spread of information. I believe that it is, without a doubt, one of the best and most defining nonfiction books currently available in the market. ■



RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT

Open Software Platform to Bring Down Energy Costs

Connecting energy users and producers with the control centres of grid companies and energy suppliers, is the aim of a free Java-based framework for energy management called OGEMA (Open Gateway Energy Management Alliance). The name is shared by the OGEMA 2.0 project. "Our system lets customers track future variable electricity prices and allows them to fit their consumption to the energy on offer. This ability is becoming increasingly important with the switch to renewables," says Dr David Nestle, Head of the Department of Energy Management at IWES, who describes the software platform as "basically an interface between the 'smart grid' and the 'smart building'". OGEMA apps receive variable electricity tariffs and automatically calculate the optimum times to run connected devices such as a refrigerator, freezer, or washing machine.

This allows consumers to turn on, say, their dishwasher at the most economical times — especially when there is an oversupply of wind energy. Air-conditioning units, radiator thermostats, heat pumps, and photovoltaic facilities can also be operated automatically by the apps. There are, for instance, applications running on OGEMA that let consumers know whether they would be better off using the electricity generated by their PV facility themselves or putting it on the grid. This information is presented to customers on a display. Other apps, meanwhile, turn off the heating in office buildings when rooms are not being used — say at the weekend, or when employees are out on the road. Another good use for OGEMA in a business context is for flexible control of combined heat and power plants to increase their profitability. As an example, reducing heat output for a short time to below predicted demand would avoid some electricity generation; this could be offered to the market as negative balancing power, giving rise to additional revenues.

The apps cover a broad spectrum of different tasks, since OGEMA is an open system, all developers and producers are free to turn their ideas for using energy more efficiently into software for the platform. "Our framework is comparable with other open-source projects such as Android. That's what marks it out from the rest: within home and building automation, all the existing systems are proprietary," says Nestle.

The OGEMA Alliance and an industry working-group were formed with the aim of driving the development of software and the transfer of the research results into the market. Participants in the working group receive regular updates on the project's progress and learn how they can programme applications for the platform. OGEMA 1.0 can already be downloaded free (www.ogema-alliance.org). Now Fraunhofer researchers are working on OGEMA 2.0, the finalized version of which is expected to be available in mid-2013. Among other things, it will feature new security functions and improved programming interfaces, while also making it easier to install apps in future.

http://www.sciencedaily.com/releases/2013/03/130313095432.htm

Engineering Breakthrough Promises Significantly More Efficient Solar Cells

The paper, "Jointly-tuned plasmonic-excitonic photovoltaics using nanoshells", describes a new technique to improve efficiency in colloidal quantum dot photovoltaics, a technology which already promises inexpensive, more efficient solar cell technology. Quantum dot photovoltaics offers the potential for low-cost, large-area solar power — however these devices are not yet highly efficient in the infrared portion of the sun's spectrum, which is responsible for half of the sun's power that reaches Earth. The solution is spectrally tuned, solution-processed plasmonic nanoparticles.

These particles, the researchers say, provide unprecedented control over light's propagation and absorption.

The new technique developed by Sargent's group shows a possible 35 per cent increase in the technology's efficiency in the near-infrared spectral region, says co-author Dr Susanna Thon. Overall, this could translate to an 11 per cent solar power conversion efficiency increase, she says, making quantum dot photovoltaics even more attractive as an alternative to current solar cell technologies. "There are two advantages to colloidal quantum dots," Thon says. "First, they're much cheaper, so they reduce the cost of electricity generation measured in cost per watt of power. But the main advantage is that by simply changing the size of the quantum dot, you can change its light-absorption spectrum. Changing the size is very easy, and this size-tunability is a property shared by plasmonic materials: by changing the size of the plasmonic particles, we were able to overlap the absorption and scattering spectra of these two key classes of nanomaterials." Sargent's group achieved the increased efficiency by embedding gold nanoshells directly into the quantum dot absorber film. However, gold is not usually thought of as an economical material; but there are other, lower-cost metals which can be used to implement the same concept proved by Thon and her co-workers. She says the current research provides a proof of principle. "People have tried to do similar work but the problem has always been that the metal they use also absorbs some light and doesn't contribute to the photocurrent — so it's just lost light." More work needs to be done, she adds. "We want to achieve more optimization, and we're also interested in looking at cheaper metals to build a better cell. We'd also like to better target where photons are absorbed in the cell — this is important photovoltaics because you want to absorb as many photons as you can as close to the charge collecting electrode as you possibly can.

"The research is also important because it shows the potential of tuning nanomaterial properties to achieve a certain goal, says Paul Weiss, Director of the California NanoSystems Institute. "This work is a great example of fulfilling the promise of nanoscience and nanotechnology," Weiss says. "By developing the means to tune the properties of nanomaterials, Sargent and his co-workers have been able to make significant improvements in an important device function, namely capturing a broader range of the solar spectrum more effectively."

http://www.sciencedaily.com/releases/2013/03/130307145716.htm

Alternative Fuel Vehicle

Due to a combination of heavy taxes on fuel, particularly in Europe, tightening environmental laws, particularly in California, and the possibility of further restrictions on greenhouse gas emissions, work on alternative power systems for vehicles has become a high priority for governments and vehicle manufacturers around the world. Current research and development is largely centred on "hybrid" vehicles that use both electric power and internal combustion. Other R&D efforts in alternative forms of power focus on developing fuel cells, alternative forms of combustion such as GDI and HCCI, and even the stored energy of compressed air.

The use of alcohol as a fuel for internal combustion engines, either alone or in combination with other fuels, has been given much attention mostly because of its possible environmental and long-term economic advantages over fossil fuel. Both ethanol and methanol have been considered for this purpose. While both can be obtained from petroleum or natural gas, ethanol may be the most interesting because many believe it to be a renewable resource, easily obtained from sugar or starch in crops and other agricultural produce such as grain, sugarcane, or even lactose. Since ethanol occurs in nature whenever yeast happens to find a sugar solution such as overripe fruit, most organisms have evolved some tolerance to ethanol, whereas methanol is toxic. Other experiments involve butanol, which can also be produced by fermentation of plants.

A hybrid vehicle uses multiple propulsion systems to provide motive power. This most commonly refers to gasoline-electric hybrid vehicles, which use gasoline (petrol) and electric batteries for the energy used to power internal-combustion engines and electric motors. These power plants are usually relatively small and would be considered 'underpowered' by themselves, but they can provide a normal driving experience when used in combination during acceleration and other manoeuvres that require greater power.

A hydrogen car is an automobile that uses hydrogen as its primary source of power for locomotion. These cars generally use the hydrogen in one of two methods: combustion or fuel cell conversion. In combustion, the hydrogen is "burned" in engines in fundamentally the same method as traditional gasoline cars. In fuel-cell conversion, the hydrogen is turned into electricity through fuel cells, which then powers electric motors. With either method, the only byproduct from the spent hydrogen is water. A small number of prototype hydrogen cars currently exist, and a significant amount of research is underway to make the technology more viable. A solar car is an electric vehicle powered by solar energy obtained from solar panels on the car. Solar cars are not a practical form of transportation; insufficient power falls on the roof of a practically sized and shaped vehicle to provide adequate performance. ■

http://www.sciencedaily.com/articles/a/alternative_fuel_vehicle.htm

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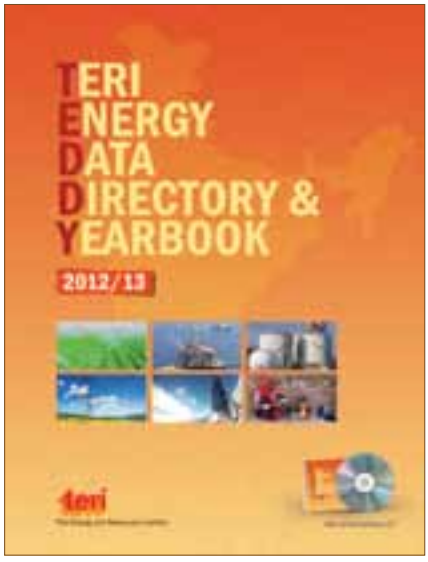

TERI Energy Data Directory & Yearbook (TEDDY) 2012/13

2013 • ISBN: 9788179935200
Pages: 460 • Binding: Hardback
Size: 220 × 280 mm • Price: ₹1995/$129

TERI Energy Data Directory Yearbook, or ***TEDDY***, is an annual publication brought out by TERI since 1986. TEDDY is often used as a reference in other peer-reviewed books and journals for energy and environment-related data. It gives an annual overview of the developments in sectors such as energy supply and consumption as well as the environment sector. It also provides a review of the government policies that have implications for these sectors of the Indian economy.

Key features

- Exhaustive compilation of data from energy supply and demand sectors.
- Recent data along with data for the past years presented in the form of structured and easy-to-understand tables.
- Recent advances made in the energy sectors are represented in the book.
- Self-explanatory figures showing the latest trends in various sectors are also part of each chapter.
- The "in focus" section in every chapter highlights a topical issue.
- The book comes with a complimentary CD that contains all the chapters and additional tables.

Table of contents

• Overview of the Indian energy sector • Organization of the energy sector in India • Commercial energy balances and conversion factors • **Energy supply:** Coal and ignite, oil and gas, power, and renewable energy sources and technologies • **Energy demand**: Agriculture, industry, transport, and domestic • **Local and global environment**: Environment, climate change and energy

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NATIONAL AND INTERNATIONAL EVENTS

National Conference on Methods Enriching Power & Energy Developments (MEPED'13)
12th April 2013
Chennai, Tamil Nadu, India
Website: http://www.meped13.com/

Hydro Power Market In India
6th to 26th April 2013
New Delhi, NCRT, India
Website: http://inframarketindia.com/
events/index.php?event_id=2

NATIONAL CONFERENCE ON RECENT INNOVATIONS IN SCIENCE AND TECHNOLOGY
26th to 27th April 2013
Kottayam, Kerala, India
Website: http://www.ncrist13.com

Engineering Sustainability 2013
7th to 9th April 2013
Pittsburgh, Pennsylvania, United States of America
*Website: http://www.mascarocenter.*pitt.edu/conference/

Power and Energy Systems - AsiaPES
10th to 12th April 2013
Phuket, Thailand
Website: http://www.iasted.org/
conferences/home-800.html

International Conference on Sustainable Development 19-20 April 2013
19th to 20th April 2013
Tirana, Albania
Website: http://ecsdev.org/index.php/
conference/iscd-2013

The 6th Energy Storage Forum – Europe 2013
23rd to 25th April 2013
Berlin, Germany
Website: http://www.
energystorageforum.com/

Hydro Power Market In India
26th to 26th April 2013
New Delhi, NCERT, India
Website: http://inframarketindia.com/
events/index.php?event_id=2

Solar Market in India-2013
7th to 8th May 2013
New Delhi, Delhi, India
Website: http://www.ibkmedia.com

The 10th International Symposium on Power of Green Energy
23rd to 25th May 2013
Toru, Poland
Website: http://gape2012.umk.pl

Energy and Sustainability 2013
19th to 21st June 2013
Bucharest, Romania
Website: http://www.wessex.
ac.uk/13-conferences/energy-and-
sustainability-2013.html

Solar Desalination Forum
26th to 29th May 2013
Abu Dhabi, United Arab Emirates
Website: http://bit.ly/YaPhCq

Ancillary Services & RES Grid Integration Forum
12th to 14th June 2013
Chicago, IL, United States of America
Website: http://www.marcusevansch.
com/AS2013_ELS

39th IEEE Photovoltaic Specialists Conference
16th to 21st June 2013
Tampa, Florida, United States of America
Website: http://www.ieee-pvsc.org/
PVSC39/

ACSEE 2013 - The Third Asian Conference on Sustainability, Energy and the Environment
6th to 9th June 2013
Osaka, Japan
Website: http://acsee.iafor.org

2nd International Conference on Environment, Energy and Biotechnology (ICEEB 2013)
8th to 9th June 2013
Kuala Lumpur, Malaysia
Website: http://www.iceeb.org/

Sustainable Development Conference: Green technology, renewable energy, and environmental protection
21st to 23rd June 2013
Bangkok, Thailand
Website: http://www.sdconference.org/

Global Energy Systems 2013
26th to 28th June 2013
Edinburgh, United Kingdom
Website: http://www.
globalenergysystemsconference.com

3rd International Conference on Environmental and Agriculture Engineering (ICEAE 2013)
6th to 7th July 2013
Hong Kong, China
Website: http://www.iceae.org/

RENEWABLE ENERGY AT A GLANCE

New and Renewable Energy Cumulative deployment of various Renewable Energy Systems/ Devices in the country as on 28/02/2013				
Renewable Energy Programme/ Systems	***Target for 2012–13***	***Deployment during February, 2013***	***Total Deployment in 2012–13***	***Cumulative achievement up to 28.02.2013***
I. POWER FROM RENEWABLES:				
A. GRID-INTERACTIVE POWER (CAPACITIES IN MW)				
Wind Power	2500	83.20	1282.20	18634.90
Small Hydro Power	350	46.05	156.98	3552.29
Biomass Power	105	15.00	113.50	1263.60
Bagasse Cogeneration	350	20.00	315.70	2300.93
Waste to Power -Urban	20	-	6.40	96.08
-Industrial		-	-	-
Solar Power (SPV)	800	210.18	505.48	1446.66
Total	***4125.00***	***374.43***	***2380.26***	***27294.46***
B. OFF-GRID/ CAPTIVE POWER (CAPACITIES IN MWEQ)				
Waste to Energy -Urban	20.00	1.06	13.82	115.56
-Industrial				
Biomass(non-bagasse) Cogeneration	60.00	5.06	60.59	443.10
Biomass Gasifiers -Rural-	1.50	-	0.672	16.792
Industrial	10.00	-	6.02	140.10
Aero-Genrators/Hybrid systems	0.50	0.24	0.44	2.09
SPV Systems (>1kW)	30.00	-	17.59	107.80
Water mills/micro hydel	2.00(500 Nos.)	-	(270 nos)	2131 Nos.
Total	***126.00***	***6.36***	***99.13***	***825.44***
II. REMOTE VILLAGE ELECTRIFICATION				
No. of Remote Village/Hamlets provided with RE Systems	-	-	-	-
III. OTHER RENEWABLE ENERGY SYSTEMS				
Family Biogas Plants (No. in lakhs)	1.25		0.77	46.11
Solar Water Heating - Coll. Areas (Million m2)	0.60		0.91	6.92

Source: www.mnre.gov.in

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General information

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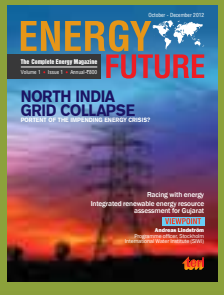
- Matte paper
- Number of pages: 96



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