Strengthening innovation-driven inclusive and sustainable development

Asia-Pacific Tech Monitor

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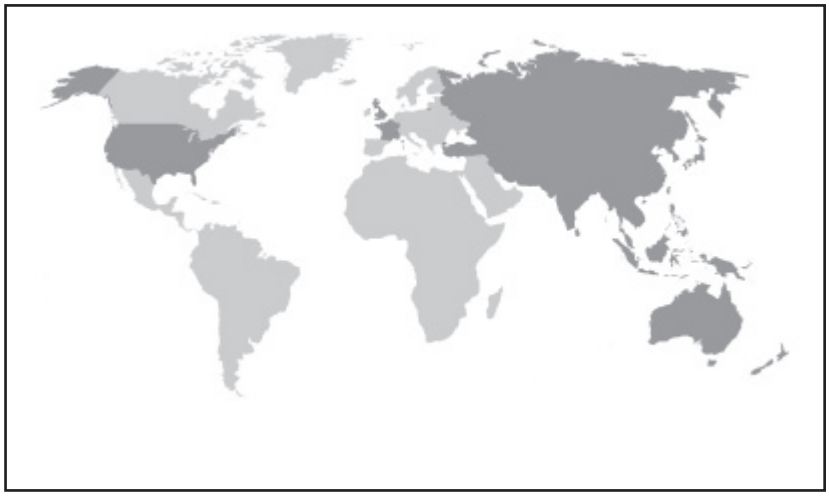
APCTT
Asian and Pacific Centre for Transfer of Technology

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

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

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

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



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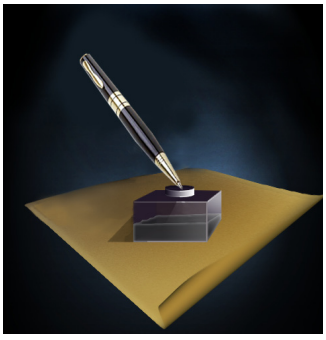


Introductory note

In the recent years, renewable energy options have demonstrated potential to reduce the environmental impacts of energy use, provide access to affordable energy, and thus play a significant role in the transition to sustainable development. For the renewable energy sector, two developments are of great significance in the post-2015 development agenda: the proposed Sustainable Development Goal 7 – ensure access to affordable, reliable, sustainable and modern energy for all; and the Sustainable Energy for All (SE4All) Initiative of the United Nations Secretary-General that aims to achieve universal access to modern energy services and to double the global rate of improvement in energy efficiency and the share of renewable energy in the global energy mix by 2030.

Towards achieving the global objectives, countries across the world need to not only expand the reach of renewable energy, but also increase affordability and access to renewable and sustainable energy such as biomass, solar, wind, small hydro, and others. The Asia-Pacific region with its rapidly growing energy demand and its rich renewable energy resource base is well placed to utilize renewable energy resources to move away from heavy dependence on fossil fuels.

Two important dimensions of renewable energy growth include (a) grid-connected renewable energy systems and (b) decentralized and distributed generation of renewable energy. Both strategies require sustained policy commitment by the national governments. Some innovative policy instruments and initiatives to promote renewable energy expansion and utilization are net metering, feed-in tariffs, renewable energy certificates, renewable portfolio standards including quota systems and power purchase agreements, and renewable energy resource mapping. These policy tools may have their own limitations and advantages when applied in different situations and therefore the national policy makers and practitioners need to take informed decisions considering all the related economic, social, and environmental factors.

There are also many successful case studies and models of renewable and sustainable energy options around the world that have demonstrated their economic viability, linkages to social development, as well as their sustainability. Successful replication of these service models in different geographical locations and socio-economic settings will require policymakers and practitioners to identify the relevant success criteria which may include, *inter alia*, technology choice, technological viability, policy and regulatory framework, enabling environment for technology transfer, availability of local supplies of raw materials, skills and equipment, market structure and dynamics, availability of finance, and socio-economic setting of target beneficiaries.

This Tech Monitor issue examines the issues and challenges, as well as exploring strategies and opportunities for strengthening national enabling environment, technology innovation ecosystems, and business practices to expand the reach of renewable energy as well as to increase the affordability of renewable and sustainable energy options in the Asia-Pacific countries.

Michael Williamson
Head, APCTT-ESCAP

Technology Market Scan

ASIA-PACIFIC

CAMBODIA

First patent application recognised

Cambodia has recognised its first-ever patent application, marking a landmark for legal service provisions in the country. The country has had a patent law in place since 2003, enacted as part of the countries world trade organization (WTO) obligations; however, it has struggled with the internal mechanisms required to enable it to actively process such applications. However, in light of the forthcoming ASEAN Economic Community deadline of the end of this year for Cambodian compliance, the nation negotiated an agreement with Singapore's Intellectual Property Office (IPOS) for assistance in processing such applications. Consequently, the first patent was granted protection and recognised in Phnom Penh on March 4th.

In a statement, IPOS said the cooperation between Singapore and Cambodia will enable prospective companies to access the regional common market more effectively, and stated that businesses or inventors seeking patent protection in Cambodia may now do so through its office.

In Cambodia, patent registration is effected by the filing of a patent application to the Ministry of Industry and Handicraft ("MIH") and includes the application form, description, claims drawings (if applicable), abstract, information concerning any previous international registrations and evidence of such prior registrations. As in many jurisdictions, an invention is patentable only if it is new, involves an inventive step, and is industrially applicable.

Although official timelines for actions to be performed by the applicant or the patent examiner are stipulated in the Patent Law and applicable regulation, these are generally extendable at the discretion of the MIH. In practice, although the Singapore application has been the initial patent granted in the country, it may take around 4 years for issuance of a patent from the date of application, although the new IPOS relationship may now reduce this. Application forms must be translated into the national language of Cambodia (Khmer) and this requirement also contributes to the approval process timeline, given a lack of translators and law firms operating in the country to verify these.

To date Cambodian patent law is not fully in line with international standards, although the Cambodian law will be familiar to legal counsel experienced in such work. The nation is a signatory to the Paris Convention for the Protection of Intellectual Property. Thus far, about 125 patents are pending with all these being priority applications from existing patents filed elsewhere. Accordingly, there is great reliance placed on the search and examination reports from the country from which priority is claimed. The new IPOS route with the assistance of Singapore may therefore be considered a preferential route for legal counsel to take at present.

Cambodia has also instigated Patent Infringement & Criminal Penalties into law, allowing a civil infringement law suit against offenders. Cambodian courts have discretion to award monetary damages and order injunctive relief, as well as issuing criminal penalties for infringement of 5–20 million Riels (~US$1,250–5,000), or 1–5 years imprisonment, or both. Repeat offenders are subject to double the fine and imprisonment term.

http://www.aseanbriefing.com

CHINA

New draft patent law released

Amendments in a new draft of the revised Patent Law focus on increased protection, patent commercialisation and administrative services, said a senior official at the State Intellectual Property Office. The new draft was based on the version sent to the State Council in early 2013 for approval and it was released on April 1st to solicit opinions. The new draft addresses challenges in legal protection, such as difficulties in collecting evidence, insufficient compensation and high costs, Song Jian Hua, Director of SIPO's Law and Treaty Department, said at an IP forum on April 20th. Courts can order suspects to provide financial records and other evidence if right owners have already made failed efforts to access them, according to the draft. The amended draft also has added regulations about online counterfeit cases. Amid a period of booming e-commerce, Internet service providers need to shoulder obligations to prevent and control illegal dealings online, she said.

Yang Wu, President of the All-China Patent Attorney Association, said, "Against the back drop of a national innovation-driven strategy, the planned amendments show a higher demand for patent protection and utilisation in our country."

The move in legislation signals China's active involvement in the changing global IP system, Yang said.

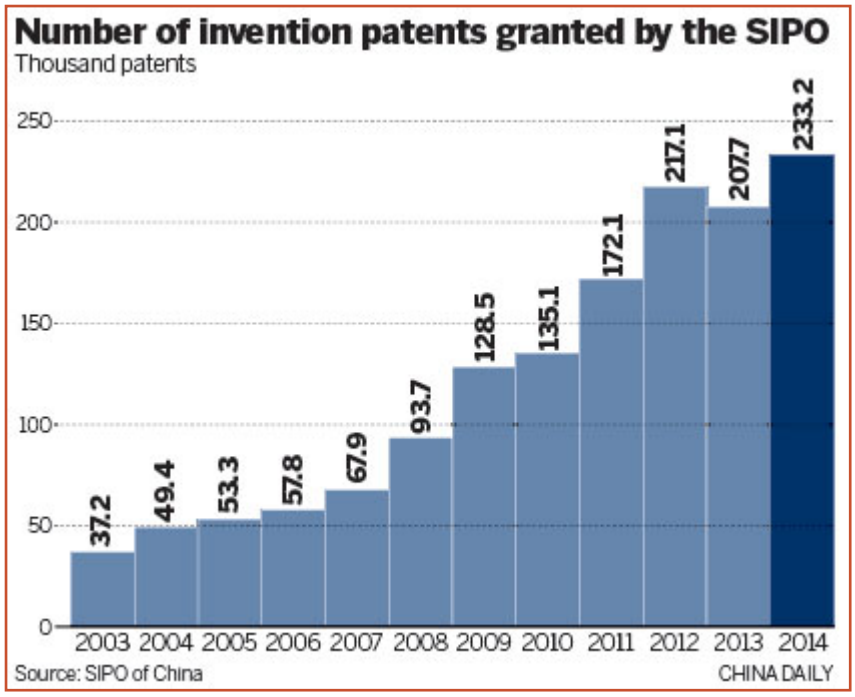
Yan Xin, Director of the Beijing Division of the IP Department at Huawei, a telecommunications giant headquartered in Shenzhen, Guangdong Province, said the design of the lower edge of a cell phone, known as a phone's jaw in the industry, was an example of how introducing partial industrial design to the law would better protect innovations.

http://www.chinadaily.com.cn

Country leads way in patent applications

China maintained its position as the world leader in annual patent applications for the fourth consecutive year in 2014, with 928,000 invention patent applications filed, a 12.5% year-on-year increase, the State Intellectual Property Office of China announced. Of the applications filed, 233,000 were granted, taking the total number of valid invention patents authorised by the office to nearly 1.2 million, according to a report released by the office.

The report also found that Chinese companies are paying more attention to international patents, with a rising awareness of their IP edge in global competition. The country received 26,000 international patent applications from domestic entities, according to the Patent Cooperation Treaty in 2014, a 14.2% increase from 2013. However, the volume of patent applica-



tions does not mean China has become a strong innovation-oriented economy, said Shen Changyu, head of the office.

"When it comes to quantity, China easily tops the world in many areas given the huge population. But developing from a big IP country to a strong one depends on the quality of patents, which forges the core of innovation for a country," Chang said. "China still has a long way to go in this regard."

Tao Xin Liang, Director of the Intellectual Property College at Shanghai University, stressed that only by increasing the technology transfer rate – the frequency with which inventions borne out of academic research reach the commercial marketplace – can the Chinese economy reap more value from its innovations.

"We should stop pursuing the numbers and focus more on helping applicants, especially small enterprises and individuals, implement their granted patents," Tao said. "In some key areas, we still heavily rely on foreign technologies without enough self-research and development (R&D)." In the telecommunication industry, for example, the number of valid patents held by foreign entities is more than 10 times the number held by domestic companies, according to the state IP report.

To encourage more rights holders, especially private innovators and small enterprises, to commercialise their patents, the Chinese government has issued a series of preferential policies, such as reducing taxes and administrative fees.

The strengthening of legal protections of IP rights against infringements has also provided a much safer environment than before for innovation to prosper in China, said Feng Xiao Qing, a professor of IP at China University of Science and Law.

http://www.chinadaily.com.cn

China aims to be leader in innovation

Chinese policymakers are laying the foundation for transformation of the country by 2020 from its primary role as a manufacturer to that of a leading innovator. Over the past three decades, China has emerged as a major manufacturing base for the world, but the country's competitiveness in advanced manufacturing remains relatively weak, partly because of domestic companies' low investment in R&D.

Only 14% of Chinese enterprises with primary operating revenue of more than 20 million yuan ($3.2 million) annually have any R&D activity. Spending on R&D accounts for only ~0.8% of their total revenue, whereas their counterparts in developed countries, such as the USA, spend ~3% of sales revenue on R&D.

To promote innovation by Chinese companies, the country's top economic planning body jointly drafted a document with more than 20 government bodies. China will level the playing field, continue to enhance its opening-up, and actively make use of global resources and markets, officials said.

Qi Cheng Yuan, Director-General of the high-tech industry department of the NDRC, said: "China welcomes the building of R&D centres in China by prestigious international scientific institutions and encourages foreign institutions to participate in China's technical programmes, including both basic and applied research," Qi said. In addition, the country will establish a market-oriented mechanism for innovation, increase the supportive role of policies and increase the voice of businesses in State innovation decisions.

http://www.chinadaily.com.cn

Obstacles for technology transfer

As China tries to ramp up its innovation economy, one obstacle is frequently standing in the way...a long, burdensome process to bring products to market or establish their wider use in their fields. It is estimated that only 20 percent of research from universities can be used in practice. In order make the process easier and faster, a national law is under discussion.

Artemisinin is a vital kind of anti-malaria medicine. Ten years ago, Tang Kexuan and his team at Shanghai's Jiao Tong University successfully registered a patent which advanced the production of the drug, increasing output by 20 percent. However, it has taken until 2015 for the fruits of the labors to be brought into general production." We started the project in 2004 and three years later, we had acquired two patents on spray technology in producing artemisinin, raising the output by 15 to 20 percent," said Tang.

The valuation of the new production technique is over ten thousand million Yuan.

But despite companies willing to part with shares for a stake in the technology, the process has not been without difficulties. "The intellectual property rights belong to Jiaotong University and it is a state-owned asset. The cooperation must be approved by the Ministry of Education and the Ministry of Finance," said Yang Yong, general manager of Wuling Yangguan Biotechnology Co., LTD.Normally the process will take two to three years. In the meantime, new technologies had been developed to produce synthetic artemisinin. Most of the research still sits on Professor Tang's bookshelf.

There are three ways to bring fruits of the research into practice: Authorization, assignment and technology investment. The third way has a relatively lower risk and is more favored by the market. But according to Shanghai Jiaotong University, since the founding of the university, there hasn't been one case of technology investment.

The reason for this is that the university doesn't have right to decide how much a technology is worth. And the process of approval at the national level is complicated and time-consuming, driving away many potential buyers." There are about 600 patents that become invalid each year. The transfer rate is even lower. There are about a hundred patents that could be transferred each year. That is no more than two to three percent of all patents registered," said Guan Xinping, deputy director of Office of Research of Research Management, Shanghai Jiaolong University.

In order to solve the problem, the Chinese government is drawing up a new law, to better define the distribution of benefit, cost and responsibilities of technology transformation.Detailed measures are also under discussion in cities across China, including giving more rights to universities and researchers to benefit more from research.

http://news.xinhuanet.com

China sets up technology transfer centers with ASEAN countries

China and Indonesia have established a technology transfer center in southwest China's Guangxi Zhuang Autonomous Region, the fifth between China and the Association of Southeast Asian Nations (ASEAN).China established transfer centers with Cambodia, Myanmar, Laos and Thailand in 2014.

"We are actively promoting the construction of such centers with more member states of the association," said Liu Jianhong, deputy director of the regional department of science and technology.Liu said the cooperation arrangements with Malaysia and Vietnam have been going smoothly.

A total of 1,228 companies, research institutions and industry associations in the fields such as agriculture and renewable energy have joined the China-ASEAN Technology Transfer Center (CATTC) since its establishment in 2013.A CATTC forum on collaborative innovation will be held in Nanning, capital of Guangxi, this September.

http://www.shanghaidaily.com

INDIA

IT centres, engineering R&D hubs for MNCs

India-based IT service centres of global firms have transformed to become the key driver of innovation from the level of providing BPO services, development of basic application and more recently delivering value. MNCs are now leveraging their captive IT centres in India to design products and services for the emerging markets as also to enable digital transformation of their global enterprises, indicating a fundamental shift in the captive business model. Engineering research and development (ER&D) activities have emerged as the fast growing segment in the IT services landscape of GIC (global in-house centres aka captive BPOs) although it accounts only a fifth of total IT-BPM (business process management) exports from India.

GICs are now working on emerging technologies such as IoT (Internet of Things), robotics, wearable devices and 3D printing, among others. Indian operations of over 300 companies are focusing on ER&D and product development services. The share of ER&D/SPD (software product development) is estimated at 59% in the overall GIC services market.

Apart from availability of the huge talent pool, the new wave of entrepreneurship and start-up culture in the country is also attracting global firms to drive innovation from India, said Shakti Sagar, chairman of Nasscom GIC Council. Last 5 years there is a significant rise in the number of GICs in India — from about 750 centres in 2010 to over 1,000 in 2015. The latest trend is to build and run centres of excellence (COEs) and establish big data labs to provide analytics. There are over 100 COEs by global firms across verticals.

http://www.thehindu.com

Reduction in royalty fees to help source technology

Indian companies paying royalty and technical fees to a non-resident can look forward to a lower tax as the Union budget has reduced the rate from 25% to 10%. This will help Indian infotech and defence companies that have big technology requirements sourced abroad. Large companies like the Indian subsidiaries of Suzuki and Holcim, which pay hefty royalty to their parent companies, will not benefit much because they already pay lower tax at rates set out in treaties with their home countries, say experts.

A large number of Indian companies pay royalty and technical fees to their parent firms abroad and an additional tax on the fees. According to Jigar Saiya, tax partner of BDO India, the base rate of tax and withholding from payment of royalties and technical fees to non-residents was increased from 10% to 25% by the then Finance Minister, P Chidambaram, in 2013.

"This resulted in increased costs for many Indian businesses that were required to make payments net of taxes. The cost of paying royalty of $100 went up from $111 to $133," Saiya said.

The proposed change, effective from April 1st, will reduce the cost for Indian businesses that were required to pay royalties/FTS to non-residents net of tax. It will also reduce the tax withholding on payments

to foreign companies providing technology or technical services to Indian businesses. For certain incomes of foreign companies based in the USA, UK and a few other countries, the proposed tax rate of 10% is lower than those provided in tax treaties.

These initiatives will help support the government's "Make in India" programme. Several defence companies might form ventures with Indian companies, said a Kotak analyst. Indian defence companies cannot compete for orders from the government because they do not have the technical capability.

Even though the government has allowed 49% foreign direct investment in defence companies, multinationals are not interested in transferring technology till they are allowed a 51% stake.

http://www.business-standard.com

Sustainable IP framework to promote R&D, economic growth: survey

A large majority of the Indian corporates strongly favoured the need for a sustainable intellectual property (IP) framework, the key driver to attract foreign direct investment and foster economic growth by encouraging R&D in the country, said a survey report by Strategic Partners Group (SPAG) on the occasion of World IP Day. According to the study titled "Benefit Sharing In a globalised India", most leadership in corporates said that IP is one of the key drivers to attract foreign direct investment and foster economic growth. Brand protection and innovation emerged as the two keywords that are associated with IP.

The leadership represented six key sectors in the country namely healthcare and pharmaceuticals, information technology, legal, entertainment and music, industry associations, academia and institutions. They pointed out that a holistic IP ecosystem will encourage R&D and thereby help India to realise its potential as a developed economy, it said.

With the intent of providing a baseline of how IP is perceived in India, an opinion poll was carried out by research and advocacy firm SPAG among 150 senior representatives in leadership roles across six sectors which presents the value of IP based on the insights provided by them.

The poll aimed at providing insights to the policy makers and developing a framework keeping in mind India's long-term business and economic interests.

The full report can be viewed at http://spag.asia/IP-Report.pdf.

http://www.menafn.com

INDONESIA

Up to 100 techno parks to be built

Human Development and Cultural Affairs Coordinating Minister Puan Maharani and Research and Technology and Higher Education Minister M Nasir have launched the development of 100 national science and technology parks.

"We hope the science and technology parks can encourage public spirit in improving national technology," Puan said at the launch ceremony at the campus of Telkom University in Bandung, West Java, on Thursday as quoted by *Antara* news agency. According to her, technology is an important issue in the globalisation era and, therefore, the techno park construction programme should be realised to encourage the community's innovation and creativity.

Science and technology parks are managed by professionals in such way that they can boost the national economy through the development and application of science and technology. The parks will be built in a number of regencies and cities in all provinces. The construction of 65 science and technology parks is expected to be completed this year."We hope the techno parks can stimulate the development of other science and technology and eventually promote the growth of the community's economy," Nasir said.

http://www.thejakartapost.com

MALAYSIA

15% R&D commercialisation rate aimed

Only 8.3% of national research and innovation products implemented during the 9th and 10th Malaysia Plan were commercialised. Deputy Minister of Science, Technology and Innovation Datuk Dr Abu Bakar Mohammad Diah said the government spent RM 795 million into 1,675 approved R&D projects during the period. "However, only 487 were completed and unfortunately only 54 projects can be commercialised," he said after opening Unimas' R&D Expo 2015 at Detar Putra.

Abu Bakar said Malaysia aimed to achieve 15% commercialisation rate by 2020. Prime Minister Datuk Seri Najib Tun Razak had in the past budget announcement wanted 360 R&D products to be commercialised by then 2020. "More importantly, the identified projects for commercialisation must have high impact," he added.

On the low success rate of commercialising innovation products, Abu Bakar said there was the need for greater efforts into commercialising research outputs as Malaysia strived to achieve the status of a high income and developed nation as envisioned in Vision 2020. "We recognise that innovation is critical in generating high income for Malaysia," he said. As such, Abu Bakar said the Ministry of Science, Technology and Innovation (Mosti) had intensified efforts to push for product commercialisation in 2014.

Abu Bakar said Mosti also offered grants up to RM 3 million under its Techno Fund scheme which provided funding for technology development, up to pre-commercialisation stage, with the commercial potential to create new businesses and generate economic wealth for the nation."Other than that, we offer RM 50,000 grant for social innovation project because we recognise that there are many projects to improve the well-being of communities. This is what we are trying to do this year – help people commercialise innovations that can generate income and in turn achieve our vision to become a high income nation by 2020," he added.

Meanwhile, Unimas Vice-Chancellor Prof Dato Dr Mohamad Kadim Suaidi said there were 130 research products being competed at the expo which was running into its 8th year, an increase of 70 products compared to last year," he said. Unimas' commitment and initiative in the field of research and innovation, Suaidi said it was recognisable especially in enhancing research culture at the university in line with the university's vision to become an exemplary university of internationally acknowledged stature.

http://www.theborneopost.com

PHILIPPINES

Green growth of SMEs pushed

The Department of Environment and Natural Resources has partnered with a Republic of Korea-based international organisation to promote environmental innovation among small and medium enterprises (SMEs) in the Philippines. The partnership between the DENR and the Asia–Europe Meeting (ASEM) SMEs Eco-Innovation Center (ASEIC) was formalised with the signing of a memorandum of understanding (MOU) by DENR USec, concurrent Environmental Management Bureau Director Jonas Leones and ASEIC Vice President Chun Hee Lee at the National College of Science and Technology in Dasmariñas, Cavite.

ASEIC was established by member countries of the ASEM in 2011 with the principal mandate of promoting cooperation between the two continents to create and enhance environmental advancement of SMEs, which are a main engine of economic growth and innovation.

ASEM is a Eurasian forum formed in 1996 to foster cooperation among its members, which include the 10-member Association of Southeast Asian Nations, 28 members of the European Union, and 13 other Asian and European countries.

In a speech read by EMB Assistant Director Eva Ocfemia, Leones expressed hope the collaboration will boost government efforts to help SMEs become more compliant with environmental standards, particularly under the DENR's Philippine Environment Partnership Programme that encourages improved environmental management and performance among industries. "SMEs contribute roughly 80% to the industrial pollution in Asia. In the Philippines, most SMEs find it difficult to comply with environmental laws," Leones said.

He said the DENR–ASEIC partnership also aims to expose local SMEs to model industries from other Asian countries and enhance entrepreneurs' knowledge on eco-innovative and low-carbon practices to lessen pollution, as well as their carbon footprint.

The MOU provides for the DENR and the ASEIC to collaborate on eco-innovation projects such as consultations for SMEs in using green technology management, transfer of technology on green growth and low-carbon industrial development, related capacity building and conferences and mutual support in research and promotion of eco-innovation practices.

http://baguiomidlandcourier.com.ph

REPUBLIC OF KOREA

Government invests 5.6 trillion won in growth areas

The government announced a plan to spend 5.6 trillion won ($5.1 billion) by 2020 to foster 19 new growth engine industries starting this year. The industries are largely technology-oriented and include smart cars, 5G mobile telecommunication, the IoT and wearable smart devices, announced two ministries dealing with technology and trade, the Ministry of Science, ICT and Future Planning and the Ministry of Trade, Industry and Energy.

Some projects were selected to further advance Korea's current strengths like automobiles, mobile telecommunication technologies and building plants abroad, whereas others aim at quickly commercialising locally developed technologies.

The future growth engine project will begin with 1 trillion won in investments by the end of this year, which will cover R&D, preparing basic infrastructure and commercialisation and easing regulations. The government is scheduled to complete deregulation plans and tax breaks by the latter half of this year, said an official from the Industry Ministry. Participants in the 19 government-led R&D projects are likely to be offered additional discounts on the corporate tax they pay, added the official.

According to the Finance Ministry, the government this year offers tax deductions of up to 3% for local conglomerates' R&D projects spending, and 25% for R&D spending carried out by small and midsize companies.

Wearable devices will receive the largest government R&D subsidy of about 98.3 billion won by 2020. To boost competitiveness of Korean-made wearable devices, the government also will invest 60.8 billion won to develop and commercialise system-on-chip semiconductors, a memory chip that stores both data and operates wearable device software.

The IoT and 5G mobile telecom technologies will each receive 77 billion won in investments. The government aims to expand the local IoT industry to 30 trillion won in 2020 and to commercialise the world's first 5G mobile network nationwide by 2020.

Projects for smart cars will receive 28.2 billion won. A provincial town will be selected as a trial city to revise traffic laws.

One of the earliest projects to be completed is polyketone, a material developed by Hyosung now in the mass commercialisation process. The government will offer subsidies to patent polyketone and other materials. The government will play matchmaker for large companies and small and mid-sized suppliers.

http://koreajoongangdaily.joins.com

Nanotech industry by 2020

The Republic of Korean government will invest 177.2 billion won (US$164.2 million) in the industrialisation of nanotechnology this year. The budget goes to seven techniques for industrial applications, including that for manufacturing 3D nanoelectronic devices used in intelligent robots and wearable smart devices, and industry

infrastructure for production performance evaluation and the like. Strategic items are also selected so that small firms, which account for 90% of the industry, can better compete in the global market.

The Ministry of Science, ICT & Future Planning and the Ministry of Trade, Industry & Energy unveiled the plan on April 30 at the main office of CrucialTec located in Pangyo, Gyeonggi Province. "The global nanotech product market is estimated to reach US$3 trillion in size in 2020," they explained, adding, "We will take up 20 percent of the market by means of large-scale investments."

Nanotechnology can be defined as the use of new and improved properties obtained by the production and control of substances at a level of 1–100 nm. Nanotechnology is universal in nature and thus can be helpful in improving biotechnology, information technology, environmental technology and many other fields.

The budget is divided into 122.4 billion won (US$113.4 million) for the development of the seven techniques, 32.5 billion won (US$30.1 million) for corporate assistance and 22.3 billion won (US$20.7 million) for infrastructure expansion. The other six of the seven techniques are: environmental nanotech sensors applied to the Internet of things for disaster prevention system establishment, nanotech sensors for food safety, functional nanotech fabrics, nanotech materials for rare metal catalysts, industrial nanotech materials for rare metal elements and energy-saving water treatment systems.

http://www.businesskorea.co.kr

SINGAPORE

R&D expenditure on the rise: A*STAR

Business spending on R&D in 2013 reached S$4.5 billion, of which local companies contributed S$1.36 billion to that figure, according to the Agency for Science, Technology and Research (A*STAR). The R&D spend in Singapore is on the rise, with the gross expenditure increasing from 2012's S$7.2 billion to S$7.6 billion in 2013, according to the A*STAR.

Sharing figures from its national survey, A*STAR on Thursday (Mar 19th) said business spending on R&D grew from S$4.4 billion to S$4.5 billion during that period.

Among local enterprises, spending inched up from S$1.3 billion to S$1.36 billion. Of this, SMEs contributed S$576 million – a 5% on-year growth – while large enterprises spent S$781 million, which represents a 4% on-year growth.

A*STAR said such spending is indicative of efforts to innovate and use leading-edge technologies to grow business and compete in the international arena. A*STAR added that Singapore is well-positioned for emerging economic opportunities through R&D outcomes. The agency said it will continue to drive innovation to capture value in areas like manufacturing, and advance technologies for urban systems – both of which are critical for Singapore's growth.

In the first 9 months of the 2014 financial year, that started from Apr 1st, A*STAR's R&D efforts have captured more than S$380 million in industry investment from more than 1,700 projects. Around 4 in 10 of A*STAR's industry projects in 2014 financial year were undertaken by SMEs.

http://www.channelnewsasia.com

THAILAND

Tax deductions on R&D offered

Thailand's National Science and Technology Development Agency (NSTDA), in collaboration with the Revenue Department and Ministry of Science and Technology (MoST), has launched an online expense certification service to help businesses demonstrate to meet the qualifications necessary for a 200% R&D tax deduction.

Although several companies in Thailand are eligible for an R&D tax deduction, only a small proportion of those companies with qualifying R&D investments have requested tax exemptions due to inconveniences and inefficiencies in the current system and concerns over confidentiality.

According to the NSTDA, the new online system is "fast, provides data security and is convenient to monitor with follow up and support." Because of this, many more businesses are expected to qualify for and claim an R&D tax deduction.

The new system is expected to reduce the project approval period to 1 or 2 months and bolster R&D to around 1% of Thailand's GDP within the next 3 years.

http://www.aseanbriefing.com

VIET NAM

Survey points to glaring gap in R&D

According to a survey on Vietnam's hi-tech application released in April 2015 by the MoST' Department of Market Development and Scientific and Technology Enterprises, Viet Nam has just 134 hi-tech enterprises. Only 25 of these enterprises have their own R&D units. Of these 25, 56% were "not innovative" and none of them proved to be "very innovative," a department survey stated.

According to a recently released joint Organisation for Economic Cooperation and Development–World Bank report on the R&D and innovation in Viet Nam, the country's gross domestic expenditure on research and development (GERD) occupied only 0.2% of gross domestic product, or about US$360 million in 2014.

Meanwhile, the rate was about 3.7% for the Republic of Korea, 3.3% for Japan, 1.8% for China and 0.8% for Malaysia. GERD includes expenditure on R&D by business enterprises, higher education institutions, as well as government and private non-profit organisations. Private companies accounted for just 15% of Vietnam's total R&D investment, and the government was responsible for 70% of investment, with the remaining funding sourced from higher education institutions.

Meanwhile, private R&D investment was nearly 80% in Japan, 75% in the Republic of Korea, 73% in China, 70% in Malaysia, 62% in Singapore, 58% in the Philippines, 45% in Thailand and 38% in Laos.

http://english.vietnamnet.vn

ASIA-PACIFIC

AUSTRALIA

Floating solar technology

Infratech Industries launches Australia's first floating solar system recently that will generate an estimated 57% more power than fixed land-based systems. The proprietary tracking, cooling and concentrating technology uses water to counteract the gradual loss of output caused by overheating solar panels to create a better performing and more efficient system.

Based in South Australia's Jamestown, the Northern Areas Council Waste Water Treatment Plant is the first to implement the new system that is expected to exceed the plant's high-energy needs and will feed through the surrounding local communities and Council buildings.

Infratech Industries' Director Felicia Whiting said the benefits extend beyond energy efficiencies to improve the treatment plant's water quality and create nearly 70 new jobs for the local community as a result of the project.

No small undertaking and privately funded, more than15 Australian engineers and research scientists in the Nano Science and Technology Department in Adelaide's Flinders University were involved in the project's technological and engineering development. The development team will remain involved as research and development continues into integrated water treatment, phosphorous treatment systems, and energy storage.

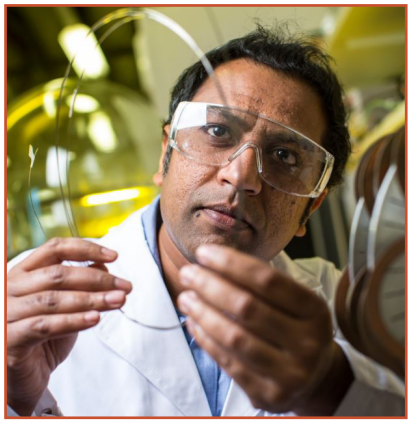
For more information, visit www.infratechindustriesinc.com.

http://www.wateronline.com

Superconducting wind turbines

A team of engineers at University of Wollongong, led by Dr Md Shahriar Hossain, assume that inexpensive superconductors may provide the key to lighter, cheaper turbines that do not require rare-earth magnets. Other turbine designs have used low-temperature superconductors, but those require liquid helium to cool the material down to superconducting temperatures. Dr Hossain's proposed design uses superconductors made of magnesium diboride (MgB_2), a material that achieves superconductivity at temperatures <39 K (–389F, –234°C), which is still quite chilly, but they are able to achieve the superconducting temperatures using an inexpensive cryocooler. Dr. Hossain elaborated:

"Cooling the superconductors in a device is, no doubt, the most challenging part. Nowadays, off-the-shelf cryocooler is available in the market. Two stage cryocoolers will be used for cooling the rotating components. The cryocooler will be operated at the first stage at 55 K and the second stage at 20 K. At 20 K we have got very high critical density compared to the well-established Nb-based superconductors. These cryocoolers will operate with ambient temperature gas helium supplied from compressors located on the stationary side. The gas helium goes into the rotor and returns through rotary coupling in a closed loop. The cost of these cryogenic arrangements will still be cheaper than using the high temperature superconductor ($25 per meter compared to $1 per meter MgB2). Niobium-based low temperature superconductor can be good option but only the downside is, it can't operate without the liquid helium which is going to be unavailable very soon and becoming costly (now $25 per liter). Many companies like China Techo-westing house, Convertim, GE, Siemens are exploring the 10 MW generator using the high and low temperature superconductors, but these will be very expensive design options. We believe that simple, lightweight, low-cost and high-critical current density at 20 K properties makes this superconductor very attractive for the industry. We have done our work on material testing and cable coil fabrication for the rotor and stator. We will start the engineering work very soon with US company."



Dr. Hossain and his colleagues have developed a small-scale superconducting field coil, but they are still working to optimize the material. They expect that to continue through 2015, when they plan to have a design that is ready to scale up.

http://www.engineering.com

Floating solar system

INDIA

Solar-powered cold storage system for farmers

The Indian Institute of Technology – Kharagpur engineers have developed a solar-powered cold storage system that works at zero running cost as a solution to the wastage of agricultural products in India. Developed at the Science and Technology entrepreneurship Park of IIT-Kharagpur by mechanical engineering students Vivek Pandey, Prateek Singhal and Devendra Gupta, the micro-cold storage system has been tested and proved in a farmland in Karnataka.

The cold storage system will be developed under the banner of Ecofrost Technologies which is an agri-focused company creating solutions to overcome problems in cold chain infrastructure. The company envisions to disrupt the current state of food supply chain in India by empowering farmers, mandi owners, and mobile cold chain players with clean technology for a sustainable future.

The project has been in the works for a while, but concrete plans for rolling out the unit are being made now. The team has setup a production unit in Pune which is up and running. The need for such solutions is huge. In India, 10 million tons of cold storage capacity is required to prevent the over 30% wastage of perishable product. The current facilities are accessible only to the big farmers/middlemen who hoard when supplies peak, leading to huge price fluctuations. The bottom of the pyramid, i.e., the small farmer, loses out, as they have to sell their product at very low prices right after harvest.

The product primarily designed for the rural segment serves their needs ideally, as it does not depend on grid electricity and after a 2-year breakeven, leads to over 40% increase in their profits. There is no running cost for this unit and it works on sustainable technology throughout the year. Using solar panels, a thermal storage methodology controls compartment cooling in tandem; with regular cooling this micro cold storage increases the shelf life of agricultural product. The power generated is sent to the compressor, running at various speeds to adjust to the cooling demand. Instead of batteries, there is a thermal storage unit that can store power for more than 36 hours for cloudy or rainy weather. The micro-cold storage system has a capacity of 5 metric tons (and the price is yet to be finalized), mainly meant for horticulture purposes.

Solar-powered cold storage system

A target to manufacture 20,000 cold storage units in the next 5 years has been set up from Pune unit. The team plans to sell units directly to farmers and create village-level entrepreneurs who will act as nodal points for cold storage in markets where a farmer can store his product at a fixed cost.

http://social.yourstory.com

Biofuel from coconut oil

Scientists who have been running the four-stroke diesel engine of a light pick-up truck on coconut oil for the past 1 year have approached the Union Government to commercialize the biofuel. The scientists are attached to the Kochi-based SCMS Institute of Bioscience and Biotechnology Research and Development and the SCMS School of Engineering and Technology.

Although the manufacturers of the Tata Ace claim mileage of 16 km/liter of diesel, the vehicle can run 22.5 km/liter of the biofuel, the scientists say."We purchased this brand new vehicle a year back. By now, it has done 20,000 km and has proved beyond doubt that coconut oil can replace diesel. We can provide this product at Rs.40 a liter," C. Mohankumar, who heads the team of six scientists, told IANS.

Mohankumar said they have already applied for a US patent and also approached the Union Ministry of Renewable Energy to take this biofuel to its logical conclusion by commercializing it. "The emission levels are lower than other forms of biodiesel, making it a very eco-friendly product too," said Mohankumar. Explaining the process, he said 760 liters of biofuel can be produced from the oil of 10,000 coconuts. "There are also five other by-products. This includes 5,000 kg of husk, 2,500 kg of coconut shells, 1,250 liters of coconut water, around 1,200 kg of cake (that can be used as cattle feed), and 70 liters of glycerol."

"Each of these products has a market value and that's how we are able to commercially supply this biofuel at Rs.40 a liter," Mohankumar said. "We have conducted numerous tests on this coconut biofuel that are for anyone to see. It shows that all the parameters are much lower than other biodiesel products," he added.

The study was published in the December 2014 issue of the journal *Fuel*.

http://zeenews.india.com

JAPAN

Fermenting rice for biofuel and feed

A technology to create biofuel and animal feed at the same time without any off-site processing has been developed by Japanese researchers. The solid-state fermentation (SSF) system involves wrapping rice plants grown to feed livestock along with yeast, enzymes, and bacteria into a bale covered with a plastic film, and capturing the ethanol produced by the resulting fermentation.

This technology builds on traditional processes used by farmers around the world to create silage to feed livestock such as cattle, goats and sheep, according to a report published in the journal *Biotechnology for Biofuels*. "Our SSF system does not require special equipment and large facilities," says Mitsuo Horita, a researcher at the National Institute for Agro-Environmental Sciences who is the project's lead researcher. "Harvested materials are immediately packed into a round bale in the field, which is similar to a conventional silo used for silage fermentation. No extra energy needs to be supplied to the system."

Horita says the system produces high yields of ethanol and silage, without any plant waste. By processing plants destined for animal feed, it also avoids competing with food crops, he says. As a result, the technology could help address criticism of biofuels, which at present are mostly created from crops such as rice and maize.

These first-generation biofuels have come under fire for driving up food prices, as their production competes with the farming of crops to feed people. Conventional biofuel manufacturer also requires energy for transport and to run industrial processing plants. However, Jahi Chappell, Director of agriculture policy at the Institute for Agriculture and Trade Policy, an NGO that promotes sustainable farming, says the SSF system may fail to solve the biofuels conundrum. "Competition that lowers food security could still happen if this process led to conversion of lands suitable for other agricultural activities into land used for biofuel and feed production," he says. According to Horita, the biggest challenge to implementing SSF on a larger scale is the cost of rolling out the technology.

Researchers would have to present the advantages of using the system to farmers, who would also need access to power stations that can buy and use the resulting ethanol, he says. However, Siwa Msangi, a researcher at the US-based International Food Policy Research Institute, says the technology is a welcome addition to global biofuel options, despite concerns about its shortcomings. "We shouldn't stop seeking ways to make better biofuels as we will need to add them to the portfolio of renewable energy sources that are necessary to offset future climate change," he says.

http://www.asianscientist.com

REPUBLIC OF KOREA

Nanowire solar cells by coating dielectrics

A Republic of Korean research team has successfully developed a techology to coat a dielectric material that can cheaply double the efficiency of silicon nanowire solar cells. Kim Sun-Kyung, Professor of the Department of Applied Physics at Kyung Hee University, announced on February 2nd, that a joint research team consisting of Korean and US scientists has succeeded in doubling the efficiency of nanowire solar cells by coating them with a dielectric material. The study was conducted in collaboration with James F. Cahoon, Professor of the Department of Chemistry at the University of North Carolina, and others.

Nanowire solar cells are made using a silicon nanowire with a 200-nm diameter and a dozens of micrometers in length in the part that changes light into electricity, instead of a silicon film. Because they cause a light-trapping optical antenna effect, nanowire solar cells can absorb more than twice as much light as thin-film photovoltaic cells. However, the nanowire solar cell cannot absorb a large amount of light, owing to its threadlike structure, making it inferior to thin-film photovoltaic cells in terms of light absorption.

The research team made a 200-nm thick solar cell using nanowire, and coated it with Si_3N_4 using plasma-enhanced chemical vapor deposition to ensure a 50-nm thickness, thereby creating a nanowire solar cell with a new structure.

The optical conversion efficiency of the newly-developed solar cell was 4%, a two-fold increase from existing nanowire solar cells. The outermost dielectric layer of nanowire refracted light probably caused nanowire to absorb more light, according to the research team. They explained that if this kind of nanowire solar cell is made with a thickness of existing thin-film photovoltaic cells, and it will be possible to increase its efficiency to the level of already-commercialized products.

The research findings were published online in the Jan. 15 issue of *Nano Letters*, a monthly scientific journal published by the American Chemical Society.

http://www.businesskorea.co.kr

VIET NAM

Pumpkin-shaped wind generator

A Viet Namese man in the southern province of Ben Tre has received a certificate of patent issued by the Viet Nam National Office of Intellectual Property for his pumpkin-shaped wind generator. The machine created by Tran Thanh Thanh, from Binh Dai District has also received an award from the Central Committee of the Ho Chi Minh Communist Youth Union for creative inventions.

The pumpkin-shaped wind generator has a 2-m diameter and 10 blades that help it to catch wind from many directions. The wind energy is then stored in a battery before it goes through a power inverter to be transformed into 220 V electricity for usage.

The machine is strong enough to run household items such as lights, fans, television, and an iron.

"Each house only needs one machine of this kind and it will have enough power for household items," Thanh said. "A generator costs VND15 million (US$706) (not to men-

tion the shipping fee), has a 5-year warranty and can work for 10 years. However, the life of this machine could be longer if it is maintained regularly," he added. Thanh said that the idea of making a wind generator came to him while he was riding an electric bike. The bike ran out of battery, but regained power after he pedaled for a while.

Thinking that his movements could create power, Thanh was encouraged to research and build a wind generator to use on days when the national grid has problems, although people told him he was just wasting his time.

Many businesses have asked Thanh to cooperate with them to produce his pumpkin-shaped wind generator to sell, but he wants to take out a bank loan to set up his own business and sell the machine.

http://tuoitrenews.vn

EUROPE

DENMARK

Superconducting direct drive technology for wind turbines

Envision Energy, the world leading Smart Energy solution provider, announced that it aims to install a superconductive generator on one of its most advanced wind turbines. The product named EcoSwing generator is designed for a +3 MW class direct drive turbine and will provide enough electricity to power 1,000 households.

Anders Rebsdorf, Head of Envision's Global Innovation Centre, commented "After years of research, superconductivity has finally matured to a level where it can be considered for testing and demonstration on a full-sized wind turbine. The EcoSwing DD generator will be one of the most ambitious superconductive systems in terms of torque density, and we are proud to spearhead this important milestone project."

The EcoSwing generator is thought to be the first superconductive generator designed for a wind turbine and promises a step change in generator development. The key advantage of the EcoSwing generator is a weight saving of more than 40% compared to conventional direct drive generators. For the entire nacelle this results in 25% less weight and of course proportionally less material usage. A particularly welcomed side effect is that the EcoSwing technology dramatically reduces rare-earth material reliance – a commodity of scarce supply and price fluctuations. The consortium composed of members from industry and science thus anticipates that EcoSwing drive-train will result in a competitive solution compared to direct drive or geared solution.

http://www.prnewswire.co.uk

THE NETHERLANDS

3D printed "light traps" to make solar cells more efficient

Physicists from the University of Utrecht in the Netherlands have developed a very interesting 3D printing application that can revolutionize the availability of environmentally-friendly energy. They have designed and 3D printed a light concentrator that essentially functions as a trap for sunlight and will enable solar cells to use as much sunlight as possible and optimize its output. This, in turn, will decrease the cost of solar energy.

Of course we have already known that 3D printers are perfect for making custom vessels for solar panels. However this project, which has been spearheaded by PhD student Lourens van Dijk, can really make solar panels more efficient. As he writes in the abstract of his paper "*3D-printed concentrator arrays for external light trapping on thin film solar cells*", his 3D-printed designs can be used for almost every solar cell that is being commercially used. "After our recent demonstration of a 3D-printed external light trap on a small solar cell, we now consider its potential for large solar panels," van Dijk writes.

The light trap itself is essentially a parabolic concentrator that redirects light back towards the solar cell, as a regular solar cell reflects (rather than absorbs) about 20% of all light. "These retro-reflections enable higher absorbance and improved power conversion efficiency. We fabricated 3D-printed external light traps with a square, hexagonal, and circular compound parabolic concentrator to test their suitability for concentrator arrays. The 3D-printed traps were placed on top of an organic solar cell which resulted in a significant enhancement of the external quantum efficiency," he writes.

This interesting build essentially enables van Dijk to capture all sunlight a cell is exposed to. The PhD student estimates that energy outputs increases by about 12% when using these 3D-printed traps, though that depends on the type of solar cell used and the type of light. And equally beneficial is that this means solar cells can be made less expensive and less thick, while increasing their efficiency.

If you are wondering why no one has thought of this concept before, well they actually have. However because of problems with the mirror design, realization of the concept was more difficult than it sounds. 3D printing fortunately proved to be a perfect solution – the plastic 3D printed traps are coated in a silver after printing to optimize their reflective properties. Van Dijk has extensively worked together with scientists from AMOLF and Solliance to achieve this effect.

3D printing technology also proved to be a perfect tool for prototyping various shapes and sizes of light traps, before settling on the final design. According to Dr. Marcel Di Vece 3D printing technology is a key tool in the development of a new generation of solar cells. 'Met onsonderzoekleggen we een fundament ondereengoedkopeenhaalbaretechniekom de efficiëntie van veeltypenzonnecellenteverbeteren,' he says.

http://www.3ders.org

Biofuel and plastics from wood waste

A process that converts waste wood into the building blocks of gasoline has been developed by researchers at the Netherland's KU Leuven's Centre for Surface Chemistry and Catalysis. According to the university, by using a new chemical process the researchers were able to convert

the cellulose in sawdust into hydrocarbon chains.

These hydrocarbons can be used as an additive in gasoline, or as a component in plastics. KU added that cellulose is the main substance in plant matter and is present in all non-edible plant parts of wood, straw, grass, cotton and old paper."At the molecular level, cellulose contains strong carbon chains. We sought to conserve these chains, but drop the oxygen bonded to them, which is undesirable in high-grade gasoline. Our researcher Beau Op de Beeck developed a new method to derive these hydrocarbon chains from cellulose," explained professor Bert Sels.

Dr Bert Lagrain added: "This is a new type of bio-refining, and we currently have a patent pending for it. We have also built a chemical reactor in our lab: we feed sawdust collected from a saw mill into the reactor and add a catalyst – a substance that sets off and speeds the chemical reaction. With the right temperature and pressure, it takes about half a day to convert the cellulose in the wood shavings into saturated hydrocarbon chains, or alkanes."

"Essentially, the method allows us to make a 'petrochemical' product using biomass – thus bridging the worlds of bioeconomics and petro chemistry," he added. According to Sels, the result is an intermediary product that requires one last simple step to become fully distilled gasoline. "Our product offers an intermediate solution for as long as our automobiles run on liquid gasoline," he continued. "It can be used as a green additive – a replacement for a portion of traditionally-refined gasoline."

However, according to the professor the possible applications go beyond gasoline. "The green hydrocarbon can also be used in the production of ethylene, propylene, and benzene – the building blocks for plastic, rubber, insulation foam, nylon, coatings and so forth," he noted.

http://www.waste-management-world.com

SWEDEN

Enzymatic process for production of biodiesel

Researchers at Lund University have developed an optimized two-phase enzymatic (lipase) system for the conversion of plant oils to biodiesel. Applied to the solvent-free ethanolysis of rapeseed oil, the system delivered a yield of 96% under mild conditions. Under the mild conditions used, chemical catalysts were inefficient. An open access paper on their work is published in the journal *Biotechnology for Biofuels*.

The current predominant method for the transesterification of triglycerides (plant and animal oils and fats) to biodiesel (a mixture of esters) uses chemical catalysts (sodium or potassium hydroxides or alkoxides). Despite its predominance, there are several drawbacks with this approach, including the need to remove inorganic salt in the downstream process; the high temperature required; and undesirable side reactions. Further, these systems are inefficient when a high free fatty acid (FFA) content is present in the starting material, thus restricting the use of conventional chemical pathways to a highly pure feedstock. An alternative approach is the use of immobilized lipase-catalyzed transesterification in the presence of an organic solvent.

In their study, the Lund researchers used a liquid formulation of *Thermomyces lanuginosus* lipase in an aqueous/organic two-phase system. This enzyme shows an excellent tolerance to ethanol, which not only made the process faster but also allowed for the total conversion of the FFA into biodiesel with a short reaction time. They optimized several different parameters in the system: biocatalyst composition, ethanol concentration, and the presence of additives.

The use of solid silica particles led to changes in the emulsion structure that permitted a larger surface area in the interphase, overcoming mass transfer limitations and thus increasing the rate of the process.

The results, the authors suggested in their paper, constitute a good starting point for efficient and cheap biodiesel production. The next step would be to adapt the methodology to readily available cheap waste oils.

http://www.greencarcongress.com

UK

Biosynthesis to develop renewable propane

Manchester (UoM) has taken a quantum leap in the renewable biosynthesis of propane. The researchers at the University's Manchester Institute of Biotechnology (MIB) collaborated with their colleagues at Imperial College, London, and University of Turku to develop a synthetic pathway that enables the renewable biosynthesis of propane.

Last year, a team of researchers at Imperial College, London, had proved that propane can be made from glucose using a genetically engineered version of bacterium *Escherichia coli*. Although they could produce propane only in tiny quantities, the success of the experiment was a proof of concept that propane production does not require its two usual sources of production – petrol refining and natural gas processing.

This current research, which was funded by the European Union, was taken up in an attempt to develop next generation bio fuels. It was published in the *Biotechnology for Biofuels*, an open access journal, with the title "A microbial platform for renewable propane synthesis based on a fermentative butanol pathway". As natural metabolic pathways for biosynthesis of propane do not exist, researchers have developed an alternative microbial biosynthetic pathway to produce renewable propane. As reported in the journal, researchers introduced a genetically engineered enzyme into an existing fermentation pathway that produces butanol to redirect that microbial path to instead produce propane.

As *Biomass* magazine quotes, Professor Nigel Scrutton, Director of the MIB, explains the significance of their work, "The chemical industry is undergoing a major transformation as a consequence of unstable energy costs, limited natural resources, and climate change. Efforts to find cleaner, more sustainable forms of energy as well as using biotechnology techniques to produce synthetic chemicals are currently being developed at The University of Manchester."

Scrutton also says "This study (is) focused on the construction and evaluation of alternative microbial biosynthetic pathways for the production of renewable propane. It also expands the metabolic toolbox for renewable propane production, providing new insight and understanding of the development of next-generation biofuels which one day could lead to commercial production."

Propane (C_3H_8) is a very volatile hydrocarbon with highly favorable physicochemical properties as a fuel. In the exploration of a commercially usable renewable alternative to complement currently used petroleum derivative fuels, researchers see propane as an attractive choice.

This achievement of propane biosynthesis, an indispensable invention as fossil fuels continue to diminish, would take the world one step closer to commercial production of renewable propane.

http://www.greenoptimistic.com

NORTH AMERICA

USA

Solar-powered desalination technology

A team of researchers from Massachusetts Institute of Technology (MIT), who collaborated with Jain Irrigation, invented a solar-powered machine that can convert brackish waters into potable drinking water, based on the Electro-dialysis-Reversal principle**.** While solar-powered desalinization plants are not totally new, they were very expensive and only developed areas like Chile and California could try them. However, the current technology seems affordable for even the developing countries to adopt.

Last year, a team from MIT conducted a field research in the villages of India, after which they pointed at the solar-powered electrodialysis as a solution where problems like freshwater scarcity, low sanitation, lack of sufficient electric power, etc., exist as in any other developing countries. The research was funded by Jain Irrigation Systems, an Indian company that builds and installs solar power systems, and sponsored by the Tata Center for Technology and Design at MIT.

"Electrodialysis works by passing a stream of water between two electrodes with opposite charges. Because the salt dissolved in water consists of positive and negative ions, the electrodes pull the ions out of the water, leaving fresher water at the center of the flow. A series of membranes separate the freshwater stream from increasingly salty ones", the MIT News Office explained.

Jain Irrigation says, the system can clean brackish water with up to 5000 ppm and convert into drinking quality water in a single pass using pre-filtration, ED-R (electrodialysis-reversal) followed by UV (Ultraviolet treatment). Although 90% of the water could be recovered (wherein reverse osmosis, it is only 40–60%), the rest 5–10% reject concentrate would be dried in a solar pond without creating any environmental hazard. It can also remove hardness, chemicals, pesticides, fertilizers, and micro-organisms. Along with being powered by solar photovoltaic cells, the ED membrane also has a long life (~10 years) – all of which make the system more energy and cost efficient when compared with reverse osmosis (RO).

http://www.greenoptimistic.com

New approach combines biomass and solar energy conversion

In a study published on March 9th in *Nature Chemistry*, University of Wisconsin–Madison chemistry Professor Kyoung-Shin Choi presents a new approach to combine solar energy conversion and biomass conversion, two important research areas for renewable energy. Choi, along with postdoctoral researcher Hyun Gil Cha, chose to take a completely new approach to solve this problem. They developed a novel PEC setup with a new anode reaction. This anode reaction requires less energy and is faster than water oxidation while producing an industrially important chemical product. The anode reaction they employed in their study is the oxidation of 5-hydroxymethylfurfural (HMF) to 2,5-furandicarboxylic acid (FDCA). HMF is a key intermediate in biomass conversion that can be derived from cellulose – a type of cheap and abundant plant matter. FDCA is an important molecule for the production of polymers.

Biomass conversion can offer a viable pathway to generate chemicals used in industrial processes without using petroleum products. Conventional biomass conversion processes use high-pressure oxygen for the conversion of HMF to FDCA at high temperatures. Choi and Cha, however, developed an efficient electrochemical method to oxidize HMF to FDCA at room temperature and ambient pressure using water as the oxygen source. Then they employed this oxidation reaction as the anode reaction of the PEC that produces hydrogen at the cathode. By doing so, they demonstrated the utility of solar energy for biomass conversion as well as the feasibility of using an oxidative biomass conversion reaction as an anode reaction in a hydrogen-forming PEC.

"Since the photoelectrochemical cell is built for the purpose of hydrogen production and HMF oxidation simply replaces oxygen production at the anode, in essence, no resources are used specifically for HMF oxidation," says Choi. In other words, FDCA is a bonus byproduct from a PEC that generates hydrogen. The production of FDCA, a valuable chemical, at the anode lowers the production cost for hydrogen. This new approach therefore presents new possibilities for research in both solar conversion and biomass conversion.

"When we first started this study, we were not sure whether our approach could be really feasible," Choi says. "However, since we knew that the impact of the study could be high when successful, we decided to invest our time and effort on this new research project at the interface of biomass conversion and solar energy conversion."

Developing and optimizing every piece of the full solar cell setup demonstrated in the study took the researchers about 2 years. Choi expects that the development of more diverse and efficient electrochemical and solar-driven biomass conversion processes will increase the efficiency and utility of solar-fuel-producing PECs.

http://phys.org

STIMULATING ENERGY INNOVATION FOR GLOBAL SUSTAINABILITY

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Abstract

Access, renewables, and efficiency have been emphasized for energy in the context of sustainable development goals. In addition, it is also important to take into consideration the dimension of resilience in energy systems. Possible measures include increasing the redundancy and diversity of the components of a system, introducing modularity in the system, and promoting distributed and decentralized systems of producing, transmitting, and utilizing energy. Novel energy technologies, notably electric vehicles and smart grids, which have been rapidly developed and adopted in industrialized countries and increasingly in emerging countries, are expected to improve the resilience of energy systems, in addition to contributing to securing access to energy for all, improving energy efficiency, and promoting renewable energies. Collaboration with stakeholders involving academia, industry, and the public sector will be particularly important to stimulate innovation on smart cities for sustainability across the globe.

Accessibility, renewables, efficiency and resilience for sustainable energy

Sustainability concerns long-term constraints on various types of resources, including energy as one of the most critical issues at the global level. The fundamental link between sustainable development and sustainable energy has been recognized internationally by the UN general assembly's declaration of 2012 as the "International Year of Sustainable Energy for All," and also of 2014–2024 as the "UN Decade for Sustainable Energy for All". Furthermore, the UN Secretary General's Sustainable Energy for All (SE4ALL) initiative sets three specific goals for the year 2030 (Secretary-General's High-Level Group on Sustainable Energy for All, 2012): ensuring universal access to modern energy services; doubling the global rate of improvement in energy efficiency; and doubling the share of renewable energy in the global energy mix.

The recommendations on energy compiled from civil society consultations, including a teleconference-based consultation that resulted in the report Advancing Regional Recommendations on the Post-2015 Agenda, an online consultation on four post-2015 reports to the Secretary-General, and a teleconference and meeting-based consultation on the UN Secretary-General's SE4ALL Initiative, as well as the Women's Major Group energy recommendations for the Open Working Group (OWG) on sustainable development goals (SDGs), made the following recommendations on energy (United Nations Non-Governmental Liaison Service, 2013): achieving universal energy access; ensuring clean, safe, and locally appropriate energy generation; advancing energy efficiency; enabling effective financing for energy; and establishing the roles of stakeholders.

OWG co-chairs' priority areas document, which was released in February 2014, summarized the proposals submitted by various stakeholders for the objectives to be included in SDGs in the area of energy as follows: ensuring universal access to modern energy services; deployment of cleaner including low- or zero-emission energy technologies; increasing the share of renewable energy in the global energy mix, including by providing policy space and necessary incentives for renewable energy; improving energy efficiency in buildings, industry, agriculture, and transport; phasing out inefficient fossil fuel subsidies that encourage wasteful consumption; mobilizing finance to invest in modern energy infrastructure; sharing knowledge and experience on appropriate regulatory frameworks and enabling environments; promoting partnerships on sustainable energy; building capacity and transferring modern energy technologies.

Although the importance of promoting access, renewables, and efficiency needs to be emphasized in proposals on energy in the context of SDGs, the aspect of resilience also cannot be ignored in considering sustainable energy systems. Today, we live in an environment that is continually faced with shocks, disturbances, and even extreme events. A disturbance or shock to the delivery of energy can lead to major socio-economic and environmental consequences. Most often, we are reminded of the destructive power that natural disasters maintain over the energy system of a region or nation. These include disasters associated, e.g., with floods, volcanic eruptions, earthquakes, hurricanes, and tsunamis. A notable example is the East Japan Great Earthquake that occurred in March 2011. This disaster caused significant disruptions on the energy system, with millions of households left without electricity not only in the area directly hit by the earthquake and tsunami, but also in other regions far remote from Tohoku. In addition to disruptions to energy systems associated with natural disasters, human mismanagement and technological errors can cause large-scale disruptions and lead to a collapse of energy systems.

It is therefore of critical importance that energy systems are equipped with

and maintain a certain level of resilience. Possible options include increasing the redundancy and diversity of the components of a system, introducing modularity in the system, and promoting distributed and decentralized systems of producing, transmitting, and utilizing energy. Innovations on energy technologies, notably electric vehicles and smart grids, have been rapidly developed and adopted in industrialized countries and increasingly in emerging countries. It is required to identify their characteristics, potentials, and challenges and to incorporate the impacts these technologies would make in pursuing the sustainability of energy systems in the future across the globe. In particular, it should be emphasized that these technologies and systems will improve the resilience of energy systems, in addition to contributing to the three targets of securing access to energy for all, improving energy efficiency, and promoting renewable energies.

Sustainability as a balance between efficiency and resilience

Recent thinking in the field of sustainability science about change, disturbance, uncertainty, and adaptability is fundamental to the governance of systems to reorganize and recover from change and disturbance without their collapse (Yarime et al., 2012). It is particularly important to recognize that the sustainability of a system can be understood as a balance between efficiency and resilience (Goerner et al., 2009; Lietaer et al., 2009; Ulanowicz et al., 2009). Efficiency is defined as the network's capacity to perform in a sufficiently organized and efficient manner as to maintain its integrity over time. Resilience is considered to be the network's reserve of flexible fallback positions and diversity of actions that can be used to meet the exigencies of novel disturbances and the novelty needed for on-going development and evolution. Rather than a static conception, the sustainability of a system requires that the system is durable and stable for generations with a sufficient capacity of resilience. It is possible that the dynamic mechanism of positive feedback growth can erode the systemic sustainability (Goerneret al., 2009).Understanding the tradeoffs between efficiency and resilience for sustainability is of critical importance in aiming at our governance of energy systems toward a more appropriate balance.

In response to the challenge of establishing governance for sustainability in many fields including energy, decision makers are increasingly voicing the need for strengthening resilience (Folke, 2006; Folke et al., 2010).We need to examine the approaches that can increase the general resiliency of a system, so that managers and policy makers will be able to assess whether the resilience of a system has increased (Kharrazi and Yarime, 2012; Kharrazi et al., 2013, 2014, 2015). This includes increasing the redundancy and diversity of the components of a system, introducing modularity in the system, and improving feedback within the system for regulatory response. Knowledge of these three methods for a given system allows policy makers with powerful tools to increase resiliency within a system to withstand a shock or disturbance, reduce risks, improve recovery, and improve regulatory feedback.

Diversity is an important concept with strong applications in various disciplines (Yarime and Kharrazi, 2015). As a basic definition, diversity is the degree of variation in a system. This can include the degree of variation in components maintaining similar functions, which can be called functional diversity, or in the components maintaining different responses to disturbances, which is response diversity (Folke et al., 2004). Diversity allows a system to be more flexible in its options when faced with a disturbance. Modularity refers to the degree to which the components of a system can be not only decomposed into separate individual units but also matched and recombined (Yarime and Kharrazi, 2015). Modularity can help contain the spread of a shock or disturbance through a system. Viewed differently, modularity is related to the connectivity within a system. A system with too much or too little modularity has fundamental trade-offs; whereas a system with too much modularity does not benefit from economies of scale associated with larger scale systems, a system with little modularity would be prone to cascading failures where a shock or disturbance can spread with high speed throughout the system. Feedback refers to the transmission of changes in one part of a system to other parts (Yarime and Kharrazi, 2015). A resilient system maintains strong feedback mechanisms for identifying thresholds and regulating the system's ability to move from one trajectory to another. Feedbacks lead to learning and self-organization toward different solutions or attractors as the new conditions arise.

The resilience of energy systems will be increased by increasing diversity in these systems, both in terms of energy production and energy consumption (Yarime and Kharrazi, 2015). This can be achieved in terms of promoting technological diversity, where, in addition to the traditional energy supplies of oil, natural gas, coal, nuclear, and hydro, new technologies, most of which would be related renewable energy sources, are developed and diffused. These new types of technologies include expansive solar, wind, geothermal, biomass, and ocean power technologies for generating energy. Diversity can further be promoted by using a wide variety of energy sources at multiple scales, for example, solar panels owned by households or a small- and medium-sized enterprise operating a wind farm. Diversity both in terms of technology and also in different scales will permit for a more flexible response to disturbances. Distributed energy systems, where electricity is generated from many small energy sources, can be designed to be modular (Yarime and Kharrazi, 2015). Currently, most countries generate electricity in very large scale and centralized systems, based on coal or nuclear power plants. Although these plants maintain the benefits associated with economies of scales, they are also unsecure, brittle, and prone to failure in case of a disturbance.

Emerging technologies for electric vehicles and smart cities

Accounting for a considerable amount of energy consumption in the world, the automotive industry is particularly facing

a significant challenge to embrace sustainability in its activities. This challenge has placed the automotive industry into a period of transformation, characterized by increased variation, experimentation, and uncertainty. Electrification of automobiles, including hybrid, fuel cells, and battery electric vehicles, has been underway as one of the approaches to address sustainability from a long-term perspective (Orsato et al., 2012). As electric vehicles are significantly different from the conventional vehicles with internal combustion engines, the automotive industry is currently under a strong pressure to innovate. As innovation involves technological, policy, and institutional aspects in integrated ways, it is of critical importance to take a systemic approach to encouraging the development and diffusion of electric vehicles.

In the past, technological change in the automotive industry in the world has been considerably influenced by environmental regulations introduced in the United States, the largest automotive market in the world (Yarime et al., 2008). The Muskie Act, which was considered as one of the most stringent environmental regulations in the world, was enacted in the United States at the beginning of the 1970s. Under this legislation, the auto industry was required to reduce the amount of emissions of carbon monoxide, hydrocarbons, and nitrogen oxides by 90%. Honda, for example, focused on utilizing its expertise in engines for technological development and became the first auto producer to succeed in complying with the stringent Californian target of emissions reduction through the development of a new type of engine, CVCC. Other auto companies such as Toyota and Nissan, on the other hand, later developed a new type of catalyst, called the three-way catalyst. Nevertheless, the two technological approaches to coping with the strong requirement of reducing automotive emissions remained within the paradigm of conventional internal combustion engines, constrained by the existing knowledge base.

In 1990, the Low Emission Vehicle regulation introduced by the California Air Resources Board required that seven large automobile producers, namely, General Motors, Ford Motors, and Chrysler in the United States and Toyota, Nissan, Honda, and Mazda in Japan, sell zero emission vehicles (ZEVs) for a small percentage of their total sales, which was to increase from 2% after 1998 to 5% after 2001 and 10% after 2003. The ZEV regulation introduced in the United States initially encouraged Japanese auto makers to develop electric vehicles, particularly battery electric cars, as they were considered to be the only option available in the industry. As the battery technologies at that time were not sufficient for commercialization, however, it was necessary to explore other technological options that could meet the stringent target of the ZEV regulation. Since the middle of the 1990s, Japanese companies have been very active in applying for patents on hybrid cars. Toyota was particularly active in developing alternative vehicle technologies and experimented various types of technologies on electric vehicles. Having worked on electric cars and nickel metal hydrate battery technologies, the company accumulated knowledge and utilized it in revitalizing the development of hybrid vehicles in-house. As the company released its first hybrid car Prius to the market in 1997, hybrid cars began to take off, and Honda started to develop technologies on hybrid vehicles. Then other major automotive producers including Nissan, Fuji Heavy Industries, and Mitsubishi Motors followed in applying for many patents on hybrid cars. Large suppliers to auto makers, such as Aisin AW and Denso, key suppliers to Toyota, are also included in major applicants. Since the early 2000s, Toyota, Nissan, Honda, and Mitsubishi Motors, as well as Japanese large electric and electronic manufacturers producing batteries, which include Hitachi, Sanyo Electric, and Panasonic, have started to make numerous applicants for patents on electric cars.

The extent to which leading auto producers are moving toward commercializing electric vehicles has been exerting a considerable impact on the automotive sector, shifting the technological trajectory and transforming the structural environment for the whole industry (Dijk and Yarime, 2010; Pohl and Yarime, 2012). Electric vehicles, which include multiple options of hybrid and fuel cell as well as battery electric vehicles, are quite distinct from conventional gasoline vehicles. The former technology critically depends on the performance of batteries, motors, inverters, and control systems, which have been traditionally beyond the expertise of automakers. Therefore, it is becoming increasingly important to incorporate different types of knowledge which are not necessarily created in-house for successful development of electric vehicles. Inter-firm relationships constitute one critical channel to produce and share new knowledge, either through a limited number of close relations like those between the Japanese automakers and battery producers, or a multitude of more open relations as in the case of the US counterparts. The strong Japanese position in battery technologies has facilitated the first step for a potential paradigmatic shift toward electric vehicles.

Recharging large amounts of electric vehicles clustered in specific areas would require additional power supply and charging stations, which leads to incurring substantial costs. Hence a large diffusion of electric vehicles will require a major innovation on the electric grid so that its control and management can be done more efficiently. The main function of the smart grid is to optimize the electric grid by efficient use of information for measuring and controlling end-points, which will enable optimization of energy production, transmission, storage, and use. When equipped with smart equipment that allows uploading as well as downloading of electricity, batteries can be used to store energy and serve as a reserve of power during the time electric vehicles are dormant. Used batteries can also provide their remaining power capacity to other uses such as backup stations, which implies extending their economic value beyond their life to power electric vehicles. Under vehicle-to-grid operations, batteries connected for recharging can also provide backup power for a number of purposes, including contingent load in the event of failure of a generating unit connected to

the grid, frequency regulation for fine-tuning the necessary instantaneous balance between supply and demand on the grid, reactive power for providing local phase-angle corrections important in AC networks, and load-following reserves, which is particularly important to backup and absorb variations in power provided by renewables such as wind and solar.

In the aftermath of the Fukushima disaster, the Japanese electricity sector has faced a serious challenge of imminent supply shortage. The electrification of mobility offers off-peak demand, which will be coupled with uncertainties on the extent of benefits and complexities of involving vehicle batteries in grid storage. As electric vehicles have started to be connected to electricity networks through the smart grid, this systemic innovation also requires active involvement of other relevant factors, such as utility providers, electric and electronic manufacturers, house building firms, and construction companies. Many of them have not been engaged in close collaboration with the automotive sector before and would have different interests and incentives, which may not necessarily compatible with each other. A key challenge for a large-scale deployment of electric vehicles will be how to implement effective integration of various types of knowledge and expertise possessed by these diverse stakeholders.

The micro grid envisions a localized collection of energy generation, storage, and transmission which, while being connected to the traditional centralized grid, is mainly targeted to a specific geographical area. In the wake of a disturbance or shock in the centralized grid, the link with the micro grid can be disconnected, and thereafter the micro grid can function autonomously on its own. Micro grids and distributed energy systems allow for greater modularity and subsequently more reliable energy in lieu of disruptions (Yarime and Kharrazi, 2015). In traditional energy systems, there was very little regulatory feedback, as real-time information was not readily available on the level of energy supply and demand. This lack of critical information requires constant oversupply of electricity, which often results in high costs. Furthermore, without dynamic information there is little regulatory control of the system to avoid collapse in case of a disturbance. To address the need for regulatory feedback in energy systems, smart technologies can be utilized effectively (Yarime and Kharrazi, 2015). Smart meters involve real-time sensors that enable two-way communication between the meter and central system, functioning as the cornerstone of the proposed smart grid system. A smart grid is a modernized electrical grid that leverages the constant feedback of information from all of its meters, sensors, and devises for quick regulatory reaction to both technological and human behavior.

It will be increasingly important to understand the emergence of new technologies such as electric vehicles and smart grids, with their characteristics, potentials, and challenges. It would be useful to elaborate how they work under what conditions and what impact they will make for the sustainability of energy systems in the future across the globe. There are leading examples of such energy systems as those in Yokohama, Austin, Amsterdam, and so on, so that they have started to be introduced in many cities and increasingly in other cities in developing countries. Innovations on energy technologies and systems are expected to improve the resilience of energy systems, in addition to contributing to the three aspects of access to energy to all, energy efficiency, and renewable energies.

Governance of innovation for sustainability

Innovation is a critical component of our efforts to tackle sustainability challenges we face today at the global level (Reid et al., 2010). Since the 1980s, when the Bayh–Dole Act was introduced in the United States, many industrialized countries have introduced policies to encourage innovation through technology transfer academia to the private sector, often with exclusive agreements on intellectual property rights (Branscomb et al., 1999; Mowery et al., 2004). Although some successful cases have been reported in transforming knowledge created by university researchers into industrial products, the existing models of university–industry–government collaboration tend to focus on narrowly-defined technical issues, mainly targeted to commercial applications (Trencher et al., 2014a, 2014b). For tackling sustainability challenges, a new approach would be required to promote innovation, involving a wider variety of stakeholders with more diverse knowledge and expertise in scientific and technological fields (Yarime et al., 2012).

Smart cities and communities are particularly considered to be one of the key areas in which a variety of science and technological knowledge need to be integrated effectively through collaboration among multiple factors. A smart city or community would involve an advanced technological system for efficient electricity supply and applications, incorporating all the behavior of the factors involved, including generators, distributors, technology developers, and consumers, through an intelligent information network. As a smart city integrates a diverse mixture of hardware as well as software in a complex way, different approaches would be possible to introducing and implementing the concept of smart cities and communities in practice, depending on the economic, social, and environmental conditions and purposes, such as energy efficiency, operating cost, environmental impact, resilience to external shocks and disturbances, and accessibility and inclusiveness to end users.

Recently, leading research universities in Asia, Europe, and North America have started to apply their expertise and sources of innovation to the goal of building smart cities and communities, involving relevant stakeholders in academia, industry, and the public sector (Trencher et al., 2013, 2014a, 2014b). A close examination of these initiatives reveals the important functions of university-driven stakeholder platforms in implementing innovation to address societal challenges (Yarime and Trencher, 2014). These include the creation of future visions based on science, setting of concrete and practical goals and targets, joint scenario making with stakeholders, securing active participation

and serious engagement of stakeholders, collection and analysis of data on societal needs and demands, development of new technologies and systems through social experimentation at universities as living laboratories, assessment of impacts with transparency, objectivity, neutrality, legitimation of innovation in society, provision of effective feedback to decision makers, incorporation into institutional design, and contribution to agenda setting at regional, national, and global levels.

On the other hand, remarkable differences are also found with regard to the direction and process of technological development on smart cities and communities between Asia, Europe, and North America. The Asian approach is characterized by a strong focus on sophistication of application technologies for extensive use of home appliances and electric vehicles. In Europe, an emphasis is placed on establishing a basic infrastructure in which information about the behavior of all the stakeholders is collected and distributed among the stakeholders appropriately so that the various objectives of the electricity grid are achieved in a more equitable way. In North America, a strong interest can be observed in creating and maintaining security through improvement in resilience against physical as well as virtual threats. These asymmetries in conceptualizing and implementing smart cities reflect the differences in how knowledge development, stakeholder networks, and institutional environment interact in dynamic and systemic manners.

These cases provide valuable insights into potential ways forward for collaboratively designing and creating knowledge and implementing innovation to tackle sustainability challenges. For follow-up efforts and new projects in the future, however, we still need to deal with remaining challenges. These include how to navigate differing motivations and incentives for serious engagement and fruitful collaboration among stakeholders, to promote joint initiatives and networking that contribute to achieving desirable goals and targets and developing complementary skills and capacities, and to identify the factors and conditions required to promote their successful implementation. The emergence of social experiments for establishing robust business models will provide valuable lessons and implications for corporate strategy, public policy, and institutional design in moving toward sustainability across the globe.

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Asia-Pacific Clean Energy Program

The Asia-Pacific Clean Energy Program (ACEP) is an outgrowth of the U.S.-Asia Pacific Comprehensive Energy Partnership, which President Obama announced at the East Asia Summit in November 2012 to support greater U.S. business engagement in the region's clean energy development. ACEP will co-locate Overseas Private Investment Corporation (OPIC) personnel with the U.S. Trade and Development Agency (USTDA) regional office at the U.S. Embassy in Bangkok to facilitate investment in – and U.S. exports for – energy projects in the region. Limited access to reliable energy and power resources represents one of the largest obstacles to social and economic growth in Southeast Asia. Due to growing demand, the region will require nearly $9 trillion in energy investments by 2035. ACEP's interagency partners, as well as the Export-Import Bank of the United States, have made available $6 billion in financing to support regional energy investments and U.S. job creation.

"As part of ACEP, USTDA is leveraging U.S. private sector expertise to foster effective new partnerships with our ASEAN counterparts geared toward increasing connectivity in a variety of sectors, including energy," USTDA General Counsel Enoh Ebong noted during the launch. "Already, USTDA's program is successfully bringing together the key players in the region to exchange ideas and offer solutions in support of ASEAN economic integration objectives."

For example, USTDA is partnering with the Electricity Regulatory Authority of Vietnam and General Electric International (GE; Schenectady, NY) to develop a wind grid code for the country's electric power sector. GE is conducting a study of Vietnam's power grid and planned wind power capacity to serve as the basis for a new grid code standard that allows for the integration and interconnection of up to 6,000 MW of new wind power. This project, along with an earlier wind energy reverse trade mission for Vietnamese power developers, has already led to export sales of U.S.-manufactured goods and services.

Ultimately, ACEP will strengthen relationships with regional power developers and host country officials to set the framework for increased deployment of clean energy resources. This work will focus on power grid modernization, natural and unconventional gas development and renewable power resources to help provide affordable, secure and cleaner energy supplies for the Asia-Pacific region.

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Renewable and sustainable energy technologies for the last mile connectivity

Bangladesh's perspectives

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Abstract

Energy is the key ingredient to alleviate poverty and to improve the socio-economic development and uplift human life style. The vision of the Government of Bangladesh (GOB) is to make electricity available for all by 2021. In order to fulfill the vision, the GOB has prepared short-, medium-, and long-term power generation plans using gas, coal, duel fuel, nuclear and renewable energy (RE) resources. RE will play a vital role in meeting the demand of electricity in future especially in the off-grid areas of the country. Realizing this fact, the government has set a target to generate 5% of the total electricity from RE resources by 2015 and 10% by 2020.To achieve this goal, electricity generation from renewable sources should be 800 MW by the year 2015 and 2,000 MW by the year 2020. To remove the barriers and to extend incentives, revision of Renewable Policy is under process. In order to achieve the target, the government has taken up different RE development programs.

Introduction

Bangladesh is a country of 147,570 sq. km. with a population of 153 million. The country has shown tremendous growth in recent years. Bangladesh has attained an average GDP growth rate of 6%. A booming economic growth, rapid urbanization and increased industrialization and development have increased the country's demand for electricity. It is recognized that energy is a key ingredient to alleviate poverty and improve the socio-economic development and uplift human life style. Realizing this important fact, the Government of Bangladesh (GOB) has set a vision to make electricity available for all by the year 2021, the Golden Jubilee Year of Independence of Bangladesh.

Bangladesh had been suffering from a mismatch between supply and demand of electricity before 2009. To overcome electricity crisis, the ruling government has given top most priority to power sector. Recognizing the importance of electricity, the GOB has diversified the fuel mix for power generation. In order to fulfill the vision and commitment of the government, immediate-, short-, medium-, and long-term power generation plan using natural gas, coal, liquid fuel, duel fuel, nuclear and renewable energy (RE) resources has been prepared. GOB has been implementing power projects under both public and private sectors.

Present electricity situation

Because of the relentless efforts of the government, commendable achievement has been made in the power sector in the recent past. The government has been able to reduce the gap between supply and demand of electricity. Currently, 68% of the population has come under electricity coverage which was 47% before 2009 and the per capita generation has been raised to 348 kWh from 220 kWh. The Table 1 shows the present electricity situation of the country.

Table 1: Present electricity situation in Bangladesh

Item	January 2015
No. of power plants	92
Power generation capacity	11,265 MW
Transmission line	9,536 circuit km
Grid sub-station	23,000 MVA
Distribution line	3.03 million km
Access to electricity	68%
Per capita power generation	348 kWh
Number of consumers	10.62 million
Average system loss	14.13%

Future planning

In order to reach the target of 2021, the government has prepared power generation master plan (PSMP 2010). Under the generation expansion plan, the government has diversified the fuel mix. Under this electricity generation program, additional 16,645 MW of electricity generation capacity will be added between 2015 and 2021.

The PSMP 2010 (which is presently under revision) sets the desired goals (Table 2):

Table 2: Goals set by the Power Generation Master Plan (PSMP 2010)

Year	MW
2016	16,000
2021	24,000
2030	40,000

Emphasis on RE

Considering the country's future energy security, the government has given due importance on RE. To expedite the process of integration of the RE technology in the country, the government has approved the Renewable Energy Policy in 2008 which became effective since January 2009. The objectives of the policy are to harness the potential of RE resources and disseminate it to the people and enable, encourage, and facilitate both public and private sector investments. In this policy, government has set a target to generate 5% of the total electricity from RE resources by 2015 and 10% by 2020. To achieve this goal, electricity generation from renewable sources should be 800 MW by the year 2015 and 2000 MW by the year 2020. To remove the barriers and to extend incentives, revision of renewable policy is under process.

Acts, rules, policies, and guidelines for the development of RE

Apart from approving the Renewable Energy Policy, some acts, policies, and regulations have been formulated to support the promotion of RE in Bangladesh. The following acts, rules, policies, and guidelines have been enacted or are under different stages of preparation:

- Electricity Act 1910; New Electricity Act 2015 under process of approval: Due importance has been given on RE.
- National Energy Policy (Revised – Draft Final): RE resources has been identified as one of the important and sustainable fuels.
- Sustainable and Renewable Energy Development Authority (SREDA) Act 2012 has been enacted to create a nodal agency to promote, develop and co-ordinate RE, energy efficiency and energy conservation programs.
- Private Sector Power Generation Policy of Bangladesh to attract private investment.
- Renewable Energy Policy 2008 (Revised – Draft Final): declaration of fiscal incentives and other benefits for RE projects.
- Emergency Energy and Power Supply Special Act, 2010: to expedite implementation and support unsolicited potential projects.
- Renewable Energy Rule (Draft) under SREDA Act: to formulate rules in details under the act.
- 500 MW Solar Program.
- Solar Program Implementation Guidelines.

Institutional framework for RE development (creation of SREDA)

The SREDA Act has been enacted in December 2012. The objectives of SREDA is to promote, develop, and co-ordinate RE and energy efficiency programs in the country. SREDA will prepare short-, medium-, and long-term plans to meet the targets set by the government through policy. SREDA will monitor all RE programs and activities implemented by the public as well as private entities. SREDA will innovate new financing and incentive mechanism for RE projects. RE rules have already been drafted under SREDA Act. Separate RE directorates have also been set up under Bangladesh Power Development Board and Bangladesh Rural Electrification Board (BREB) to carry forward research and development of RE technologies and to implement RE projects.

RE resources of Bangladesh

The prospect of RE in Bangladesh has a bright prospect. However, in the present scenario RE will remain as a supplement to conventional energy situation. RE will still play an important role to reach the consumers who are outside the national grid or where grid connection will be delayed. Major sources of RE in Bangladesh are as follows:

- solar energy;
- mini and micro hydro;
- wind energy; and
- biomass.

Solar energy

Bangladesh has bright prospect for consumer-based solar projects. However, Bangladesh is a land constraint country and cannot afford many large solar power projects. About 1 hectare (2.47 acres) of land is required for 1 MW (DC) solar power. Several RE projects are in operation mostly in consumers' base as well as community base. However, some grid tied projects are also under process of implementation.

Mini hydro & micro hydro project

Bangladesh is a flat terrain stretching from north extremity to south of the sea (Bay of Bengal) except some hilly area in Chittagong hill tracts. Hence, the gradient is not significant to offer prospect of hydroelectricity except Chittagong hill tracts. Only one hydropower plant (230 MW) exists in Kaptai in this area. Some small plants can be envisaged in this area only.

Wind energy

Bangladesh has a long coastal region. Data from earlier measurements and analysis of upper air data show that wind energy resource of Bangladesh is <7 m/s. At present, several wind resource assessment programs are ongoing in the country. Small wind turbines can be installed in the coastal regions of the country. Several organizations have installed low capacity wind turbines in the coastal region of Bangladesh. However, progress in the wind energy sector of Bangladesh is not impressive.

Biomass

Energy from biomass has prospect in the rural as well as urban areas. Apart from cow dung, other biomasses such as wood, forest residue, municipal solid waste, poultry litter, and cow dung are the popular wastes to be used as source of biomass energy. Institute of Fuel Research and Development of the Bangladesh Council for Scientific and Industrial Research (BCSIR) is carrying out different pilot projects in biomass since 1973.

Different government organizations such as Local Government and Engineering Department (LGED), Department of Public Health Engineering, Department of Livestock Services, Bangladesh Agricultural Extension Department, and NGOs are also working in this field. A project under LGED is in progress for installation of 10,000 biogas plants, of which 2,000 biogas plants are community based.

Achievement in RE sector

Commendable achievement has been made in the RE sector in the last few years. At present about 404 MW is being generated from RE sources. Solar Home System (SHS) is a success story of Bangladesh. It has been hugely popular in the rural areas of Bangladesh especially in the off-grid regions of Bangladesh. Table 3 shows the achievement made so far in the RE sector of Bangladesh.

Table 3: RE sector achievements in Bangladesh

Methods	Capacity (MW)
Installation of SHS (3.5 million)	150
Installation of roof-top PV s at government/semi-government offices	3.00
Installation of roof-top PVs in commercial buildings and shopping malls	1.00
Installation of PVs by the consumer during new electricity connections	11.00
Installation of wind-based power plants	2.00
Installation of biomass-based power plants	1.00
Installation of biogas-based power plants	5.00
Installation of solar irrigation (93 numbers)	1.00
Hydro	230.00
Total (MW)	**404.00**

RE development program

Power generation targets from RE

In line with the government's Renewable Energy Policy targets, the government has a plan to develop at least 800 MW power from RE by 2015 as stated earlier.

Table 4: Expected RE generation in Bangladesh

Resources	Capacity (MW)
Solar	500
Wind	200
Others	100
Total	**800**

Expected generation from RE under public and private sector initiatives is presented in Table 4.

500 MW Solar Program

To materialize the RE target, GOB has taken the "500 MW Solar Program". Considering project financing, implementation approach and modus operandi projects are categorized into two types: commercial projects and social sector projects. Commercial projects will be implemented by the private sector, whereas social projects will be implemented by the different ministries and agencies as a part of social responsibilities of the government. Commercial projects are (a) solar park (grid connected), (b) solar irrigation, (c) solar mini-grid/micro-grid, (d) solar rooftop; and social projects are (a) rural health centers, (b) remote educational institutes, (c) Union e-Centers, (d) remote religious establishments, (e) off-grid railway stations, (f) government and semi-government offices in the off-grid areas. Share of commercial and social projects is given in Table 5:

Table 5: Share of commercial and social solar power projects in Bangladesh

Types of projects	Capacity (MW)
Commercial solar power projects	340
Social sector solar power projects	160
Total (MW)	500

Wind resources mapping programs

Bangladesh has potential of wind energy, mainly in the coastal areas and offshore islands. Government has a plan to generate electricity from wind power under public and private initiatives. However, private investors will not feel encouraged without reliable and complete wind resources data (bankable wind data). For that reason, wind resource mapping project has been taken up by the government.

SHS program

Infrastructure Development Co. Ltd. (IDCOL) promotes and disseminates SHS program in remote rural areas through its solar energy program with the financial support from the World Bank, Global Environment Facility, KfW, GIZ, Asian Development Bank, and Islamic Development Bank. IDCOL started the program in January 2003 and till February 2015 it could successfully finance almost 3.6 million SHSs with a capacity of ~150 MW. They are installing about 80,000 SHSs per month through their partner organizations (POs). SHSs are popular among the off-grid area people where grid electricity expansion is expensive. IDCOL aims to finance 6 million SHSs by the end of 2016. Apart from IDCOL, BREB is also operating SHS program with the help of Palli Bidyut Samity (PBS). BREB started this program since 1996 and so far they have supported 15,250 SHSs of 0.9 MWp installed capacity.

Solar roof-top program in government/semi-government office

To meet the increasing demand of electricity, government and semi-government offices have also started to install roof-top solar system to meet their light and fan loads. So far they have installed roof-top solar of 3 MW capacities while installing another 1 MW system.

Solar PV installation by the new consumers

To promote renewable energy, power division has issued an executive order in 2010 addressing the new consumers to set up roof-top solar system on voluntary basis at specific percentage of total sanction load. Through this executive order and by the co-operation of the new consumers, almost 11 MW solar systems have been installed by the 24,050 consumers.

Solar irrigation

Bangladesh is predominantly an agrarian country having 14.76 million hectares of total land of which 7.56 million hectares are irrigable land. Plenty of water is needed for irrigation in Boro (dry) season (January–April). Country's agricultural sector has long tradition of being dependent on rain water for irrigation. However, mechanized irrigation took ground during early 70s with a view to increase agricul-

tural productivity. According to the survey conducted by the Bangladesh Agricultural Development Corporation (BADC) about 1.42 million diesel operated irrigation pumps require about 1 million MT imported diesel per year. On the other hand electricity demands for 0.33 million electric operated irrigation pumps are about 1700 MW. Considering the energy crisis of the country and increasing price of petroleum products across the world, it is important to explore alternative energy sources for irrigation to ensure food and energy security as well as climate change mitigation. In this context the application of solar irrigation pump has tremendous potential.

Solar powered irrigation system is an innovative, economic, and environment friendly solution for the agro-based economy of Bangladesh. This system mainly consists of solar panels and solar power operated pump. Primarily diesel operated shallow and low lift pumps preferably used in triple crop areas were targeted to get replaced by the solar irrigation pumps. Program has been taken by the government to replace 18,700 diesel-based irrigation pumps by solar irrigation pumps. The project will be implemented by IDCOL. IDCOL will select private entities (called PO) to implement the program. IDCOL will provide grant and concessionary loan and necessary technical and promotional support to the POs for successful implementation of the program. Under this program, about 150 MW of electricity will be generated.

Solar mini grid

Providing access to electricity to remote villages always lie as a challenge because either grid expansion is not possible there or would be very expensive. Government has prepared a guideline for Remote Area Power Supply System to facilitate electricity access to unprivileged areas. A commercial model has been identified under the guideline to implement the mini grid project through private sector. Each project will be implemented under distributed utility concept integrating solar-based generation and distribution management. However, government will provide necessary fiscal and financial support. Initially 30 remote Upazillas have been identified for solar mini grid where grid expansion is not planned for next 5–20 years. Total solar power capacity addition from this component will be 25 MW. IDCOL will provide grant and concessionary loan and necessary technical and promotional support to the POs for successful implementation of the program.

Solar social sector projects

As part of "500 MW Solar Program" social projects will be implemented by the different ministries and agencies as a part of social responsibilities of the government. Social projects are as follows:

- *Solar electrification in health centers*: It is estimated that there are 18,000 rural community clinics in remote villages. Many health units do not have either dependable supply or even electricity access. Electricity is required for operation of health units, surgery, and preservation of vaccinations and medicines.
- *Solar electrification in remote educational institutes*: Government plans to introduce multimedia classroom facility in each school as a part of modernization of education system. However, many remote schools do not have either dependable supply or even electricity access. This project aims to provide solar power systems to selected remote government and non-governmental educational institutions.
- *Solar electrification at union e-centers*: Government has taken a remarkable initiative by setting up about 4,501 information centers at union level to ensure access to information to all citizens of Bangladesh even to a remote villager. Because many of the unions do not have reliable electricity during day time, it would be sensible to install solar PV systems at the union information centers so that the remote villagers do not suffer for electricity outage. Nearly 1013 e-centers already have solar PV system.
- *Installation of SHS in religious establishments*: Most of the religious establishments such as mosques, temples, and pagodas are operated through government and public support. Those establishments have occasional electricity usage pattern throughout the day depending on prayer times. Many establishments are even in remote areas where there is no grid electricity. Solar electrification of those religious establishments would not only reduce pressure on grid electricity but would also ensure fulfillment of government's social commitment.
- *Solar electrification at remote railway stations*: Bangladesh railway has so far 450 railway stations. Many stations are at remote locations. Those railway stations do not have either electricity access or reliable supply. Solar PV with battery back-up supply will ensure reliable electricity access to those railway stations.

Conclusion

The government has taken all efforts to overcome problems in the power sector. It is firmly believed that Bangladesh will be able to meet electricity demand in a sustainable way. Government is pledge bound to provide electricity to all by the year 2021. Bangladesh would like to move forward with the same pace and spirit for the generation of green energy to safe environment. However, still now clean energy is not cost effective. By and large, action-oriented national commitment from all stakeholders, regulatory bodies, and support from the development partners are the key to the success for achieving the government-declared vision of "Electricity for all by 2021". However, even with the best effort of the government, total area of Bangladesh cannot be brought under national electricity grid connectivity. Approximately 10% of the remote areas of Bangladesh will remain out of national grid. For the last mile connectivity of these areas, Bangladesh will have to depend on RE technology. ■

Power generation technology assessment with considerations on environmental factors

A Vietnamese case study

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Abstract

Power generation sector is the major cause of greenhouse gas emission in Viet Nam. For the purpose of sustainable development of the national power system, it is necessary to create an indicator set to evaluate different power generation technologies. The authors used Multi-Criteria Decision Analysis, in combination with analytic hierarchy process and Expert Choice software to develop an indicator set of assessing environmental friendly power generation technology. The results showed that this methodology is applicable for energy sector. At the same time, the case study with nine existing power generation technologies in Viet Nam indicates that small hydropower is the most potential technology to be prioritized in the near future.

Introduction

Nowadays, climate change adaptation and sustainable development are the most imporant issues. As a developing country with long coastlines, Viet Nam is vulnerable to climate change and has to face with impacts of climate change on livelihood, natural resources, social structure, infrastructure, and national economy. Meanwhile, power production sector is the pollution-intensive sector, which is the cause of greenhouse gas (GHG) emission and climate change. The article constructs and develops the indicator set to prioritize different power generation technologies, which is applied into Vietnamese conditions to give out the priority list of power generation technologies.

Literature review

Power is the input for all economic activities and at the same time is a carbon intensive sector, with contribution of 35% to the national GHG emissions in 2000 (Nguyen, 2006). Therefore, the selection of power generation technology plays an important role in efficient power production and consumption, as well as GHG reduction. The power generation technology, which has high efficiency, uses variety of fuels, and reduce GHG emission, will reduce the production cost and contribute to the economic growth.

In Viet Nam, there are five thermal power generation technologies being currently employed, including pulverized coal power generation with high steam pressure, circulating fuel boiler (CFB) power generation, steam and gas cogeneration, integrated gasification combined cycle (IGCC), and cogeneration with high capacity technology (Electricity Viet Nam and Energy Institute, 2008; World Bank, 2009). Among these technologies, the most common ones are pulverized coal power generation, and steam and gas cogeneration. There still exits some power plants using diesel as input material; however, because of their low efficiency, they are not selected as developing trends in Viet Nam.

It is expected that turbine thermal power with critical and supercritical steam and CFB power generation with high capacity will be basically utilized in the near future. Moreover, heat and power cogeneration is planned to develop at larger scale (Electricity Viet Nam and Energy Institute, 2008; Vietnamese Government, 2011). It should be noted that the environmental treatment technology is not paid sufficient attention in the existing thermal power plants, and there is no assured evidence that environmental issues will be cared in the near future.

Besides, some renewable power plants have been developing in Viet Nam, including annually controlled hydropower, small and super small hydropower, solar water heating system with lower power, wind energy, low power solar photovoltaic, biomass power, or heating system (Vietnamese Government, 2011). Until 2025, it is expected that the quality and quantity of solar water heating system will be improved, in terms of its popularity and capacity. This technology will be applied at both household and public scales. Moreover, quantity and scale of wind power and solar power stations will be promoted. For biomass-based power technologies, biogas technology will be developed at high capacity to provide heat and power for households and farms, whereas biomass will be utilized to generate heat at high capacity. Other renewable power technologies including tidal power, heat–power generation from geothermal will be developed, and established reservoir hydropower will still play an important role in the energy mix (Ministry of Industry and Trade, 2008).

The power generation technology is outdated in most power plants; however, many new power plants, which will be connected into the system, are evaluated to be at technologically acceptable quality. Energy consumption technologies in other sectors are outdated and energy intensive, which is equal to 1.5 times that of other countries. The replacement of old technologies by low carbon, efficient, and advanced ones are inevitable and essential for the socio-economic

development. Therefore, it requires further study on indicators and pathways to change into the suitable technologies.

Different energy technologies have different impacts on societal issues, including positive and negative impacts. On one hand, the energy technology assists the energy accessibility of the population; improves people's living standard, and creates jobs. On the other hand, when an energy project is implemented, there will be a huge number of households required to migrate. Until the project is operating, a range of water, air, soil pollutions arises which leads to negative impacts on health and mental life of the community.

The environmental impacts of energy project largely depend on the types of technology. For example, thermal power with input material of fossil fuels is the cause of air pollution, including emission of GHG, water pollution while hydropower changes the water flow, and impacts the ecology upstream and downstream and around the reservoir. At the same time, climate change has potential impacts on energy projects. Hydropower seems to be most impacted by climate change as the amount of water reduces in summer because of increased temperature, and water evaporation. Moreover, the occurrence of severe weather events and disasters such as flood and heat waves influences the reservoir and operation regulation of the plants. The impacts of climate change on hydropower were recognized in Hoa Binh and Trian power plants, Viet Nam.

The low efficiency of the power generation technologies, high negative environmental impacts of climate change on power plants, and the scarcity of input materials for generating power indicate that some technologies have no chance to develop in the near future. The study selected nine technologies that have largest potential to develop in the near future. These technologies are selected based on its large current utilization, potential utilization, societal, economic, and environmental benefits, including:

- critical and supercritical steam turbine thermal power;
- CFB with high capacity;
- gas-steam cogeneration;
- thermal power generation at large scale;
- IGCC;
- biomass power;
- wind power;
- small hydropower; and
- reservoir hydropower.

At the same time, the construction and evaluation of an indicator set of energy technology with consideration to environmental factors will be the basis for technology prioritization which will in turn assist the decision maker in private sectors to invest on the most economical and efficient project. In case of Viet Nam, the results of the study support the decision makers at central level to draft the policy to sustainably develop the mixture of energy technology in financial constraint situation.

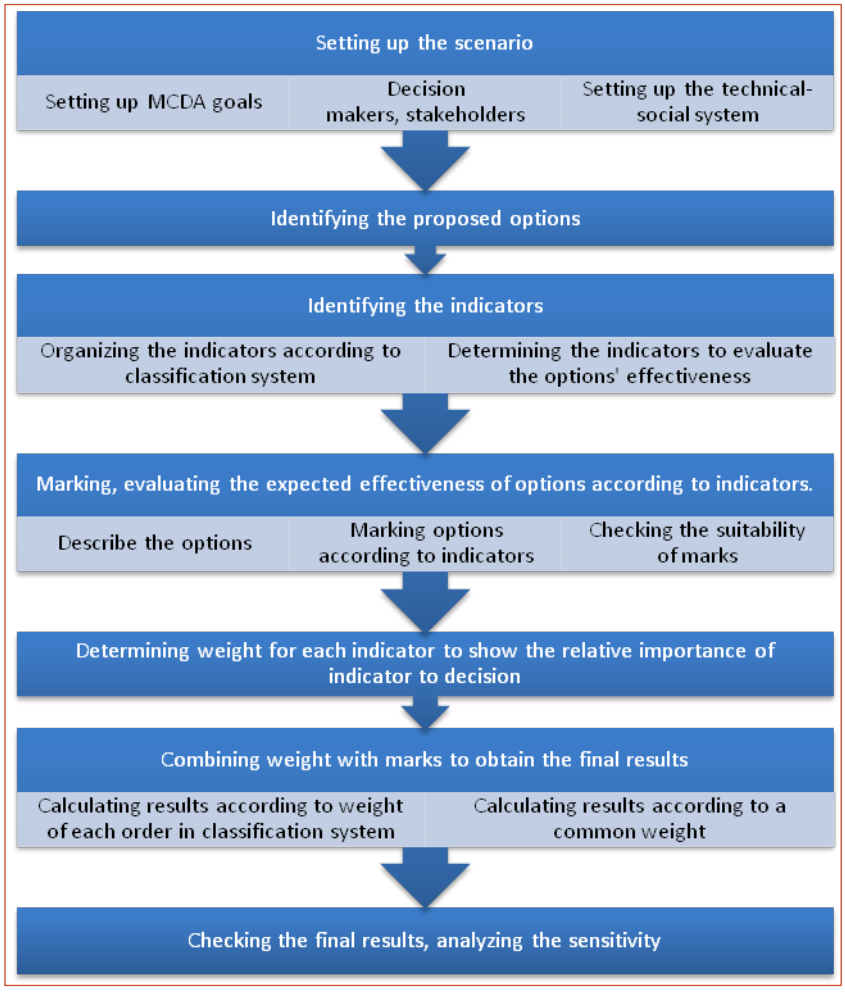

Figure 1: Steps of conducting MCDA

Methodology

The study utilized Multi-Criteria Decision Analysis (MCDA) to prioritize different power generation technologies. It is effective in solving complex problems, in which the solutions should meet financial and non-financial issues (e.g., social and environmental issues). By this method, information is organized and synthesized to support the decision makers and provide them with a comprehensive and reliable view on their decision. This methodology is also useful in classifying complex indicator groups into simple indicator sets, arranging them in order and identifying the final weight.

In this study, MCDA arranges the technologies from the most prioritized to the

least prioritized technology on the basis of its eligibility to specific indicator. It does not determine the best technology, which meets all requirements/criteria/indicators, as they are sometimes trade-offs, e.g., the technology, which brings a lot of benefits, is usually costly. Expert choice software is also used to support the technique of indicator classification of MCDA. Figure 1 presents the steps of conducting MCDA.

To identify indicators with correspondent weights and arrange the priority of the technology, analytic hierarchy process is applied. Its inputs are answers of decision makers, experts in relevant sector (e.g., energy–power) on the relative importance of indicator A compared to indicator B, which is normally called pairwise comparison. The importance of two indicators will be compared with a scale from 1/9 to 9, in which, 1/9 is totally less important and 9 is totally more important (Figure 2). The importance of the indicators, as recognized by the experts, indicates its high weight. Fifteen selected experts are professionals, experienced on energy–power sector, working in Institute of Energy – Viet Nam Academy of Science and Technology. Experts' opinions, which are equally evaluated, are collected by interview and questionnaire.

Similarly, experts' opinions are consulted to prioritize the technology. The experts are required to mark the technology with a scale of 1–100. The higher the mark, the better the technology is. There are three senior energy experts being consulted to prioritize the technology.

The software Expert Choice is utilized to analyze and process the data collected from experts' interview and questionnaire. The software classifies, selects, and orders indicator on the basis of diversified input data to create a tree model of indicators. At the same time, it evaluates the consistency and the sensitivity of the experts' opinions, in which inconsistency indicator of under 0.1 is acceptable. Input for the software includes matrix comparing the relative importance of pairs of indicators, whereas outputs are weights of indicators and marks of technologies.

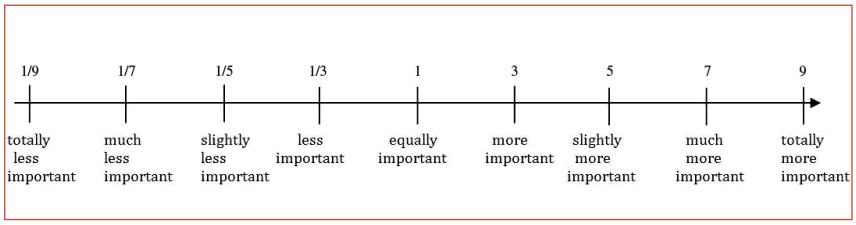

Figure 2: Scale of importance marking

Results

With the aim of maximizing the contribution of power generation technologies into sustainable development and GHG emission reduction/climate change impact reduction, the system of indicator, which covers four major aspects namely economy, society, environment, and technology, is constructed. Through group discussions among elite energy experts, lesson learnt from UNDP and UNFCCC's guidelines, Viet Nam governmental strategies on sustainable development, existing technologies, potential technologies, technological demand forecast, and capability of GHG emission reduction of technologies (Prime Minister, 2004; UNDP and UNFCCC, 2009).

The study identifies four indicator groups, including "Contribution to the nation", "Adaptive capability", "Technological feasibility", and "Financial feasibility". These indicators can be in forms of quantitative and/or qualitative data measuring and describing environmental impacts on the air, water, land, and natural resource consumption; economic impacts on the national economy, import demand, export opportunity, and energy saving; social impacts on energy accessibility, job creation, human health, and capacity building; and climate change adaptability. Figure 3 presents indicator groups and indicators.

These indicators then are compared in pairs to obtain the weights of indicators. The higher weight indicates its more importance as recognized by energy experts. The data from experts' evaluation is entered into Expert Choice software to verify its consistency and sensitivity. The evaluations that meet the requirement of consistency (e.g. inconsistency factor is smaller than 0.1) will be utilized to compare the importance of indicator, or obtain weights of the indicators. Figure 4 indicates weights of indicators.

The economic contribution is the indicator having highest weight, which indicates the importance of power generation technology to national economy, especially in a developing country like

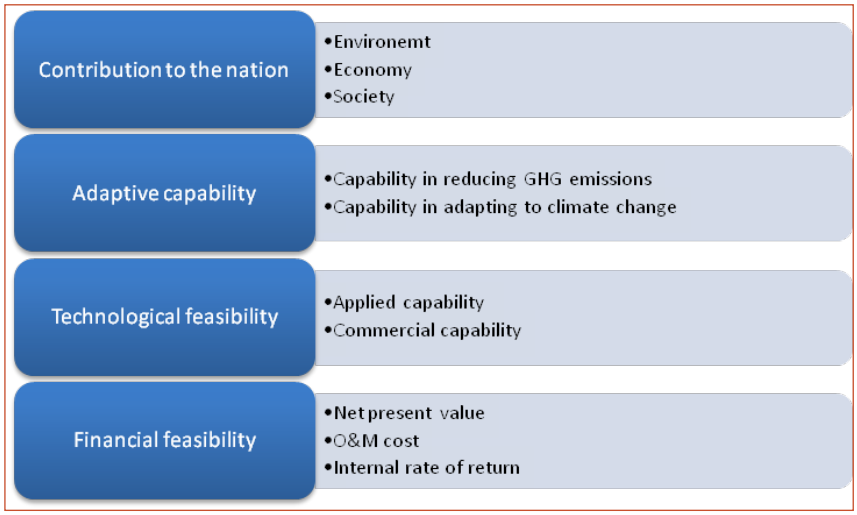

Figure 3: Indicator groups and indicators

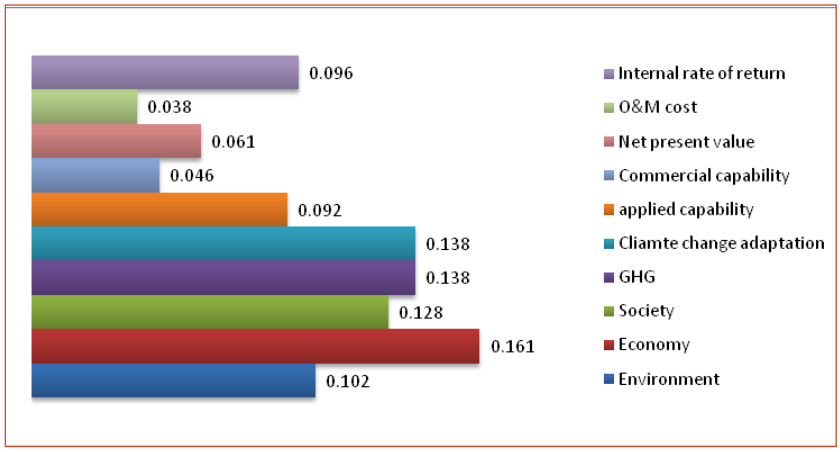

Figure 4: Final weights of indicators

Viet Nam. Also, the weights of environmental and social contributions are at high end of the scale, which is explained by the high weight of indicator group "Contribution to sustainable development".

Impacts related to climate change rank second, with capability in reducing GHG emissions and capability in adapting to climate change. Similar to "Contribution to sustainable development" indicator group, the weight of level 1 indicator "Adaptive capability" is much higher than the other remaining indicator groups, at 0.276 compared to 0.138 of "Technological feasibility" and 0.195 of "Financial feasibility".

The five remaining indicators, including applied capacity, commercial capacity, net present value, O&M cost, and internal rate of return have low weights, ranging from 0.038 to 0.096, indicating that the technological and financial feasibility are not as important as the contribution of technology to the national development and its climate change adaptation and mitigation ability.

These weights are applied to prioritize nine potential power generation technologies, namely critical and supercritical steam turbine thermal power, CFB with high capacity, gas–steam cogeneration, thermal power generation at large scale, IGCC, biomass power, wind power, small hydropower, and reservoir hydropower. The evaluation of three senior energy experts, combined with the obtained weights, shows that small hydropower is the most potential technology at 89.31. This technology should be prioritized as it brings economic, social, and environmental benefits. At the same time, it is assessed to be suitable to Viet Nam's capacity and development demand. Meanwhile biomass energy for power generation has the lowest mark at 75.9 out of 100. Its low prioritization originates from its low financial and technological feasibility, which in turn is because of disperse distribution of the input material, harvest period dependence, inconvenient and high transportation cost. Figure 5 presents the detail result of prioritized power generation technologies.

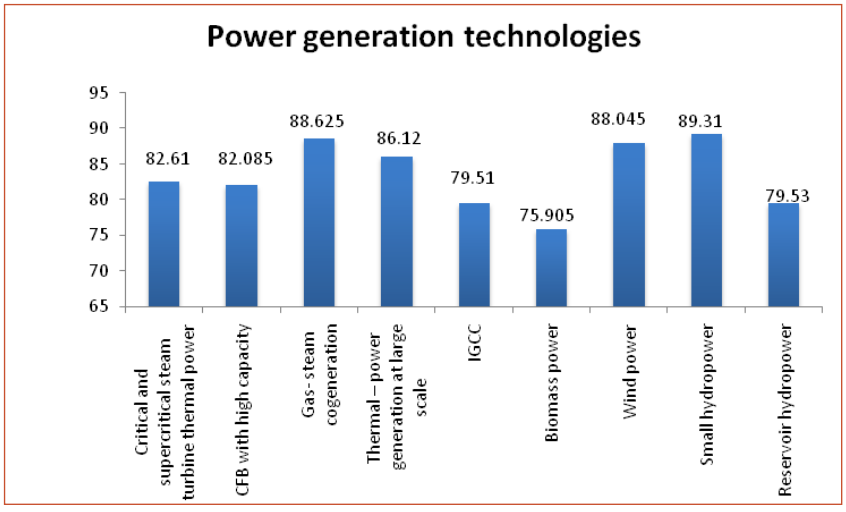

Figure 5: Prioritization of power generation technologies

The obtained results seem to be suitable to the national development requirement of Viet Nam, oriented by the government so as to industrialize, modernize, and sustainably develop the country. The prioritized technologies are advanced technologies, which have high capability of climate change adaptation and mitigation. At the same time, the results hinder the development trend of renewable energy in Viet Nam, which focus on hydropower energy and wind power.

Conclusion

In summary, the study use MCDA and expert consultation to adapt and develop an indicator set to prioritize power generation technologies, which is suitable to Viet Nam situation. The indicator set is applied to assess nine potential power generation technologies, with the most prioritized one being small hydropower. It is recommended that hydropower should be supported for sustainable energy system development and MCDA can be utilized to construct an indicator set for assessing technologies in other sectors and supporting the decision-making process in prioritizing the most beneficial technologies.

Acknowledgment

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Asia Pacific SE4All Hub

The Asia Pacific SE4All Hub is led by the Asian Development Bank (ADB), the United Nations Development Programme (UNDP) and the Economic and Social Commission for Asia and the Pacific (ESCAP), with the Hub Secretariat hosted at ADB Headquarters in Manila, Philippines. The three organizations will help catalyze major new investment opportunities to speed-up the transformation of the world's energy systems, pursue the elimination of energy poverty, and boost prosperity. The Hub will leverage on the existing structures of ADB, UNDP and ESCAP energy programs and integrate the strengths of all three development partners. It looks to grow its partnerships and consolidate efforts to promote Sustainable Energy for All in Asia and the Pacific region

The Asia-Pacific Region:

- Out of the 4.2 billion people living in the Asia- Pacific region, 615 million have no access to electricity while 1.8 billion have no access to clean cooking.
- By 2035, developing Asia's share in primary global energy consumption is expected to increase to as much as 56%.
- The region is extremely dependent on imported petroleum to meet its energy needs, particularly the Pacific Islands, which accounts for the highest of any region in the world.
- Asia-Pacific, under threat from climate change, and faced with growing dependence on energy imports, is turning to renewables to meet the energy demand.

The SE4All Asia Pacific Hub aims to accelerate and facilitate the achievement of SE4All's goals to transform energy systems for a sustainable, prosperous future by harnessing its three development partners' convening power, country presence and networks to mobilize partnerships to catalyze concrete actions at the country level.

The Asia Pacific Hub will facilitate and coordinate core activities in the region, with respect to the SE4All goals, in close cooperation with the SE4All's Global Facilitation Team. A better policy environment will accelerate the further development of sustainable energy, which is why the AP-SE4All Hub established a Sustainable Energy Center for Excellence, hosted by the Sustainable Energy Association of Singapore. The Singapore-based facility will become a venue for the region's policy makers to receive training on policy, technology, and project financing matters in the sustainable energy sector.

Forging partnerships with diverse groups of institutions is crucial in addressing energy challenges facing the region. Partnerships mobilize resources (financial, human, and others), leverage knowledge, meet unique needs for highly specialized development projects, and make aid more effective throughout Asia and the Pacific. The Asia Pacific Hub is seeking new partners to support inclusive, environmentally sustainable growth and development in the region.

Key Activities of the Asia-Pacific Hub for the SE4All Initiative:

- Support the preparation of rapid assessments, country action plans and investment prospectuses.
- Facilitate policy dialogues among stakeholders.
- Catalyze investments in energy access, renewable energy, and energy efficiency.
- Develop market-based approaches for the delivery and consumption of energy.
- Build synergies and promote knowledge sharing among its stakeholders.
- Conduct regular monitoring and evaluation of activities and initiatives of its stakeholders.

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Community-based renewable energy systems

THE PICO-HYDROPOWER PROJECT EXPERIENCE IN THE PHILIPPINES

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Abstract

The Philippines has initiated a gradual transition toward the utilization of a sustainable energy development model that seeks to minimize the use of carbon intensive technologies by accelerating the exploration and development of alternative fuels, renewable energy (RE) resources, and clean energy technologies. In line with these imperatives and the need to further sector reforms instituted through the Electric Power Industry Reform Act, the Renewable Energy Law was ratified in 2008 with the expectation of providing the Philippine energy sector with a viable alternative policy framework that synthesizes the goals of expanding the deployment of energy infrastructure and provision of energy services with national socio-economic and environmental targets. The assessment of provisions contained in existing legislative and regulatory frameworks suggests a partiality toward prioritizing the development of private utility-scale conventional and RE electric power generation capacity and the intensification of electric grid connections. The article provides a perspective of the Philippine RE industry by reviewing key policy and regulatory mechanisms with significant implications on community-managed energy infrastructure and service provision projects that utilize RE and distributed energy systems.

Introduction

Facing pressures from the relatively high growth in energy demand from the escalation of population and economic development, increasing energy rates, exposure of the local economy to risks posed by global economic disruptions and price volatility of fossil-based energy products, and the significant vulnerability of the country to effects of climate change, the Philippines has initiated a gradual transition toward the utilization of a sustainable energy development model that seeks to minimize the use of carbon intensive resources and technologies by accelerating the exploration and development of alternative fuels, renewable energy (RE) resources, and clean energy technologies. In line with these imperatives and the need to further advance sector reforms instituted through the Electric Power Industry Reform Act (EPIRA) (Republic Act No. 9136), the Renewable Energy Law (Republic Act No. 9513) was ratified in 2008 with the expectation of providing the Philippine energy sector with a viable alternative policy framework which synthesizes the goals of expanding the deployment of energy infrastructure and provision of energy services in consideration of national socio-economic and environmental targets.

The assessment of provisions contained in existing legislative and regulatory frameworks suggests a partiality toward privatization as evidenced by the development of centrally dispatched utility-scale conventional and RE electric power generation capacity and the intensification of electricity grid connections. Proponents assert that the implementation of large-scale electric power capacity addition projects combined with the extension of the grid benefits a wider quantity of people and geographic areas in terms of increasing the availability of energy services, in addition to decreasing associated operational costs and tariffs because of economies of scale. In comparison, deployment of small RE-based generation units, distributed generation systems, and projects utilizing alternative electrification topologies require higher capitalization, donor grants, or concessional loan support to achieve financial viability and eventual implementation, particularly for energy projects in small-island, isolated, and unviable locations.

The resulting paucity in investments and construction of additional electric power generation capacity and distribution facilities despite the institutionalization of the EPIRA and the Renewable Energy Law have aggravated problems in access and equitable provision of basic energy infrastructure and services to households located in rural and marginalized communities throughout the country.

The article provides a perspective of the Philippine RE industry by reviewing existing key policy and regulatory mechanisms and opens the discussion on utilizing community-based RE systems as alternative delivery mechanisms for energy infrastructure and service provision projects. The adoption of such mechanisms will ensure the balanced development of a local RE market with on-grid and off-grid segments, delineate sector governance, and harmonize the interests of the Government of the Philippines (GOP), local government units (LGUs), private RE project developers, non-government organizations (NGOs), distribution utilities (DUs), end-users, and consumers.

Assessment of outcomes from the adoption of EPIRA reforms *vis-à-vis* support to renewable energy development

The policy and regulatory framework of the Philippine electric power industry underwent extensive transformations and reforms during the past three decades, particularly with the ratification of EPIRA in 2001. The EPIRA mandated broad ranging reforms designed to improve the operating efficiency of the electric power industry and significantly reduce increas-

ing levels of public debt and financial losses incurred from contingent liabilities and the transactional costs associated with independent power producers (IPP) take-or-pay contracts, entered into by the GOP to ease the electricity capacity deficit arising from electric power crisis during the early 1990s. Applicable and significant objectives affecting RE development have been taken into consideration in the following:

- *Renewable Energy Policy Framework for the development of the RE sector with respect to adopted EPIRA reforms*: The Renewable Energy Policy Framework (2003) was formulated by the Department of Energy (DOE) as a long-term policy framework in parallel with the EPIRA to intensify the development of the RE sector within the restructured electric power industry. The objectives of the framework in line with EPIRA reforms include: (i) the promotion and widespread utilization of RE technologies and resources to double the generation capacity share of RE within the timeframe of the framework and (ii) encourage the development of a competitive market with the conventional technologies for electric power generation. Analysis shows that provisions contained in the EPIRA and the Renewable Energy Policy Framework were inadequate in supporting the development of a competitive market for RE within the effective duration of the framework, particularly for the small-to-medium scale projects using second wave technologies. In comparison, only large-scale RE projects using first wave technologies, even if executed on a project finance basis, had the capacity to compete with conventional electric power generation projects because of economic scales. In addition, the EPIRA was deficient in specifying valid technical and economic metrics specific to RE and classified RE projects under the same category as conventional electric power generation projects. For example, the EPIRA provides for the central dispatch of generation facilities based on merit order. Because RE does not utilize any fuel to produce electricity, the cost of electricity production tends to be lower in comparison to conventional electricity generation technologies. As such, the addition of RE into the generation mix should tend to lower the average cost per kWh of electricity by substantially displacing the higher priced generating capacity required during peak load. However, because of the intermittency of RE resources, there may be instances when the availability of the RE resource may not coincide with the demand in terms of quantity and the instance when the RE generating facility needs to be dispatched.
- *Total national electrification*: Accelerating the provision of basic electric services and infrastructure to communities located in remote, unviable, and missionary areas remains as one of the primary policy objectives of the GOP. The implementation of total national electrification projects and programs opens the potential toward furthering the development of RE in the country. Particularly for remote rural communities where conventional electric power generation and grid extension might not be feasible, electrification through the deployment of RE-based energy systems presents what may possibly be the least-cost option in providing remote rural and off-grid communities with access to basic energy services.
- *Establishment of alternative service delivery mechanisms for isolated and unviable areas*: The EPIRA mandates DUs to provide reliable and universally available electricity services for consumers within respective franchise areas, including isolated or economically unviable areas, deemed as missionary areas because of the distance of the locale from the main transmission/distribution grid or technical and/or geographic difficulties confronting conventional grid extension. The responsibility for the generation and/or supply of electric power in missionary areas, particularly for small-islands and isolated grids, has been delegated to the National Power Corporation Small Power Utilities Group (NPC-SPUG). In cases where the DU holding the franchise has been unable to provide an economically feasible electricity service for an unviable area within a reasonable period, EPIRA provides for the possibility of allowing neighboring DUs with franchise areas adjoining that particular unviable area to assume the provision of electricity infrastructure and services from the franchise holder. However, in the event that the franchise holder and the neighboring DUs are unable to provide electricity infrastructure and services, EPIRA further provides for the option of allowing the DU to waive the franchise and open that particular area to qualified third parties (QTPs) or as new power producers (NPPs) for delegated missionary areas, subject to the administration of NPC-SPUG and regulation by the Energy Regulatory Commission (ERC).[1] The QTP or NPP mechanism applies for DUs, private investor owned utilities, and LGUs operating small-island and isolated grids utilizing conventional and/or RE generating units.

Renewable Energy Law (Republic Act No. 9513)

Taken in part with the declaration of policy under EPIRA, the Renewable Energy Law establishes the policy framework that integrates and harmonizes initiatives of the Philippine electric power industry toward the accelerated development and advancement of RE resources, adoption of sustainable energy development strategies as mechanisms to achieve energy security, and the development of a strategic program to further the widespread utilization of RE resources and technologies. The GOP asserts the following policies and objectives with regard to the development of RE resources and technologies for both the on-grid and off-grid markets:

- Accelerate the exploration and development of RE resources and technologies to achieve energy self-reliance through

[1]ERC Resolution No.21, Series of 2011 defines NPC-SPUG areas as a locale or region not connected to the national transmission grid system, where NPC-SPUG directly supervises the provision of electric generation services, including associated delivery systems. In comparison, a delegated missionary area refers to locale or region not connected to the national transmission grid system, where a NPP has been chosen through a competitive selection process and supervises the provision of electric generation services, including associated delivery systems on behalf of NPC-SPUG.

Table 1: Fiscal incentives as provided by the renewable energy law

Fiscal incentive	RE project developers	Local RE suppliers/ equipment manufacturers
Income tax holiday (7 years)	Yes	Yes
Duty-free importation	Yes (machinery/equipment)	Yes (components/parts)
VAT-free importation		Yes (components/parts)
Special realty tax rate (1.5%)	Yes	
Corporate tax rate after income tax holiday (10%)	Yes	
Accelerated depreciation	Yes	Yes
Zero VAT rating for resales and purchases	Yes	Yes
Cash incentive (50% of the universal charge for missionary electrification)	Yes	
Tax exemption on carbon emission reduction credits	Yes	
Tax credits	Yes (domestic capital equipment and services)	Yes (domestic capital components and parts)
Net operating loss carryover	Yes	

Table 2: Non-fiscal incentives as provided by the Renewable Energy Law

Non-fiscal incentive	RE project developers	Electricity generators/ suppliers	End-users
Renewable portfolio standards	Yes	Yes	
Feed-in-tariff (technology)	Yes	Yes	
RE market	Yes	Yes	
Green energy option			Yes
Net-metering			Yes
Exception from government share	Yes (micro-scale non-commercial projects: ≤100kW)		Yes (micro-scale non-commercial projects: ≤100kW)
Exception from universal charge			Yes
Tax rebate for re-components			Yes
Financial assistance program	Yes		Yes
Incentives for host communities			Yes
Priority grid dispatch	Yes	Yes	

the adoption of sustainable energy development strategies to: (i) reduce dependence on fossil fuels; (ii) minimize exposure to the price volatility of international petroleum markets; (iii) adopt clean energy technologies to mitigate climate change; and (iv) promote socio-economic development in rural areas.

- Increase the utilization of RE through the institutionalization of the national and local capability development in the use of RE systems and the promotion of cost-effective commercial applications by providing fiscal (Table 1) and non-fiscal incentives (Table 2).

Perspectives to electrification and access to energy infrastructure and services

Over the past decade, externally supported projects and programs have made impressive gains in improving the access to electric power infrastructure and services in many developing countries. Yet nearly 1.4 billion people across the developing world (~280 million households in rural and urban communities) remain without electricity. Of the nearly 240 million unserved households located in rural areas, many reside in isolated or unviable communities far from the main electricity transmission/distribution grid or because of technical, economic, and/or geographic difficulties confronting the utilization of conventional centralized electrification topologies (Terrado et al., 2008).

Empirical studies and available literature highlight the inherent link and role of sustainable energy in environmental and socio-economic development. According to the Johannesburg Declaration, formulated during the World Summit on Sustainable Development in 2002, ensuring universal access to reliable, affordable, economically viable, socially acceptable, and environmentally sound energy services and resources underpin efforts to considerably reduce the level of poverty and must be provided in parallel to mechanisms that ensure basic socioeconomic services to people currently located within marginalized settlements or communities.

Policy imperatives for electrification

Recognizing the high correlation between the provision of energy access and socio-

economic development, the GOP has prioritized accelerated rural electrification initiatives during the past few decades and realized the electrification of nearly all villages nationwide in 2009 (NEA, 2010). However, rural electrification projects and programs initiated by the GOP and implemented under the auspices of multilateral and bilateral donors focused primarily on infrastructure development and the provision services to address basic energy needs, with the assumption that the mere provision of electricity infrastructure or services will coincidentally enhance the income of rural households and small-to-medium scale enterprises by virtue of an increase in the level of productivity (Silva and Nakata, 2009). The challenge of ensuring long-term technical and financial sustainability generally remained overlooked or underestimated during the course of project or program planning, design, and implementation.

Government policies as contained in the EPIRA and the Renewable Energy Law further dictate a move toward privatization and establishment of private–public partnerships as mechanisms to build infrastructure and provide services to the public, including the electricity generation and distribution. DOE circular DC-2004-01-001 prescribes the "rules and procedures for private sector participation in existing NPC-SPUG areas, pursuant to Rule 13 of the implementing rules and regulations of the Electric Power Industry Reform Act of 2001." The DOE circular provides a greater opportunity for the private sector in the development of conventional and RE electric power generation facilities in missionary electrification areas as QTPs or NPPs, as mentioned in the preceding sections.

Technology options

Historically, technology options have generally remained dependent on the topology applicable for the project, based mainly on the potential of minimizing the capital costs involved, available RE resources, and community load profiles, in addition to the maximum level of benefits attained as a result of project implementation. Typical electrification topologies utilized for electrification infrastructure development projects, along with some general attributes have been enumerated as follows:

- *Grid extension*: Involves the extension of national transmission and distribution lines to connect communities to the available electric power supply.
- *Isolated or mini/micro-grids*: Autonomous local distribution grid energized by a local generating plant (e.g., diesel generators, micro-hydropower turbines, hybrid-systems, and others) instead of connecting to a larger transmission and distribution network. Electrification projects utilizing an isolated grid topology involve the installation or deployment of an electric power generation plant and the construction of a local distribution grid for a particular community. The choice of technology utilized for the electric power generation plant depends primarily on the available energy resources and local conditions.
- *Stand-alone or individual systems*: Directly coupled electric power generation systems that provide electricity to a single household or to a clustered group of households without utilizing a distribution grid. Stand-alone systems may be applied in situations where the construction of a distribution grid extension or an isolated/mini distribution grid has been found to be unviable because of high investment costs, high dispersion of households, and a low estimated load density within the settlement or community.

  The advantages and the issues for these general attributes are given in Table 3.

Community participation in typical energy infrastructure projects

Based on documentation and the common experiences collated by NGOs and observed by the author on past local off-grid and missionary electrification activities, the participation of the community in DOE, NPC-SPUG, DU, QTP, or NPP initiated rural electrification projects and programs typically takes on the following forms (Penalba, 2006; Pimbert and Pretty, 1994):

- *Passive participation*: Members of the community are appraised of the project plan, objectives, and activities at some stage of project implementation. The project management provides the announcements with minimal mechanisms to respond to suggestions or comments provided by the community. All information belongs to the project proponent.
- *Participation as provider of information*: Members of the community participate in the project by providing information deemed as necessary by the project proponent. The collection of data and information conducted through the use of rapid appraisal surveys or similar methods. The results of the analysis of gathered data and information are normally shared to the community as part of the information dissemination activities of the project. Minimal opportunity exists for stakeholders to provide further feedback or influence the outcome of proceedings and implementation of the project.
- *Participation by consultation*: Stakeholders within and outside of the community are consulted by external agents, who define both the problems and the solutions by analysis of gathered information. Although the project proponents typically do not have any obligation to take the views of the community stakeholders into consideration, a modification of the project implementation methodology and outcomes may be done in light of stakeholder's feedback. As such, the consultative process does not actually offer any share in the decision making to the community stakeholders. The results of the analysis of gathered data and information are normally shared to the community as part of the information dissemination activities of the project.

General decision-making process for rural electrification projects

With the adherence of the DOE, DUs/electric cooperatives (ECs), and prospective QTPs and NPPs to an approach which focuses mainly on the technical and physical development of electric power

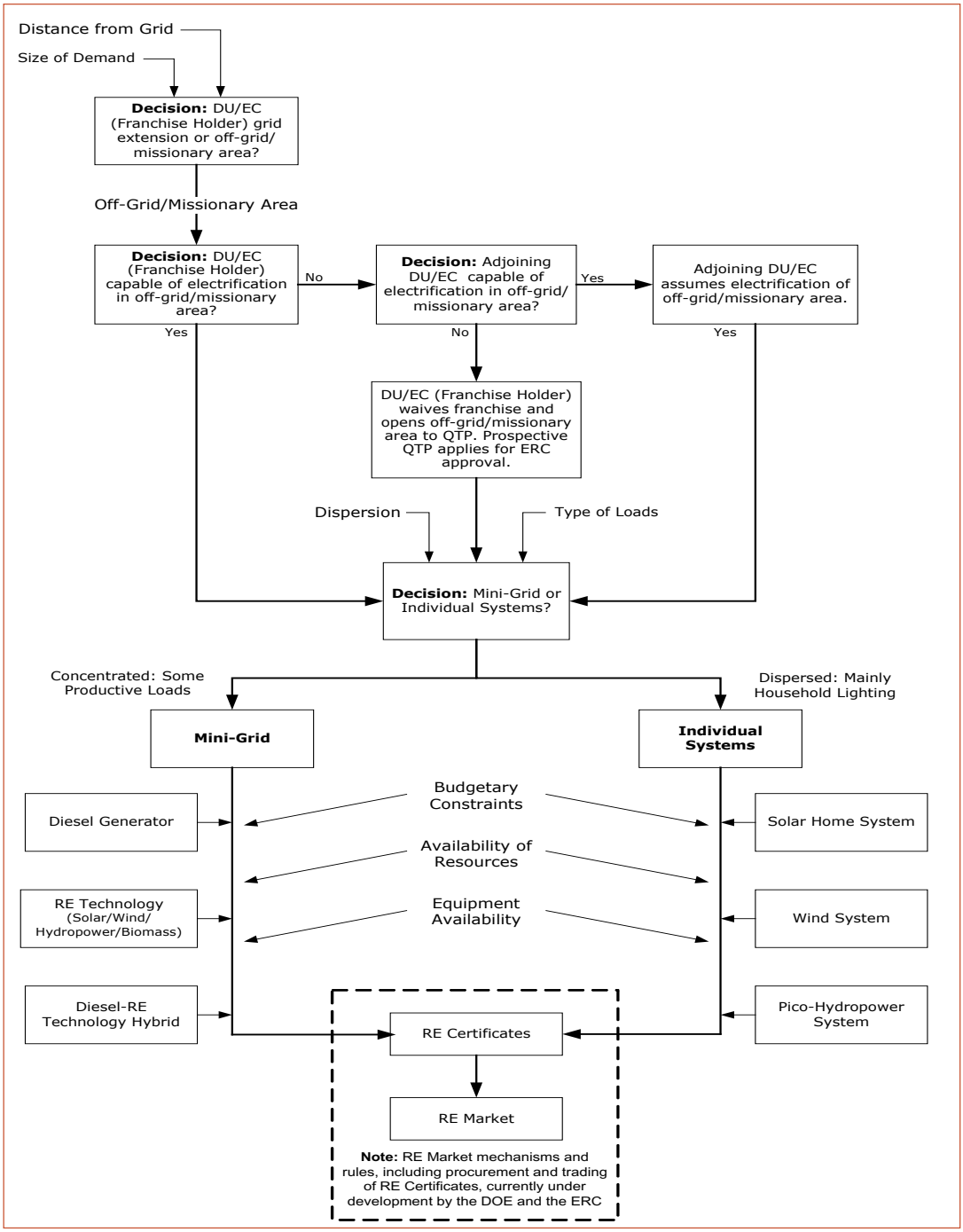
Table 3: Advantages and issues of technology options

Advantages	Issues
Grid extension	
Minimal capital costs necessary to provide a significant margin of electric power capacity in cases where conventional grid extension has been found to be a viable alternative. The high capacity margin at the outset allows the system to handle any reasonable increase in demand with no limitation on the community load density.	• DUs have little incentive to connect or extend the grid to consumers located beyond existing networks because of higher unit connection costs and a low probability of rapid cost recovery. • May be prone to pilferage.
Relatively low maintenance costs	
High technical reliability	
Isolated or mini/micro-grids	
Electric power generating equipment size based on average capacity requirements of the community, which may be less constrained compared to capacity limitations of stand-alone systems.	Investment cost may be substantial, taking into consideration acceptable thresholds in community size and load density to ensure financial sustainability of the generating plant and local distribution network.
Collective investments enable the community to procure electricity generation systems with higher quality, longer expected lifetimes, better reliability, and lower life-cycle costs compared to the use of a number of smaller stand-alone systems (Sandgren et al., 2009).	Requires the establishment of a local organization or group to manage the operation and maintenance of the power generation equipment and local distribution grid.
Facilitates transition from an isolated grid topology to grid extension by minimizing economic risks with respect to ensuring an acceptable level of load density and community size.	Available power per consumer may be constrained. In addition, lower flexibility in coping with an increase in demand and community size.
Stand-alone or individual systems	
Investment costs may be adapted to the capacity and willingness of households to pay for the system or service. Systems flexible in coping with an increase in demand because of modularity and ease of deployment.	Requires the establishment of an accessible local service center and adequate value chain for components/ systems to enable consumers to maintain, replace, and repair stand-alone system components and equipment.
Flexible delivery mechanisms such as direct sales (interest free installment payments), lease-to-own, lease with fee for service schemes, and others.	Available power per system normally constrained, resulting in low support for energy intensive loads.
Least cost option for low-income households when utilized with RE resources because of minimal operation and maintenance costs.	In cases of systems with battery storage, intensive capacity building must be conducted to ensure proper load management and utilization planning. Improper system usage can lessen battery life and system reliability.

infrastructure, the choice for a project design and mechanism for off-grid and missionary electrification takes into primary consideration the capability of the DU/EC, QTP, or NPP to provide economically feasible electric power services, based on screening criteria such as the cost of grid extension given the distance of the community or settlement from the last transmission or distribution node, size of demand, and compliance with regulatory imperatives contained in the EPIRA and the Renewable Energy Law. Once established that extending the distribution grid does not present an economically feasible methodology for electrifying an unserved community, determining the appropriate electrification topology and technology option will be the next step in the decision-making process. Implicit in the process will be the upfront collection of baseline data on household energy consumption, income, the willingness of various sectors within the community to pay for electricity infrastructure and/or services, geographic dispersion of households, existence of productive loads, and availability of local energy resources.

In cases where end-users have been found to be few and geographically dispersed and with energy consumption limited to mostly domestic lighting, DUs, prospective QTPs and NPPs, and other electric power infrastructure and service providers tend toward a project design utilizing RE technology (solar photovoltaics, wind, and run-of-river pico-hydropower)-based individual or stand-alone generation systems. In comparison, where most end-users have been found to be clustered or concentrated within a geographic area such that the load density has been found to be sufficient to economically support interconnection of end-users, project design leans toward the use of a mini- or micro-grid with a centrally located generation system using either conventional (diesel generator), RE (run-of-river micro-hydropower and mini-hydropower, wind, and biomass), or hybrid (diesel-RE) technologies.

For small-island and isolated grids, the project design typically follows a mini-grid topology and the QTP mechanism with consideration for the technology option to be utilized. Figure 1 illustrates the general decision-making process in off-grid or missionary electrification project design and the common technology options.



Source: Adapted from Terrado et al. (2008)

Figure 1: Diagrammatic representation of the current rural electrification decision-making process based on a technology driven approach and the legislative imperatives of the EPIRA and Renewable Energy Law

Community-based RE systems (CBRES) approach

The CBRES approach presents a variation on the concept of community-driven development (CDD) as applied to decentralized RE resource and technology development and the provision of basic electricity infrastructure and services to rural and off-grid areas. CBRES provides a strategy that transfers resources and delegates the control of decisions regarding resource utilization and the planning, design, and implementation of potential projects directly to community groups, as partners

in the development process. CBRES serves as an effective mechanism in implementing electricity development projects by achieving immediate and lasting results at the grassroots level. CBRES provides the following benefits (Dongier et al., 2001):

- *Improves efficiency and effectiveness in the provision of infrastructure and services*: Community management of development investments usually results in lower costs for operation and more productively employed assets. Studies conducted by Sibol ng Agham at Teknolohiya (SIBAT, 2007) and YAMOG Renewable Energy Development Group (2010) on community organized pico-hydropower and micro-hydropower systems in the Cordilleras found that systems constructed with labor equity and operated by the community had higher reliability, availability, and longevity in comparison to systems constructed under official development assistance and GOP initiated rural electrification projects and programs.
- *Complements market and public sector activities*: Experience has shown that policies aimed at promoting national economic competitiveness and government initiated public investment programs remain essential but insufficient and slow in delivering basic services and ineffective in reaching the poor and marginalized (Dongier et al., 2001; Penalba, 2006). For more than a decade, proponents of electrification through the use of off-grid and distributed RE generation technologies have employed CBRES as a platform to address critical gaps in the provision of basic energy infrastructure and services to remote and marginalized communities by achieving immediate and lasting results at the grassroots level. Available literature have established that the deployment of RE technologies utilizing the CBRES approach serves as a viable alternative in addressing the inadequate energy access of many remote and marginalized communities (Sandgren et al., 2009).
- *Renders the development process more inclusive of the interests of the poor and marginalized groups*: With the CDD characteristic of providing primary focus on community directed and managed development, CBRES employs mechanisms and elements that ensure the direct involvement of the entire community or community representatives in the planning, design, implementation, and monitoring of community RE development projects vis-à-vis the integration of such projects to market and public sector initiatives. The direct involvement of the community in decision-making and implementation provides empowerment to the community and groups within the community generally excluded or passively participating in the development process.
- *Enhances sustainability*: CBRES provides mechanisms for expressing community feedback that enhances the responsiveness of services and the sustainability of infrastructure development projects. As consumers/end-users, community members serve as the most legitimate, informed, and reliable source of information on what must be prioritized within the community. Facilities such as health centers, schools, and energy and water supply systems tend to have higher utilization rates and are better maintained than when investment decisions have been made by actors outside the community. Experience also demonstrates that the demand for a service may be better articulated when communities contribute to identifying investment costs and control investment choices (Roxas and Santiago, 2010; Silva and Nakata, 2009)
- *Empowers the poor, builds social capital, and strengthens governance – CBRES empowers the poor and marginalized*: The World Development Report (2000) identifies empowerment as one of the three elements necessary to reduce the incidence of poverty. Targeted community-driven approaches, such as CBRES, devolve control and decision-making to the poor and marginalized, which empowers them immediately and directly. Although clear rules, transparency, and accountability provide important safeguards to prevent corruption or the capture of community resources by financially capable sectors, the speed and directness with which CDD and/or CBRES empowers poor or marginalized people have been rarely matched by other institutional frameworks. Control over decisions and resources can also give communities the opportunity to build social capital (defined as the ability of individuals to secure benefits as a result of membership in social networks) by expanding the depth and range of included networks. The expansion of social networks remains critical for long-term growth and development, providing positive short-term effects on welfare and lessens risk exposure (Silva and Nakata, 2009).
- *Allows project or program initiatives to be taken to scale*: With the devolution of responsibilities and resources of individual households to the community level, activities can occur simultaneously in a large number of areas without being constrained by a central bureaucracy. When poor communities are trusted to drive development and are given appropriate information, support, and clear rules, a system can be put in place not to provide for the poor, but to facilitate an active and ongoing role in rolling out development poverty reduction efforts.

Case study: the pico-hydropower program in the Philippines

The pico-hydropower project in the Philippines was conceptualized as a CDM structured project within the parameters provided by the gold standard methodology because of the potential of family pico-hydropower systems in enhancing the access of off-grid rural households and communities to reliable energy services while reducing CO_2 emissions through the displacement of fossil fuel options, in particular, the utilization of kerosene lamps. CDM effectively reduces investment barri-

ers by increasing economic viability of the project in terms of providing financial support for initial equipment outlay for community deployments through generated emission reduction certificates.

The Nordelbisches Missions zentrum (NMZ) and the Evangelischer Entwicklung dienst provided the necessary financial support for project implementation under the condition that any generated emission reduction certificates from the project shall be transferred to NMZ.

Project outcomes and lessons learned

During the initial phase of implementation, the project has been able to deploy 35 pico-hydropower systems ranging from 200 W to 1 kW categorized as demonstration and direct community installations. The total capacity of all systems installed within the target regions is 9.3 kW, mitigating an estimated 28.25 tons of CO_2 emissions from kerosene lamps per year based on the quantity of installed systems and the estimated annual emission reduction per unit type.

Based on studies and available literature, an inherent link between sustainable energy with environmental and socio-economic development initiatives has been recognized and documented, particularly in the Johannesburg Plan of Implementation, formulated during the World Summit on Sustainable Development. According to the Johannesburg Plan, ensuring universal access to reliable, affordable, economically viable, socially acceptable, and environmentally sound energy services and resources underpin efforts to considerably reduce the level of poverty and must be provided in parallel to mechanisms that ensure basic socio-economic services to people currently located within marginalized settlements or communities. Strong community participation and organization has been an essential element of project preparation and implementation to ensure technical and economic sustainability of the pico-hydropower system installed in the community. Achieving the level of participation envisioned by the Renewable Energy Association of the Philippines (REAP) management team has been a major challenge, as most communities were situated in remote rural areas and highly marginalized with low-proficiency for project management and limited temporal and economic resources to support non-livelihood generating activities.

The project presented and confirmed the importance of CDD through the partnerships forged between the community, government institutions, and the private sector in the development of sustainable RE-based rural electrification strategies which in turn supports the establishment of productive livelihood and social applications for the community. Some of the lessons learned have been enumerated as follows:

- *Adaptation and responsiveness of community organizing approaches*: RE-based electrification projects utilizing a single homogenous approach toward community development tasks and activities must be able to adapt its approach to match the local conditions within each community based on culture, needs, and aspirations. Using such an approach provided the means of obtaining the trust and explicit consent of the community, ensuring the commitment of the community members toward taking ownership and accomplishing the objectives of the project, and thus confirming the importance of utilizing a CDD approach.
- *Community counterpart contributions*: With subsidies, grants, and financial support provided in the implementation of donor-driven energy infrastructure development projects, most community beneficiaries took on a mentality of dependency where a project or program was expected to provide everything from planning to the implementation and operational framework. This significantly lessened the responsibility, accountability, and sense of ownership of the community with respect to the objectives of the project and that of the infrastructure and equipment deployed. Participative mechanisms and partnerships ensured the understanding and appreciation of the community with regard to the value of working and contributing toward socio-economic development. In addition, the establishment of an integrated management structure facilitated the coordination and rapid mobilization of the community toward accepting and contributing to the successful implementation and sustainability.
- *Building multisectoral alliances*: Sustainable rural electrification projects require the application of multidisciplinary approaches, necessitating the forging of partnerships with as many public and private sector organizations as possible to ensure the project completion and provide access to much needed technical, financial, and marketing assistance for the development of related productive livelihood and social applications.

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Selected Renewable/Sustainable Energy Programmes in Asia and the Pacific

Asia Sustainable and Alternative Energy (ASTAE) Program

https://www.astae.net

Since 1992, the World Bank's Asia Sustainable and Alternative Energy Program (ASTAE) has been helping the East Asia and Pacific (EAP) and South Asia (SAR) regions transition to sustainable, inclusive, and low carbon green growth paths. To help countries make this transition, ASTAE's work program rests on three pillars:

- Renewable Energy,
- Energy Efficiency, and
- Access to Energy, which dovetails with the SEA4ALL objectives.

ASTAE helps to promote regional collaboration by supporting knowledge exchange and study tours between countries as part of its country-specific activities, through dedicated regional programs (such as the East Asia Clean Stove Initiative) and by replication of approaches from one country to another (such as the ASTAE-supported Energizing Green Growth of Da Nang City in Vietnam activity, which led to implementation of the process piloted in Da Nang in Surabaya, Indonesia).

Pacific Regional Data Repository

http://prdrse4all.spc.int

The Pacific Regional Data Repository is a Data and Information Revolution for the Pacific Island Countries and Territories (PICTs). It is a web-based one-stop-shop energy portal and database management system intended to support Pacific governments and their development partners working in the energy sector by facilitating access to up-to-date, reliable energy data and project information. The establishment of the PRDR supports the engagement of PICTs in the SE4ALL initiative in terms of significantly cutting down the project development time and costs, avoiding a repeat of past mistakes and efficiently replicating best practices. The existence of the PRDR significantly enhances the accountability of PICTs to its citizens and development partners alike. Furthermore, it enhances the monitoring and evaluation of the performance of PICTs under the SE4ALL initiative.

Asia Solar Energy Initiative

http://aric.adb.org/initiative/adb-asia-solar-energy-initiative

In May 2010, the Asian Development Bank (ADB) announced its Asia Solar Energy Initiative (ASEI) to catalyze generation of about 3,000 megawatts of solar power by 2013. ADB plans to provide $2.25 billion in finance to the initiative, which is expected to leverage an additional $6.75 billion in investments from others over the same period. The ASEI will make available a range of projects, and finance and knowledge sharing mechanisms, so as to attract other development banks, commercial banks, and the private sector to invest in these projects. In addition to direct financing, ASEI will set a target of raising $500 million from donor countries to "buy down" the high up-front capital costs of investing in solar energy, as well as design other innovative ways to attract private-sector investment.

Renewable Energy Support Programme for ASEAN

http://www.aseanenergy.org

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Towards sustainable energy for all in the Pacific

Charting Fiji's roadmap to success

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Abstract

Fiji, like its Pacific neighbours, has been perennially faced with issues of fossil fuel supply and the electrification of its remote rural areas, including its 300-odd outer islands. The country has, over the years, found that the most appropriate solution to this energy access and security problem is the use of Solar Home Systems (SHS) for lighting and mini-grids powered by diesel or hydropower for heavier power demands. The UN Secretary General's Sustainable Energy for All (SE4ALL) by 2030 initiative has given fresh impetus to Fiji's efforts towards finding these solutions. The country realises the role of small- and medium-sized enterprises (SMEs) towards solving its energy problems, particularly in the provision of small grid-connected power generation systems. After reviewing the Fijian energy sector, this article analyses the barriers that prospective SMEs face in entering the Fijian energy market and outlines past and the most recent actions that have been taken to overcome the problems.

Introduction

In common with other Pacific island countries (PICs), Fiji's energy scene is characterised by a heavy dependence on imported fossil fuels and problems of energy access and security faced by its rural poor (Johnston, 2012).

In an ideal world, the solution would easily be available in grid electricity for the basic domestic, commercial and industrial needs of the country. For the transportation sector, the fuel needs could be met by fossil fuels supplemented wherever possible by biofuel blends. However, the real world is always faced with issues which are absent in the ideal world. In the case of Fiji (and most of its neighbouring islands), the problem stems from their scattered islands topography (Figure 1) and the absence of indigenous fossil fuel supplies. This makes large grid supplies economically unviable for all but the largest islands, and besets the outer islands with supply chain issues with regard to the distribution of fuel for their transportation and power generation needs.

Therefore, one has to look for more innovative solutions to ensure that the population situated in Fiji's small outer islands are supplied with the basic energy necessities. Solar energy, in the form of Solar Home Systems (SHS), can supply the basic lighting needs to the rural communities. For heavier power consumption demands such as refrigerators and microwaves, the answer could lie in village mini-grids powered, e.g., by biofuel-blend fuelled diesel gensets and nano-hydro systems.

Fiji, in conjunction with its Pacific Island neighbours, has been actively engaged in working towards these goals for several decades. The SE4ALL initiative declared by the UN Secretary-General in 2012 and launched in the Pacific in 2014 (SE4ALL-Pacific, 2014) has served to add fresh impetus to these activities. The island nation has embraced this new global energy goal with enthusiasm and vigour.

However, nothing will work without the basic ingredients for success in energy development. These include availability of the renewable energy (RE) resources, the appropriate human resources, institutional mechanisms, the enabling policies and legislations and, above all, the possibility of technology transfer and the entrepreneurs who make it possible.

This article reviews the Fijian energy sector and illustrates the importance that has been placed on providing the basic energy needs for all citizens regardless of where they live or their economic status. It acknowledges the role of small and medium enterprises (SMEs) in achieving this goal, and provides an insight into the policies, institutional mechanisms as well as the capacity building required to achieve the general goal of sustainable energy for all. It ends by outlining the past and present actions taken towards achieving these ends

Background to the energy sector

Located in the South Pacific (Long 177 E to 178 W, Lat 12 to 22 S), Fiji has a land area of 18,333 km^2. However, this is distributed among ~300 small islands and two large islands of Viti Lev and Vanua Levu (which together account for 87% of the total land area) spread out over a sea surface area of 1.3 million km^2 (Figure 1).

Fiji is one of the more developed PICs. However, its varied geology of volcanic islands interspersed with coral atolls means that the country is perennially faced with energy challenges that include the full range of energy issues encountered by the other PICs. These include:

- impracticality of large grid supply due to the small size of an island population;

Figure 1: Map of the Republic of Fiji

- absence of indigenous fuel resources;
- fuel supply issues due to the remoteness of an outer island;
- lack of science and technology infrastructure, human resources and institutional and legislative mechanisms to develop and produce energy technologies (including RE technologies) locally.

Fiji thus provides a representative case study for the issues facing the sustainable energy development of the PICs.

The country's population of 850,000 is concentrated mainly on Viti Levu and Vanua Levu (Fiji Census, 2007). Table 1 provides a picture of Fiji's population distribution.

Energy access and security

The scattered topography of Fiji not only makes transportation and general accessibility difficult, but also means high differential costs of basic commodities and high risks of supply chain disruptions for the outer island (or maritime region) rural communities.

The energy access and security situation within the country may be assessed in terms of energy security indicators prepared by the regional energy policy framework (Framework for Action on Energy Security in the Pacific, FAESP) administered by the Secretariat of the Pacific Community (SPC) (SPC, 2010). These include electrification rate, access to small power in rural areas (where large grids are unavailable) and access to modern energy (including clean energy such as natural gas for cooking) in the rural and urban areas. The initial assessment of these indicators, carried out in 2012 by the SPC, is shown for Fiji and the forum island countries (FICs) in Table 2.

The figures show that although Fiji performs favourably compared to the other FICs, the biggest issue is access to electrical power in its rural areas, consisting of the maritime region and the interiors of the larger island.

Power generation and distribution in Fiji

Fiji uses four types of supply and distribution of electricity: national grid, [managed by the Fiji Electricity Authority (FEA)], mini village grids (maintained by village communities), Ministry of Works' grids (maintained by the Ministry of Works) and SHS (for individual households).

Hydro-energy has been the main source of energy in Fiji for the national power supply system since the commissioning of the Monasavu Hydro Scheme in 1983 on the main island of Viti Levu (FEA, 2013). The FEA operates four grid systems in Fiji: one on Viti Levu (known as the Viti Levu Interconnected System or VLIS), two on the island of Vanua Levu (Labasa and Savusavu), and one on Ovalau.

According to a recent government statement, the FEA provides grid-connected power to 89% of the Fiji population (Fiji Energy Forum, 2015). The electricity demand in Fiji has been growing at ~5% per annum over the last 5 years and is expected to increase significantly in the coming years. The total peak load for all the grid systems is estimated at 138 MW. FEA has a total installed capacity of about 215 MW. In 2012, about 64% of the electricity was generated from hydro and 33% from diesel generators (FEA, 2012).

Table 1: Land areas and population distributions of the islands in the Fiji group

Name of island	Area (km²)	% of total area	Estimated population	% of total population
Viti Levu	10,420	56.9	600,000	70.6
Vanua Levu	5,556	30.3	130,000	15.3
Taveuni	470	2.6	9000	1.1
Kadavu	411	2.2	10,200	1.2
Ovalau	106.4	1.1	9,100	1.1
~300 other islands	1,370	7.4	91,700	10.8
Total	**18,333**	**100**	**850,000**	**100**

Source: Fiji Department of Energy (2012)

The remainder was provided by independent power producers (IPPs) that contributed between 2% and 3% of Fiji's electricity, whereas wind and solar provided ~1% of FEA power. The electricity mix (Figure 2) shows that hydro and thermal generation were approximately equal in 2010. With the recent addition of 40 MW hydro capacity at Nadarivatu, the renewable contribution has become the lead source of electricity generation.

The problem of electrifying the rural areas of the country remains a major issue. As with its neighbouring PICs, Fiji has taken up the challenge with the use of small diesel genset-based village grids and individual SHS. The latter is a relatively recent small power solution for the remote regions. A typical SHS will consist of a solar panel (85–135 W), charge-controller/battery and inverter system that can power a few low-wattage light bulbs and a power-point. The rural power generation situation in 2014 is summarised in Table 3.

The challenges

It is clearly obvious from Table 3 that the heavy dependence of the outer island communities on the older diesel-powered technology for their power needs exists. Although the recently introduced SHS systems are able to provide ample lighting for households, they are currently catering for only 1.6% of the total electricity demand (as opposed to 96% from diesel generators) in the rural areas.

A related issue is the difficulty in the availability of diesel fuel (due to supply chain issues) on the outer islands. As a result gensets are only operated about 4 hours every evening, severely curtailing energy access and the quality of life for these communities.

Finally, there is a lack of capacity in the country in the use and management of new energy technologies, and in the administrative and institutional infrastructure required for the establishment of a new industry.

Another challenge is the lack of appropriate policies and legislation to facilitate the most appropriate and economic implementation of the technologies. Although a draft national energy policy (NEP) exists, there are no policies and legislations that facilitate the entry of IPPs into the power generation scene, or regulations enabling the individual home owner to sell power to the grid.

As mentioned earlier, Fiji and the other PICs have taken a two-pronged approach to the solution: provision of grid electricity for the more densely-populated urban areas and mini-grids and SHS for the rural communities. The FEA provides the grid electricity supply, whereas the Fiji Department of Energy (FDOE) caters for the rural electrification as well as looking after the policy issues. As similar energy challenges are shared by most of the PICs, there is call for policy-making at both the regional as well as national level among the Pacific islands.

The following sections show how Fiji and the Pacific region have been trying to address these challenges in the past, and the most recent initiatives taken towards their solution.

The regional perspective – a common energy framework

The PICs have been aware of their common energy challenges for some time and have been actively engaged in developing regional and national policies that address the problem (Singh, 2012a). At the regional level, these efforts have resulted in the eventual development, in 2010, of the FAESP (SPC 2010).

Table 2: Energy security indicator profile for Fiji and the Forum Island Countries (FICs) – 2009

Energy security indicator	Fiji	Average for FICs
Electrification rate (%)	72	23
Access to small power rural (%)	12	8
Access to modern energy rural (%)	86	36
Access to modern energy urban (%)	96	77

Source: Data extracted from SPC (2012)

The FAESP starts with clear statements of vision, goal and expected outcomes. It is based on 11 guiding principles, and seven themes that include leadership and governance, energy planning and policy, production and supply, conversion, end use, data and information and financing, monitoring and evaluation.

These statements of policies are realised via an implementation plan (called the Implementation Plan for Energy Security in the Pacific, IPESP) that assigns actual activities to the policies, apportions responsibilities and institutes a system of monitoring and evaluation.

The Fiji National Energy Policy

Fiji's first National Energy Policy, adopted in 2006, was reviewed in 2013 to take into account the numerous developments that had taken place since, chief among these

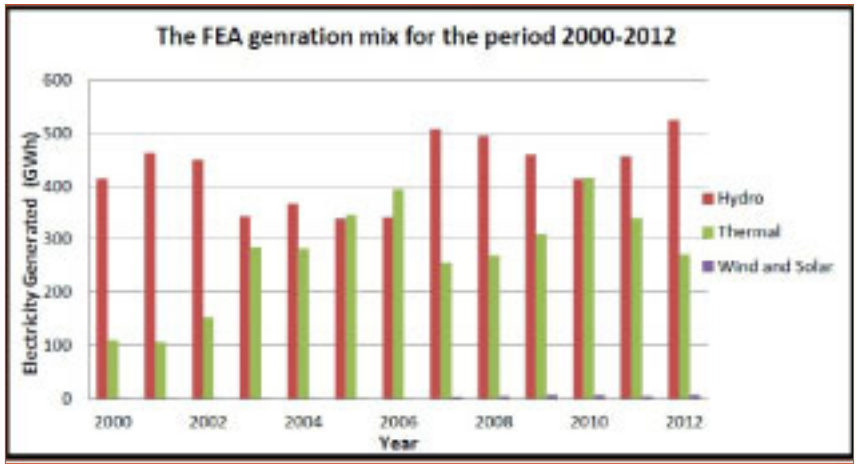

Figure 2: The Fiji Electricity Authority (FEA) energy generation mix for the period 2000–2012

Table 3: Rural power generation technologies available in Fiji in 2013

Technology	Number	Total power (kW)	% of total
Solar Home System	3,100	240	1.6
Mini hydro	1	100	0.7
Mini hydro	1	30	0.2
Biofuel (20/80) plants	4	120	0.8
Diesel units	500	14,071	96

Source: Fiji Department of Energy (2014)

being the UN Secretary-General's SE4ALL by 2030 initiative.

This revised document, the Fiji National Energy Policy 2013 (FNEP, 2013), whose final draft was completed in November 2013, has the objectives of providing all Fijians with access to affordable and reliable modern energy services, establishing environmentally sound and sustainable systems for energy production, procurement, transportation, distribution and end-use, and increasing the efficient use of energy and the use of indigenous energy sources to reduce the financial burden of energy imports on Fiji.

The document sets targets for the energy sector in line with the three objectives of the UN SE4ALL by 2030 initiative, which are universal access to modern energy services, doubling the global rate of improvement in energy efficiency (EE) and the share of RE in the global energy mix by 2030. It details specific policies for grid-based power supply, rural electrification, RE, the transport sector, petroleum and biofuels, and EE.

Fiji's rural electrification drive

To ensure that rural communities in the outreaches of the country have a better chance of enjoying the same quality of life as the urban dwellers (an unspoken motivation behind the launching of the SE4ALL initiative), a minimum level of electrification is absolutely necessary. This can be achieved through either individual home electrification via SHS or the provision of mini-grids.

Solar Home Systems

The FDOE began installing the SHS as early as 1983, starting with a few dozen systems at Namara village in Kadavu and Vatulele village in Koro (IRENA, 2013).

The projects were operated under the Renewable Energy Services Company (RESCO) scheme. Under the RESCO scheme, the equipment is owned by the government, installed and maintained by a private company, and where the home owner pays a pre-determined fee for the maintenance of the system (FDOE, 2015). The systems replace the kerosene and benzene lamps which were used earlier by the villages and provide power for small electrical appliances such as radios and mobile chargers.

Although the early projects failed due to various factors, including lack of proper management by village cooperatives and poorly trained technicians, lessons seem to have been learnt. By 2012, the FDOE had completed 2,400 SHS projects in the northern division (in the districts of Bua, Macuata and Cakudrove in Vanua Levu) alone. This has been supplemented by 1,000 systems installed through the Pacific Island Forum Secretariat's Pacific Environment Community (PEC) Fund obtained from the Japanese government under the PALM5 funding (PEC, 2012). The scheme is proving to be very popular, encouraging the FDOE to proceed with the planning of more installations in all rural villages and maritime islands.

The biofuels implementation project

SHS is not capable of providing all the electrical energy needs of the household. For higher power consumption needs, devices such as diesel generator sets (gensets) and nano- or pico-hydro systems are appropriate.

A solution to the issue of diesel supply to the outer islands is the use of alternative diesel engine fuels produced from locally available sources. These can be either pure plant oil such as coconut oil (CNO) or biofuels which are chemically derived from such oils such as biodiesel. This biofuel can be made from the chemical treatment of coconut oil and can then be used as either neat fuel for diesel engines (i.e., 100% biodiesel) or in blends such as B5 (5% biodiesel/95% petroleum diesel).

Coconut plantations occur in abundance in Fiji and the rest of the PICs. Fiji can easily produce enough biodiesel from its coconut plantations to provide all the B5 for its own fuel needs (Singh, 2012b). However, producing biodiesel is not cost effective when compared with the price of petroleum diesel in Fiji's outer islands. A cheaper alternative is to use coconut oil in engines with modified fuel injection systems, or to use CNO-diesel blends.

In the past, all copra produced in the outer islands had to be transported to a central copra mill at Savusavu in Vanua Levu. This was a costly and time-consuming task. Over the last 5 years, the FDOE has adopted a new strategy through its Biofuels Implementation Project which drastically alleviates the transportation requirement. It has done this by establishing small-scale copra mills placed strategically on the outer islands that provide the CNO production needs of the local regions. The scheme utilises village-based cooperatives which manage the milling, blending and distribution of the 20% CNO–80% diesel blends. Three mills have been operating at Koro in the eastern division, Rotuma in the far North of Fiji and Cicia in the Lau group. Others have been planned for the outer islands of Gau, Moala, Matuku, Lakeba and Kadavu.

Small hydro

Small hydro is another candidate for the rural power generation mix. Hydro-power schemes vary in size from large (>100 MW), to medium (15–100 MW), to small (1–15 MW), to mini (100 kW–1 MW), to micro (5–100 kW) and nano/pico (<1 kW). The larger schemes are capital intensive and unsuitable for the low demands of the rural context, where the grid-electricity demands can be amply met by mini/micro-hydro schemes.

The mini/micro-hydro schemes that existed in Fiji in 2014 are listed in Table 4. Currently, a 700-kW mini-hydro scheme is in the process of being constructed on the island of Taveuni, near Vanua Levu.

Table 4: Hydro schemes in Fiji in 2014

Project/scheme	Location	Year commissioned	Capacity (kW)
Wainikeu	Savusavu,Vanua Levu	1992	800
Bukuya	Ba, Viti Levu	1989	100
Buca	Cakaudrove, Vanua Levu	2011	30
Muana, Cakaudrove	Vanua Levu	1999	30
Koro	Kadavu	1994	20
Nasoqo	Viti Levu	1984	4
Vatukarasa	Viti Levu	1993	3

Dissecting the problem

Despite these efforts, the energy status quo in Fiji is far from satisfactory. The most important concern is that technology transfer is not taking place as rapidly as one would like to facilitate the desired developments in both the urban and the rural energy sectors.

It is well recognised that private sector investment, in the form of SMEs, is needed to effect successful technology transfer. However, this cannot happen unless the pre-requisites are met. In addition, they are many in number and nature. An important example is the availability of human resources. There is a need for trained and experienced person-power at all levels of the sector to facilitate the industry.

The government is aware that the real way forward for the energy industry in Fiji is through SMEs. However, despite its concerted efforts, there are currently a handful of small private sector enterprises who have established successful businesses in the country. It is a question of more SMEs flocking to the Pacific not invested in new businesses.

A major contributing factor may be lack of investor confidence. The reasons for this possible state of affairs may be conveniently analysed into obvious causes and possible causes.

Reasons for lack of investor confidence

Bureaucracy

Red tape still exists in the Fijian bureaucracy in copious amounts. The new-look Investment Fiji (formerly known as Fiji Trade and Investment Bureau) is trying to overcome the problem, but with mixed success.

Financing

Financing for start-ups is still very difficult to obtain in the country. In an effort to fill this financial gap, the Fiji Development Bank has re-invented itself to offer market-driven loans to would-be energy investors. However, few other banks seem to have joined the fray. Government subsidies for new energy industries are not conducive enough. Venture capital is virtually non-existent in the country.

Lack of facilitating legislation and regulation

This is perhaps one of the most important factors that is currently inhibiting the arrival of more SMEs to the Fijian shores. The most important deterrents to new business are as follows:

- There are no feed-in tariff legislations to assure new IPPs attractive power purchase agreements.
- There are no net-metering regulations to enable the individual home-owner to benefit from investing in domestic roof-top solar PV panels, leaving an entire new energy industry in limbo.

Possible causes for lack of investor confidence

There are other (not-so-obvious) reasons for the absence of strong interest in the Fijian and other PIC energy sectors by SMEs. They relate to understanding the market, identifying the opportunities and the local capacity for effecting such energy projects.

Assessing the true scale of the market

It is a question of availability of sufficient market for energy. The question can be answered by considering who will use the technology and where will it be used. The rural poor will be covered under the government's rural electrification scheme. However, few seem to be aware of the opportunity tourism offers. With well over 600,000 visitor arrivals in the country last year, bringing in $1.3 billion in revenues to the country, this industry is well and truly thriving. Furthermore, there is a need to electrify the tourist resorts which frequently exist on the small outer islands. The recent installation of the 240 kW PV system at the Turtle Island Resort is a case in hand (Turtle Island Resort, 2013).

Local human and institutional capacity

The lack of human capacity in the energy sector will have a critical influence on the prospects of developing any new energy enterprise in the country. Taking human capacity as an example, the scarcity of technical expertise in the country will force the new enterprise into bringing such people from abroad at great expense and potential difficulties due to the country's immigration laws. Furthermore, the lack of appropriate institutional infrastructure will cause delays in obtaining the appropriate permissions.

Fixing the problem

These issues are known to the regional and national authorities and their development partners. They began thinking about them as early as 2002 when the first attempts at a regional solution, the Pacific Island Energy Policy and Plan, was attempted. Since then, energy projects and programmes of action have been developed, as well as being vigorously pursued, by several governmental, intergovernmental, non-governmental and

tertiary sector agencies, including the Council of Regional Organisations of the Pacific (CROP) agencies.

The players

The main players that have been instrumental in developing the energy sector in the specific case of Fiji may be grouped into the FDOE (a department within the Ministry of Infrastructure and Transportation), the development partners and intergovernmental and non-governmental agencies.

The FDOE oversees energy policy developments and takes charge of the country's rural electrification scheme. The development partners include all nations and international organizations that have supported energy development in the region financially. They include the United Nations Development Programme (UNDP) and the European Union (EU) on the one hand and individual governments represented through their specific agencies such as USAid for the USA, AUSAid for Australia, JICA for Japan, and KOICA for the Republic of Korea on the other.

Energy projects are largely implemented by members of the CROP agencies. This consists of the Pacific Island Forum Secretariat, SPC, Secretariat of the Pacific Regional Environmental Programme, Pacific Power Association, the University of the South Pacific (USP), Pacific Islands Forum Fisheries Agency, South Pacific Tourism Organization and the Pacific Islands Development Programme. Figure 3 shows the picture of a 45 kW solar PV system that was donated to USP by the Republic of Korean government under the KOICA project.

Another important energy organization that has been very active in implementing energy projects in the region is the International Union for the Conservation of Nature.

Past activities

Numerous energy projects had been implemented by governments and regional agencies over the past decade, all with the implicit aim of improving the quality of life in remote areas through the provision of energy. The Fiji government's own activities had included energy resource assessments (hydropower, wind, ocean energy), implementation of small-scale hydro-power and SHS (Tables 3 and 4) and its biofuel implementation project.

Other agencies had been active in implementing energy projects in the region. Two examples were the North Pacific ACP Renewable Energy and Energy Efficiency (North-REP) project implemented by the SPC and Small Developing Island Renewable Energy Knowledge and Technology Transfer (DIREKT) project implemented by USP.

Figure 3: 45 kW grid-connected solar PV system at USP Lower Campus, Suva, Fiji Islands

North-REP project

The North-REP project contains many of the features of most donor-funded projects in the region, including awareness-raising, policy-making, resource assessment, project planning and implementation.

This four-year project (June 2010–June 2014) was funded by the EU under its European Development Fund (EDF)-10 programme with a total budget of 14.44 million euros. Its overall objective was to improve the quality of life in the Pacific nations of the Republic of Marshall Islands (RMIs), the Federated States of Micronesia and Palau through the provision of basic electricity to the outer islands and reducing fossil fuel imports through EE and the use of RE.

To achieve the above-mentioned criteria, the following process need to be implemented:

- Undertook energy resource assessments;
- Raised awareness of RE and EE through brochures and focus group meetings;
- Facilitated the development of energy policies for the countries; and
- Enabled the acquisition and installation of RE technologies on the outer islands, and set up schemes for the maintenance of the technologies.

Project DIREKT

The Project DIREKT was a 3-year EU-funded RE project undertaken by a consortium of five university campuses (Hamburg University of Applied Sciences, University of West Indies St Augustine and Cave Hill Campuses, University of Mauritius and the University of the South Pacific) that began in November 2010 with the general aim of raising awareness, building capacity and promoting knowledge and technology transfer in RE among the private sector, governmental and non-governmental organizations of the ACP

region. An important objective was the development and implementation of pilot projects in each of the five regions to demonstrate the type of technology transfer that could take place.

Towards these ends the USP organised a series of RE-awareness and networking events in Fiji, Tonga and the RMIs, as well as a pilot project in the implementation of a hydropower project to meet the basic energy needs of a remote Fijian village community in the Ra province in Viti Levu.

The pilot project is described in a video available at the project website (Project DIREKT, 2010).

Recent activities

The Fiji Renewable Energy Power Project (FREPP)

According to the government announcement at the Fiji Renewable Energy Investors Forum (see in what follows), the country will need $1.5 billion in the next 10 years to "bring clean reliable energy to the market-place", particularly in the form of grid-connected RE power. As the government will be unable to meet this financial burden in its entirety, it will need to rely on the private sector for support.

This sector, however, is currently facing various barriers to its entry into the Fijian energy market scene. The aim of the FREPP is the removal of all such barriers to private sector investment in the generation of grid-connected RE-based power in Fiji (FREPP, 2015). The Global Environment Fund (GEF)-funded project has four main components, each addressing a specific barrier, namely:

- energy policy and regulatory frameworks;
- RE resource assessments and RE-based project assessments;
- RE-based power generation demonstrations; and
- RE institutional strengthening.

The program has already produced resource assessments of the waste-to-energy potential for grid-power generation in Fiji.

Renewable Energy Investment Forum for Fiji

FREPP's most recent success was its involvement in the organization of the Fiji Clean Energy Investment Forum (also dubbed the Renewable Energy Investors Forum for Fiji) in capital city Suva on 9th April 2015 (Fiji Energy Forum, 2015).

The aim of this FDOE/UNDP/FREPP-organised event was to provide "an opportunity to present new favourable conditions in Fiji for investing in RE and engage with IPPs." The main focus was on the electricity sector, and it provided a venue for project developers, financial institutions and Fiji's power utility (FEA) to bring to light some of the promising opportunities in the power sector for investors. The event attracted a large contingent of energy entrepreneurs from several countries around the world.

Two important outcomes of the meeting were an announcement by the ministry of plans to move forward with the resolution of the energy regulatory issue and an update by FEA of the most recent large-scale grid power production projects for the country.

The Ministry for Infrastructure and Transportation (the government ministry that contains the Department of Energy) announced that the regulation of the feed-in tariff rates for IPPs and net-metering for home owners will be moved from FEA's control to an independent body which will also cater for similar regulatory needs of other sectors such as water and information technology.

The CEO of FEA provided the following update on the range of new power production projects that have either been signed off and were ready for commencement or were on the drawing board.

Three projects that were ready to roll were as follows.

- A 17.8 MW Vuda Renewable Energy Power Development project. This fuelwood-based thermal power generation project will be undertaken by AJYNK Ltd of New Zealand.
- The 40 MW Rarawai Mill co-generation plant. This $100 m project had 70% financing from the Indian government, would use the sugar-mill produced bagasse supplemented with hog-fuel from the local timber industry to produce power through the entire year and would have enhanced transmission capacity to transport the electricity to the user.
- The 10 MW ($8.4 m) Labasa co-generation project, which will also be able to run the whole year with extra fuel obtained as residues from the local timber industry.

Projects that were in the pipeline were as follows.

- The 44 MW Qaliwana (Central Viti Levu) hydro project costing $265 m.
- The 49MW, $US324 m Lower Ba River hydro project that will occur in three stages.
- The JICA-supported 32 MW Waivaka (Central Viti Levu) hydro project.

Conclusion

- Fiji is committed to the objectives of SE4ALL. Its energy development plan, in the form of its rural development policy which was instituted as early as 1983, is well in line with the SE4ALL initiative.
- The necessary steps towards achieving success for rural electrification include the political will, identification of the barriers, drawing up the appropriate plan of action and finding the funding to implement the plan. Fiji has taken up all these tasks with vigour and enthusiasm.
- The planning stage was given the necessary impetus with the revision of the 2006 NEP to produce the draft 2013 version. The barriers have been well investigated, and some of the key barriers have been identified through FREPP.
- The Renewable Energy Investors' Forum that took place recently in Suva demonstrates the country's seriousness about the removal of the barriers to grid-connected power generation in Fiji and obtaining the necessary assistance from the private sector to fill the gap in the country's power-generation requirements.

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Asia Pacific Energy Portal

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) recently launched an innovative new online portal that will provide unprecedented access to information on the energy policies of countries in Asia and the Pacific, and advance the sustainable energy agenda in the region.The Asia Pacific Energy Portal offers member States powerful tools, including highly interactive data visualizations that enable rapid trends identification as well as policy tracking and search. The unique combination of data and policy information in one application will help improve analysis of the energy situation, policies and their development impact.Alongside the portal, ESCAP also launched the first annual *Regional Trends Report on Energy for Sustainable Development in Asia and the Pacific.* The Report provides an additional platform for member States to share their experiences through case studies regarding the energy sector and its future development.

Launching the report and the portal on the sidelines of the 71st Commission session in Bangkok this week, Dr. Shamshad Akhtar, United Nations Under-Secretary General and Executive Secretary of ESCAP explained that the report and the portal are part of the three pillars of the Asia Pacific Energy Forum (APEF) Implementation Support Mechanism set up by ESCAP in 2013. "The portal will continue to evolve to further expand the knowledge base supporting both the regional and global agendas such as the Sustainable Energy for All initiative and the sustainable development goals," said Dr. Akhtar. "Future development will include incorporation of more data and the creation of energy resource and infrastructure maps. The portal could also be linked in the future with the regional data repository on Sustainable Energy for All in the Pacific."

Dr. Akhtar emphasized that APEF and its outcome documents demonstrate the commitment of ESCAP member States to cooperate on a common energy agenda that seeks a cleaner, more efficient, equitable, and secure energy future. "ESCAP is committed to support member State cooperation on a common energy agenda for shared prosperity, social equity and sustainability," she added.

For more information about the portal, access:

http://www.asiapacificenergy.org

Tech Events

2015

Jul 13–15
Beijing, China

7th Asia Pacific Biotech Congress
Contact: Guest Relations
OMICS Group Conferences
E-mail: bioasiapacific@omicsgroup.com
Web: http://www.biotechnologycongress.com

Jul 30–Aug 1
Pune, India

International Photovoltaic Solar Energy Conference (Solar Asia – 2015)
Contact: Convenors/Coordinators
Department of Physics, Savitribai Phule Pune University, Pune 411007, India
Tel: +91-20-25699072, 044-25692678
E-mails: ipsec@physics.unipune.ac.in, n.chaure@physics.unipune.ac.in
Web: http://unipune.ac.in/ipsec2015/

Aug 4–6
Bandung, Indonesia

7th Indonesia International Conference on Innovation, Entrepreneurship and Small Business (IICIES 2015)
Contact: Center for Innovation, Entrepreneurship, and Leadership (CIEL SBM ITB)
SBM ITB Building, 3rd Floor, Room 314, Jl. Ganesha No. 10, Bandung, West Java, Indonesia
Tel: +62-22-2531923, ext: 313; Fax: +62-22-2504249
E-mail: iicies@sbm-itb.ac.id
Web: http://www.iicies.org

Aug 23–25
Bangkok, Thailand

2015 International Conference on Renewable Energy and Development – ICRED 2015
Contact: Mr. Zeke Zhou
Tel: +86-27-86666663, +86-18062000004
E-mail: icred@saise.org
Web: http://www.icred.org

Sep 1–3
Bankok, Thailand

Renewable Energy World Asia Exhibition & Conference (CIEPEC)
Contact: H+K Strategies, Thailand
Tel: +66-(0)2-627-3501
E-mail: powerweek2015@hkstrategies.com
Web: http://www.renewableenergyworld-asia.com

Sep 3–4
Penang, Malaysia

2015 4th International Conference on Engineering and Innovative Materials (ICEIM 2015)
Contact: Ms. Emma Wang
Conference Secretary – ICEIM 2015
International Academy of Computer Technology (IACT)
3308 N Mayfield Ave, San Bernardino, CA 92405, USA
Tel: +1-661-888-4278
E-mail: iceim@iact.net
Web: http://www.iceim.org

Sep 16–18
Ho Chi Minh City, Viet Nam

13th Global Conference on Sustainable Manufacturing (GCSM)
Contact: Dr. Dang Quang Vinh
Vietnamese-German University, Global Production Engineering & Management, Le Lai Street, Hoa Phu Ward, Berlin, Germany
Mobile: +84-(0)-909-688-981
E-mail: gcsm@vgu.edu.vn
Web: http://www.gcsm.eu

Sep 24–26
Manila, Philippines

ENVIRO-TECH PHILIPPINES 2015
Contact: Global-Link (Global-Link Marketing and Management Services Inc.)
Unit 1003 Antel 2000 Corporate Center,
121 Valero St. Salcedo Village, Makati City, Philippines
Tel: +632-750-8588; Fax: +632-750-8585
E-mail: info@globallinkmp.com

Sep 25–26
Ho Chi Minh City, Viet Nam

The Second Gene and Immunotherapy Conference
Contact: Pham Van Phuc, Registration Manager
227 Nguyen Van Cu, District 5, Ho Chi Minh City, Viet Nam
E-mail: pvphuc@hcmuns.edu.vn
Web: http://www.biomedconference.com

Oct 5–6
Puducherry, India

International Conference on Climate Change Resilience (CCR)
Contact: Department of Ecology and Environmental Sciences, School of Life Sciences, Pondicherry University, R. V. Nagar, Kalapet, Puducherry 605014, India
Tel: +91-413-2654323
E-mail: icccr2015@gmail.com

Oct 19–21
Johor Bahru, Malaysia

2015 IEEE Conference on Energy Conversion (CENCON 2015)
Contact: Dr. Gobbi Ramasamy
Mobile: +60-13-3403323
E-mails: cencon@fke.utm.my, gobbi@ieee.org
Web: http://cencon2015.pels-malaysia.org

Oct 21–23
Shanghai, China

International Bioenergy (Shanghai) Exhibition and Asian Bioenergy Conference 2015
Contact: Conference Organizer
Tel: +39-055/500-22-80
E-mail: info@ibsce.com
Web: http://www.ibsce.com

Oct 26–29
Berlin, Germany

IEA Bioenergy Conference 2015
Contact: Fachagentur Nachwachsende Rohstoffee.V. (FNR)
Tel: +49-3843-6930-165; Fax: +49-3843-6930-102
E-mail: v.pelikan@fnr.de
Web: http://ieabioenergy2015.org

Oct 28–30
New Delhi, India

6th Annual Conference of the International Society for Integrated Disaster Risk Management (IDRiM 2015)
Contact: Technology Information, Forecasting and
Department of Science and Technology (DST),
'A' Wing, VishwakarmaBhavan, Shaheed Jeet Singh Marg,
New Delhi 110016, India
Tel: +91-11-26592600, 044-42525600; Fax: +91-11-26961158
E-mail: idrimconference@gmail.com
Web: http://www.idrim2015.org

Nov 11–12
Yogyakarta, Indonesia

International Conference on Engineering and Technology for Sustainable Development (ICET4SD) 2015
Contact: Conference Coordinator
Faculty of Industrial Technology, Universitas Islam Indonesia
JalanKaliurang Km. 14,5 Yogyakarta 55584, Indonesia
Tel: +62-274-895287; Fax: +62-274-895007
E-mail: secretariat@icet4sd.org
Web: http://icet4sd.org

Nov 12–13
Chiang Mai, Thailand

International Conference on Innovation and Sustainability 2015 (ICOIS 2015)
Contact: Mr. Sunti Senman
Humanities and Social Sciences,
Prince of Songkla University
Pattani Campus, 181 Charoen Pradit Road, Rusamilae,
Muang, Pattani 94000, Thailand
Tel: +66-813537639
E-mail: huso.conference@gmail.com
Web: http://www.icois2015.com

Nov 14–15
Dubai, United Arab Emirates

Asia-Pacific Conference on Nanotechnology (ACN'15)
Contact: International ASET Inc.
Unit No. 417, 1376 Bank St., Ottawa,
Ontario K1H 7Y3, Canada
Tel: +1-613-695-3040
E-mail: info@ACNseries.com
Web: http://acnseries.com

Nov 22–23
Colombo, Sri Lanka

Second International Conference on Environment Technology & Energy 2015
Contact: Prabhath Patabendi
Convener ETE 2015
Tel: +1-647-447-2393
E-mail: prabhath@theicrd.org
Web: http://www.enviornment3000.com

Dec 7–10
Tiruchengode, India

International Conference on Nanomaterials and Nanotechnology (NANO-15)
Contact: Prof. Dr. V. Rajendran,
Organising Chair NANO-15,
Center for Nanoscience and Technology,
K.S. Rangasamy College of Technology (Autonomous),
K.S.R Kalvinagar, Tiruchengode (Tk) 637 215,
Namakkal (Dt.) Tamilnadu, India
Tel: +91-4288-274741-4; Fax: +91-4288-274880, 274745
Mobile: +91-9994130303
E-mails: nano15@ksrct.ac.in, directorrd@ksrct.ac.in
Web: http://www.nano15.ksrct.ac.in

Tech Ventures & Opportunities

Business Coach

Tech Opportunities

Technology Resources and Networks of APC T T

Technology Opportunities
www.technology4.sme.net

Business Information
www.businesss-asia.net

Innovation Systems
www.nis.apctt.org

Biotechnology Network
www.binasia.net

Traditional Medicine Network
www.apctt-tm.net

Latest Innovations & News
www.techmonitor.net

Starting a business
Pricing your product

Business Knowledge Resource Online, India

http://www.archive.india.gov.in

Fixing the right price for a product is the most difficult task as it affects the volume of sales of the product of the firm as well as the profits of the firm. Although non-price factors have become more important in recent decades, price remains one of the important elements in determining the market share and profitability. Prices are set by a firm by taking into consideration factors like costs, profit targets, competition and perceived value of products. Taking into account the various factors, the steps generally followed in setting the price of a product are given in the following sections.

Setting the pricing objective of the firm

It is the most important step as it varies from firm to firm. Setting a lower price may attract more customers and thus fetch a larger market share for the firm's product. However, charging a higher price might reflect a high quality and prestige product.

Determining the demand for the product

Demand for the product sets a ceiling price. Penetration pricing is used when the product has a highly elastic demand and there is strong competition in the market. Under this policy, prices are fixed below the competitive level to obtain a larger share of the market. Once your product is in demand or is accepted in the market, the price of your product is increased. However, when the demand for the product with respect to price is more inelastic, higher prices are charged for the product. This policy is generally followed during the initial stages of the new product.

Estimating the costs and profits

Costs set a floor price. Amount spent and return expected is the key factor in deciding the price. The various costs involved in producing the product must be covered in pricing the product. On a long-term basis also the price be must taken into consideration along with the costs of doing business. This also includes sales forecast and profit margin.

Determining the competition for the product

Competitors' prices and the price of substitutes provide an orientation point. The number of competitors for the product in the market as well as the policy followed by them is also an important factor. Competitive pricing is used if the market is highly competitive and the product is not differentiated from that of the competitor's.

Considering the governmental regulations

Government policies and incentives are also taken into consideration. Prices are also affected by various tax liabilities which a company and the product is subjected to. It includes excise duty, sales tax and local taxes like octroi.

Sales tax is levied on the sale of moveable goods in India at the rates which vary depending on the type and nature of goods and the State in which sale has taken place. The Central and State Governments are both empowered to impose sales tax. The Central Sales tax deals with transactions in the nature of inter-state sales, whereas the State sales tax deals with intra-state sales.

Octroi is a tax levied on the entry of goods into a municipality or any other specified jurisdiction for use, consumption or sale. Goods in transit are exempted from it.

Selecting a suitable pricing method/policy

Right price for the product can be determined through pricing research and by adopting test-marketing techniques. The various pricing methods are:

- *Perceived value pricing:* A firm sets its price in relation to the value delivered and perceived by the customer. Perceived value is made up of several elements like buyer's image of the product performance, warranty, trustworthiness, esteem, etc. Each customer gives different weightage to these elements. Some may be price buyers, others may be value buyers and still others may be loyal buyers. If the price is either higher than the value perceived or lower than the value perceived, the company will not be able to make potential profits.
- *Value pricing*: Companies develop brand loyalty for their product by charging a fairly low price for a high-quality offering.
- *Going rate pricing*: It is followed if it is difficult to ascertain the exact costs involved and the competitive response. Hence, firms fix their price on competitor's price by charging the same, more or less than the major competitor.
- *Introducing a product at a premium price*: When a product is innovative and competition is low or non-existent, this policy can be applied. Thus profits are optimised. However, when competition arises prices are lowered.
- *Ethical pricing*: Price is fixed keeping the welfare of the society in mind. For many life-saving drugs, this particular policy is used. The product is sold at the lowest possible price with

either a very reasonable margin or no profit at all. Profit may be earned from other products.

- *Full line pricing*: If you are selling a range of particular product, e.g., pickles, then you fix the price for the product in a particular range, this way you may earn more profit in one flavour and less on the other. However, you cannot sell only the one that gives maximum profit, or else a customer may switch over to another brand where he/she would be able to exercise an option for other flavours.

The Central and State Governments have passed certain legislations to control production, supply, distribution as well as price of a number of commodities. The Essential Commodities Act,1955, is one such important legislation. Under the Act, the State Governments/UT Administrations have issued various control orders to regulate various aspects of trading in essential commodities such as food grains, edible oils, pulses, kerosene, sugar, etc. The Central Government regularly monitors the action taken by State Governments/UT Administrations to implement the provisions of the Act.

The Government is empowered to enlist any class of commodity as essential commodity as well as regulate or prohibit the production, supply, distribution, price and trade in any of these commodities for the following purposes:

- maintaining or increasing their supplies;
- equitable distribution and availability at fair prices of the commodities concerned; and
- securing any essential commodity for the defence of India or the efficient conduct of military operations.

The list of commodities declared as "essential" under the Essential Commodities Act, 1955, is reviewed from time to time in the light of changes in the economic situation and particularly with regard to their production and supply. For example, keeping in view production and demand of some of the commodities, it was felt that these could be removed from the list of essential commodities. Hence, with effect from 15th February.2002, Government removed 11 classes of commodities in full and one in part from the list of commodities declared as essential under the Essential Commodities Act, 1955. Similar efforts are underway to delete more commodities from the purview of the Act to facilitate free trade and commerce, for which alternative legal mechanism is being worked out for protection of consumers' interest etc.

Creative Productivity Index: Analysing Creativity and Innovation in Asia

This report presents the results and analysis of the Creative Productivity Index (CPI) for a select number of Asian economies. The CPI was built by The Economist Intelligence Unit. The Asian Development Bank (ADB) commissioned the work on developing the CPI as part of an overall study on Asia's knowledge economies. The report provides a benchmarking of a number of economies in Asia on creative productivity, an important attribute for strengthening knowledge-based economic development. This index gives policy makers a unique tool to assess how to foster creativity and innovation in Asia. Innovation-led growth is crucial for developing Asia to maintain and accelerate the pace of growth of its economies.

Following are the key findings of the CPI:

- Japan leads the CPI, followed by Finland and the Republic of Korea;
- Cambodia and Pakistan, with much room for improvement, are ranked lowest in the CPI;
- Singapore leads the CPI for innovation inputs;
- Finland and Hong Kong, China are best in the CPI for innovation outputs;
- Low- and middle-income economies will benefit most from policies to increase creative inputs; and
- There are many different dimensions of creativity that are captured in this report.

Many Asian developing economies face a challenge to avoid being stuck in the middle-income trap. They need to transition from an imitation-driven economy to an innovation-based growth model more commonly found in developed countries. Richer economies are clearly able to invest more in physical infrastructure such as transport networks, communications, and power generation, which are key underlying factors in economic creativity and innovation. However, some differences are a result of the enabling environment that facilitates the generation of creative outputs from creative inputs. A poorer country may not be able to muster the same level of creative inputs as a richer country, but can still benefit by using what resources it does have efficiently. While the precise policy recommendations will differ for each economy, the results of this report highlight a number of important policy areas where an increased emphasis would be beneficial for many Asian economies.

For more information, contact:

Asian Development Bank
6 ADB Avenue, Mandaluyong City 1550
Metro Manila, Philippines
Tel: + 63 2 632 4444; Fax: +63 2 632 4442
Web: http://www.adb.org

Setting up a business in Thailand

Accounting and financial reporting requirements

Thailand Board of Investment, Thailand

http://www.boi.go.th

Books of accounts and statutory records

Companies must keep books and follow accounting procedures as specified in the Civil and Commercial Code, the Revenue Code and the Accounts Act. Documents may be prepared in any language, provided that a Thai translation is attached. All accounting entries should be written in ink, typewritten or printed. Specifically, Section 12 of the Accounts Act of 2000 provides rules on how accounts should be maintained:

"In keeping accounts, the person with the duty to keep accounts must hand over the documents required for making accounting entries to the bookkeeper correctly and completely, in order that the accounts so kept may show the results of operations, financial position according to facts and accounting standards."

Accounting period

An accounting period must be 12 months. Unless the Articles of Association state otherwise, a newly established company should close accounts within 12 months of its registration. Thereafter, the accounts should be closed every 12 months. If a company wishes to change its accounting period, it must obtain written approval from the Director-General of the Revenue Department.

Reporting requirements

All juristic companies, partnerships, branches of foreign companies and joint ventures are required to prepare financial statements for each accounting period. The financial statement must be audited by and subjected to the opinion of a certified auditor, with the exception of the financial statement of a registered partnership established under Thai law, whose total capital, assets and income are not more than that prescribed in Ministerial Regulations. The performance record is to be certified by the company's auditor, approved by shareholders, and filed with the Commercial Registration Department of the Ministry of Commerce and with the Revenue Department of the Ministry of Finance.

Accounting principles

In general, the basic accounting principles practiced in the USA are accepted in Thailand, as are accounting methods and conventions sanctioned by law. The Institute of Certified Accountants and Auditors of Thailand is the authoritative group promoting the application of generally accepted accounting principles.

Any accounting method adopted by a company must be used consistently and may be changed only with approval of the Revenue Department. Certain accounting practices of note include the following items.

Depreciation: The Revenue Code permits the use of varying depreciation rates according to the nature of the asset, which has the effect of depreciating the asset over a period that may be shorter than its estimated useful life. These maximum depreciation rates are not mandatory. A company may use a lower rate that approximates the estimated useful life of the asset. If a lower rate is used in the books of the accounts, the same rate must be used in the income tax return.

Accounting for Pension Plans: Contributions to a pension or provident fund are not deductible for tax purposes unless they are actually paid out to the employees, or if the fund is approved by the Revenue Department and managed by a licensed fund manager.

Consolidation: Local companies with either foreign or local subsidiaries are not required to consolidate their financial statements for tax and other government reporting purposes, except for listed companies, which must submit consolidated financial statements to the Securities and Exchange Commission of Thailand.

Statutory Reserve: A statutory reserve of at least 5% of annual net profit arising from the business must be appropriated by the company at each distribution of dividends until the reserve reaches at least 10% of the company's authorised capital.

Stock Dividends: Stock dividends are taxable as ordinary dividends and may be declared only if there is an approved increase in authorised capital. The law requires the authorised capital to be subscribed in full by the shareholders.

Auditing requirements and standards

Audited financial statements of juristic entities (i.e., a limited company, registered partnership, branch, representative office, regional office of a foreign corporation, or joint venture) must be certified by an authorised auditor and be submitted to the Revenue Department and to the Commercial Registrar for each accounting year.

However, for a registered partnership with registered capital of less than 5 million baht, total revenue of no more than 30 million baht and total assets of no more than 30 million baht, financial statement does not need to be certified by an authorised auditor.

Auditing practices conforming to international standards are, for the most part, recognised and practiced by authorised auditors in Thailand.

Technology transfer arrangement in the Philippines

Intellectual Property Office of the Philippines (IPOPHL)

http://www.ipophil.gov.ph

Technology Transfer Arrangement refers to contracts or agreements, including renewals thereof, involving the transfer of systematic knowledge for the manufacture of a product, the application of a process, or rendering of a service including management contracts; and the transfer, assignment or licensing of all forms of intellectual property (IP) rights, including licensing of computer software except computer software developed for mass market.

The signing of Republic Act 8293, otherwise known as the IP Code, on June 6th, 1997, liberalizes regulations on technology transfer registration particularly the rate of fees or royalties and strengthens IP rights protection in the Philippines. Voluntary Licensing has been provided by the Code. Recordal with the IP Philippines of agreements that involve transmission of rights is necessary. However, registration is no longer required where the agreement is in conformity of the requirements of the law under Sections 87 and 88.

Section 87 of the IP Code covers the prohibited clauses which are adverse to competition and trade.

Prohibited Clauses (Section 87, IP Code)

1. Those that impose on the licensee the obligation to acquire from a specific source capital goods, intermediate products, raw materials, and other technologies, or of permanently employing personnel indicated by the licensor;
2. Those pursuant to which the licensee reserves the right to fix the sale or resale prices of the products manufactured on the basis of the license;
3. Those that contain restrictions regarding the volume and structure of production;
4. Those that prohibit the use of competitive technologies in a non-exclusive technology transfer arrangement;
5. Those that establish full or partial purchase option in favor of the licensor;
6. Those that obligate the licensee to transfer for free to the licensor the inventions or improvements that may be obtained through the use of the licensed technology;
7. Those that require payment of royalties to the owners of patents that are not used;
8. Those that prohibit the licensee to export the licensed product unless justified for the protection of the legitimate interest of the licensor such as exports to countries where exclusive licenses to manufacture and/or distribute the licensed product(s) have already been granted;
9. Those that restrict the use of the technology supplied after the expiration of the technology transfer arrangement, except in cases of early termination of the technology transfer arrangement because of reason(s) attributable to the licensee;
10. Those that require payments for patents and other industrial property rights after their expiration or termination of the technology transfer arrangement;
11. Those that require that the technology recipient shall not contest the validity of any of the patents of the technology supplier;
12. Those that restrict the research and development activities of the licensee designed to absorb and adapt the transferred technology to local conditions or to initiate research and development programs in connection with new products, processes or equipment;
13. Those that prevent the licensee from adapting the imported technology to local conditions, or introducing innovation to it, as long as it does not impair the standards prescribed by the licensor; and
14. Those that exempt the licensor from liability for non-fulfillment of his responsibilities under the technology transfer arrangement and/or liability arising from third party suits brought about by the use of the licensed product or the licensed technology.

On the other hand, Section 88 of the IP Code contains provisions that need to be included in voluntary license agreement as follows:

1. The laws of the Philippines shall govern the interpretation of the agreement and in the event of litigation, the venue shall be the proper court in the place where the licensee has its principal office.
2. Continued access to improvements in techniques and processes related to the technology shall be made available during the period of the technology transfer arrangement.
3. In the event the technology transfer arrangement shall provide for arbitration, the Procedure of Arbitration of the Arbitration Law of the Philippines or the Arbitration Law of the United Nations Commission on International Trade Law or the Rules of Conciliation and Arbitration of the International Chamber of Commerce shall apply and the venue of arbitration shall be the Philippines or any neutral country.
4. The Philippine taxes on all payments relating to the technology transfer arrangement shall be borne by the licensor.

Technopreneurship and commercialization in Malaysia

Technology Park Malaysia, Malaysia
http://www.tpm.com.my

Centre for Technology Commercialization

Where high tech happens?

The Center for Technology Commercialization (CTC) is dedicated to stimulate the needs of the country's key stakeholders in harnessing technology for wealth creation. Universities, research institutes, venture financiers, technopreneurs, intellectual property specialists, governmental regulators, researchers, business entities, and industry players will come together at CTC to make technology commercialization a reality.

The future of great ideas

The CTC offers advisory and consultancy services in facilitating technology transfer, research and development (R&D) commercialization, project management, strategic intellectual property management advice, market research, and opportunity analysis as well as professional development programs to increase commercial potential of projects.

In collaboration with the Ministry of Science, Technology, and Innovation (MOSTI)

The CTC is working with the Innovation and Commercialization Division of MOSTI toward the commercialization of products developed through R&D activities sponsored by the Ministry, by way of MOSTI/TPM products commercialization prospecting sessions. CTC's project monitoring team has also been appointed by MOSTI to manage and monitor grants given out under the Technofund, Sciencefund, and Innofund grants. These grants are for the Biotechnology, Agriculture, and Industry Clusters to encourage development of new products for commercialization.

CTC impacts

- *Equipped with experienced managers*: CTC's service offerings include the facilitation of business matching for start-ups and early-stage enterprises for the following conditions:
  - Conducting market survey for companies intending to embark on new product development recognizing the importance of knowing which features are needed or often used by customers and what kind of support they require.
  - Organizing round table discussions with relevant technical and business experts to develop the best possible strategies and bringing new intellectual insight for specific business enhancements.
  - Sourcing of experts and advisory personnel to be part of organizations that require such services on specific needs or retainer basis.
  - Developing links between institutes of higher learning, Government R&D institutions, funding organizations, and Government implementing agencies – parties that form the research and innovation value chain.

Innovation Incubation Center

The Innovation Incubation Center (IIC) aspires to accelerate the growth of technopreneurs in the renewable energy, ICT, biotech and engineering industries to grow from ideation to commercialization via provision of intervention programs in critical areas.

IIC objectives

- To incubate and nurture knowledge-based enterprises by providing expertise and support in technical and business skills.
- To provide handholding services that include comprehensive coaching, mentoring, consultancy, and training to enhance technopreneurship.
- To facilitate technopreneurs for better access to funding.
- To facilitate R&D, innovation and commercialization activities by providing advanced infrastructure, equipment, and facilities.
- To facilitate government & private sector smart partnerships in technology development and commercialization of research results.
- To provide a platform for the establishment of strategic business, and market linkages for the incubates/technopreneurs with MNCs, GLCs, research institutes, academia, financial community, and industry, locally and globally.

SME Finance Initiative

The SME/Finance Initiative (SME/FI) is a knowledge-cum-business network that will put together development banks, other specialized financial institutions and development organizations in different countries to discuss and address specific issues in the financing of and other support services to SMEs.

For more information, access:
http://www.smefi.com

Starting a business in Malaysia

Source of funds

SME Corp., Malaysia

http://www.smeinfo.com.my

How much money do you need?

It depends on your type of business and how quickly you plan to expand. You should sit down and write out how much your expected expenses will be for at least the next 24 months and how much you project to bring in as far as income on a monthly basis. There are several companies that can help you get started with funding your business.

You can refer back to your business plan or start asking yourself what type of expenses do you need the money for? Generally, for a start-up business, there will be a few costs involved as in what follows:

- *Cost of sales*: Product inventory, raw materials, manufacturing equipment, shipping, packaging, shipping insurance and warehousing.
- *Professional fees*: Setting up a legal structure for your business, trademarks, copyrights, patents, drafting partnership and non-disclosure agreements, attorney fees for ongoing consultation and retaining an accountant.
- *Technology costs*: Computer hardware, computer software, printers, cell phones, PDAs, website development and maintenance, high-speed internet access, servers, security measures and IT consulting.
- *Administrative costs*: Various types of business insurance, office supplies, licenses and permits, express shipping and postage, product packaging, parking, rent, utilities, phones, copier, fax machine, desks, chairs and filing cabinets – anything else you need to have on a daily basis to operate a business.
- *Sales and marketing costs*: Printing of stationery, marketing materials, advertising, public relations, event or trade show attendance or sponsorship, trade association or chamber of commerce membership fees, travel and entertainment for client meetings and mailing or lead lists.
- *Wages and benefits*: Employee salaries, payroll taxes, benefits and workers' compensation.

No matter what your business type, take into account everything you will spend, from the moment you dig into the start-up process, through the time you are ready to sell a product or service.

Where to get the money?

All businesses require some form of finance. The most basic rule in financing a business is to commit yourself and your savings or other resources to the business. This will ensure your whole-hearted commitment to its success. This is also a strong sign of good faith and commitment for other potential lenders/investors as, if you are not seen to be willing to risk your own funds why anyone else should!

Further, for a start-up business, there may not be a wide variety of sources of funds as it is still untested. Hence, you will have to come up with the capital, from personal savings or through selling of surplus assets you may have.

Personal saving

There is nothing like having your own money saved, to put into your startup. You have the satisfaction of having saved it on your own, and the knowledge that you do not owe anyone. When using your own money to finance a business, you will feel more personally invested in the project, because it is basically your money on the line. However, there is more flexibility in using your own money. For example, if your business is having a slow start, you do not need to worry about paying back a bank loan because you used your own money.

But the risk you may face is that it is your money, and if you are not successful, the money is gone, and with it the opportunity to do anything else with it later. It can also create another financial burden. Most people have a savings account for general purposes. In other words, the money is not saved for any particular purpose and is used whenever it is needed for whatever reason. As such, draining such an account may negatively affect your financial situation if you need to dip into that savings account for an emergency.

However, if the personal savings you use to finance a business was money saved for that particular purpose, you should not have any financial troubles as a result of the draining of that account. If your savings account was set up for the purpose of opening a business, this means that you planned ahead and reserved that savings account for that purpose only, and thus, will not feel the pinch in an emergency because you will have other funds available for that purpose.

Financing with debt

Financing a business with debt involves securing a loan. This can be in the form of either unsecured or secured debt. Unsecured debt refers to a loan taken without having to put up any specific form of security or collateral. This involves mainly borrowing from family or friends, a credit card, line of credit and other similar means.

Secured debt, on the other hand, refers to loans where you are required to put up some form of collateral in exchange for the loan, for example, mortgage on the house or refinancing your car, among others. For secured debts, you need to be able to assure the

lender about your ability to meet your payments either through your business or other means. To secure such debt is some cases you will need to present a solid business plan, evidence of your experience and of your ability to repay.

Family and friends: Raising finance from family and friends can be rewarding for both parties: you get the finance to start or expand your business, whereas your family and friends have the satisfaction of helping you while earning interest on their spare cash. Family and friends may accept more flexible terms and conditions that are better suited to your business than those offered by commercial banks. Often arrangements with family and friends are informal and based purely on trust and verbal assurances. However, a formal written agreement is strongly advised to minimise disputes in the future. Preserving your relationships with friends and family is as important as pursuing your business opportunity.

Personal loan: Financing a business with personal loans means that you borrow the money personally to invest it in your business. This is typically used at start-up or early stages where the business has not established enough history or performance to be able to secure a loan on its own merit.

Mortgage loan: Another source for financing a business is a home mortgage loan. Some banks allow you to mortgage or refinance your house. This may be a risky move as if you are unable to make the scheduled payments, you risk losing your home. It is therefore crucial that you are confident on your continued ability to make all payments scheduled.

Insurance loan: Another source of loan could be from your insurance policy. If you have been paying for a life insurance policy that builds up a cash value you are entitled to take up a loan on the cash value amount. Many insurance companies will loan you money with the cash value as security. This is a rather expensive method of financing a business and also means reduced benefits if you are unable to clear the loan and interests accrued.

Credit cards: Credit cards can also be a source for financing a business when you are first getting started. However, this is another expensive method as the rates charged can be high and it could also affect your credit rating, required for other sources of financing.

Government

Small business loans: There are a variety of government small business loans and programmes that can be used in financing a business, including those specifically for Bumiputeras and micro entrepreneurs. Most of these loans are administered by the financial institutions like the development financial institutions and the commercial banks. Although some are directly administered by the department/agency involved. Funding from these sources may be relatively easier to secure as the government department/agency guarantees your loan, if you are approved.

Grants: There are often a variety of government grant programmes for specific types of start-up businesses. For more information, search online on government websites. Unless they are reputable, do not pay money to sites that tell you they will give you a big list of where you can get grant money. The risk is that while grants are rarely required to be paid back, accountability is higher, and you might have to work within a difficult deadline, to show your progress. If you do not achieve the progress you indicated in your proposal, there may be some sort of penalty.

Bank loans

Banks lend money to existing businesses but for a start-up, it may be very difficult to get a bank loan as they do not have a track record. Banks require a sound business plan and must be convinced of the viability of your business before they agree to lend you money. Banks also normally need collateral as security.

If you have a solid business plan and the lender agrees, this can often be the cheapest (considering the interest rate) loan sources available. The risk is that besides the fact that it is often hard for a start-up to qualify because there is little evidence that you will be profitable; if you do get a loan, it can be like a ticking time bomb if your business is not doing well.

Equity financing

Equity Financing is borrowing where the investor/financier becomes a part-owner of the business in the process. This could be through venture capital or issuing shares.

Venture capitalists do not want to remain in your business forever. Generally, they want to see an exit strategy that will see them out in about 5 years, with a high return on their investment as their reward.

In terms of areas of interest, venture capitalists are interested in both high technology and various other industries. Normally they fund businesses which have already been launched and have probably reached profitability.

The angel investor, on the other hand, is a special type of venture capitalist. Usually an individual with substantial funds, the "angel" provides capital to start-up companies and takes a personal stake in the venture. Depending on the individual "angel", their requests for any form of control or a quick return on investment will differ. However, similar to regular venture capitalists, they seek high returns on their investment for the risks they take on.

ASEAN SME Service Center

The ASEAN SME Service Center serves as the portal or gateway to facilitate SMEs throughout ASEAN region and beyond to reach business services provided by SME service providers from public, private, academic institution non-profit organization, and other sectors; in a convenient, comparable, and centralized manner.

For more information, access:
http://www.aseansme.org

Financing schemes and incentives for SMEs in India

Development Commissioner (MSME), Ministry of Micro, Small & Medium Enterprises, Government of India

http://www.dcmsme.gov.in

Main schemes of Small Industries Development Bank of India (SIDBI)

- *National Equity Fund Scheme* whichprovides equity support to small entrepreneurs setting up projects in tiny sector.
- *Technology Development & Modernisation Fund Scheme* for providing finance to existing small-scale industry (SSI) units for technology upgradation/modernisation.
- *Single Window Scheme* to provide both term loan for fixed assets and loan for working capital capital through the same agency.
- *Composite Loan Scheme* for equipment and/or working capital and also for worksheds to artisans, village and cottage industries in tiny sector.
- *Mahila Udyam Nidhi (MUN) Scheme* provides equity support to women entrepreneurs for setting up projects in tiny sector.
- *Scheme for financing activities relating to marketing* of SSI products which provides assistance for undertaking various marketing-related activities such as marketing research, R&D, product upgradation, participation in trade fairs and exhibitions, advertising branding, establishing distribution networks including show room, retail outlet, wears-housing facility, etc.
- *Equipment Finance Scheme* for acquisition of machinery/equipment including diesel generator sets which are not related to any specific project.
- *Venture Capital Scheme* to encourage SSI ventures/subcontracting units to acquire capital equipment, as also requisite technology for building up export capabilities/import substitution including cost of total quality management and acquisition of ISO-9000 certification and for expansion of capacity.
- *ISO 9000 Scheme* to meet the expenses on consultancy, documentation, audit, certification fee, equipment and calibrating instruments required for obtaining ISO 9000 certification.
- *Micro Credit Scheme* to meet the requirement of well-managed voluntary agencies that are in existence for at least 5 years; have a good track record and established network and experience in small savings-cum-credit programmes with self-help group individuals.

New schemes

- To enhance the export capabilities of SSI units;
- Scheme for marketing assistance;
- Infrastructure development scheme;
- Scheme for acquisition of ISO 9000 certification;
- Factoring services;
- Bills rediscounting scheme against inland supply bills of SSIs.

Major schemes

Technology Development & Modernisation Fund (TDMF)

SIDBI has set up TDMF scheme for direct assistance of SSIs to encourage existing industrial units in the sector, to modernise their production facilities and adopt improved and updated technology so as to strengthen their export capabilities.

National Equity Fund (NEF)

NEF under SIDBI provides equity type assistance to SSI units, tiny units at 5% service charges. The scope of this scheme was widened during 2000–2001 raising the limit of loan from Rs. 6.25 lakhs to Rs. 10 lakhs and project cost limit from Rs. 25 lakhs to Rs. 50 lakhs.

- The following are eligible for assistance under the scheme:
  - New projects in tiny and small-scale sectors for manufacturing, preservation or processing of goods irrespective of the location (except for the units in metropolitan areas).
  - Existing tiny and SSI units and service enterprises as mentioned earlier (including those which have availed of NEF assistance earlier), undertaking expansion, modernisation, technology upgradation and diversification irrespective of location (except in metropolitan areas).
  - Sick units in the tiny and small-scale sectors including service enterprises as mentioned earlier, which are considered potentially viable, irrespective of the location of the units (except for the units in metropolitan areas).
  - All industrial activities and service activities (except road transport operators).

India Innovation Growth Programme

Indiainnovates.in, India

http://www.indiainnovates.in

The India Innovation Growth Programme is a joint initiative of the Department of Science and Technology, Govt. of India; Lockheed Martin Corporation; Indo-US Science and Technology Forum, Federation of Indian Chambers of Commerce and Industry; Stanford Graduate School of Business and the IC2 Institute at the University of Texas. The aim of this programme is to accelerate innovative Indian technologies into the global markets. The India Innovation Growth Programme is the only programme of its kind, because of its focus on teaching using world-class commercialisation strategies and the business development assistance provided.

During the first phase of the programme, the project team comprising subject matter experts from the Federation of Indian Chambers of Commerce and Industry (FICCI) will select 100 innovative technologies from a wide range of sectors such as aeronautics, agriculture, biotechnology, chemistry, communications, computing, defence, electronics, environment, healthcare, information technology, manufacturing, materials, life sciences, nanotechnology, petrochemical, semiconductors and transportation.

FICCI approved applications and technologies will be evaluated and ranked by a joint team comprising all programme partners. Predefined parameters (such as development status, patent status, funding required to technology development, etc.) will be used to select the most appropriate technology companies to go forward in the programme. The assessment will be done in two phases. During the first phase, evaluators review and offer constructive feedback on the technical and commercialisation potential of the application submissions. In the second phase, refined applications are scored based on predefined parameters and evaluator feedback to select the top 50.

During the second phase of the program, the selected 50 innovators will be given a week long advanced training in basic principles of product commercialisation, readiness for market, business models, intellectual property (IP) rights, competitive positioning, and mechanisms for revenue by experienced faculty members from the Stanford Graduate School of Business. The Entrepreneurship Workshop is organised to provide training to the innovators and also prepare them to participate in an Innovator's Competition.

The top 50 innovators will then present their innovations to a panel of judges comprising renowned technologists and commercialisation experts from India and the USA. At the end of the competition, 30 best innovations will be awarded.

Thereafter, the top 50 innovators will receive professional business development assistance from FICCI and top 8 both by FICCI and the IC2 Institute, University of Texas. The business development managers at FICCI and IC2 Institute work towards assisting the winners in commercialising their technological innovations and finding them suitable business partners in India as well as global markets.

The programme process is outlined below:

Apply to the program

Interested innovators should apply to participate in the programme using the online application form.

First screening

Applications are evaluated by FICCI to select the top 100 innovations

Ranking of the top 100 technologies

FICCI approved applications and technologies will be evaluated and ranked by a joint team comprising all programme partners.

Second screening to select the top 50

The assessment will be done in two phases. During the first phase, evaluators review and offer constructive feedback on the technical and commercialisation potential of the application submissions. In the second phase, refined applications are scored based on predefined parameters and evaluator's feedback to select the top 50.

Entrepreneurship workshop

During the second phase of the programme, the selected 50 innovators will be given a week long advanced training in basic principles of product commercialisation, readiness for market, business models, IP rights, competitive positioning and mechanisms for revenue by experienced faculty members from the Stanford Graduate School of Business.

Innovator's competition

The top 50 innovators will then present their innovations to a panel of judges comprising renowned technologists and commercialisation experts from India and the USA. At the end of the competition, 30 best innovations will be awarded.

Business development

Thereafter, the top 50 innovators will receive professional business development assistance from FICCI and top 8 both by FICCI and the IC2 Institute, University of Texas.

Markets

Innovators connect with new national and global partners.

Eco-innovation project in Sri Lanka

National Cleaner Production Centre (NCPC), Sri Lanka

http://www.ncpcsrilanka.org

"Rethinking the business strategy"

Improving the organisational structure, products/services, processes, market approach, service delivery mechanisms, etc., in a creative and innovative way is necessary to maintain the competitiveness of the businesses. Incorporating the sustainability dimension to the innovation process helps the companies to emerge as green enterprises with extraordinary performance that leads eventually to be triumphant in the global and local markets.

Eco-innovation is an approach that has been adopted by enterprises knowingly or unknowingly to harness to benefits by incorporating sustainability dimension to the innovation process; United Nations Environmental Programme (UNEP) undertook in 2009 to develop this concept into a formal approach/tool with an application methodology so that small and medium-sized enterprises (SMEs) in the developing countries also can benefit.

Why is eco-innovation approach necessary?

In recent decades, there has been a growing recognition among manufacturing business leaders on sustainability challenges such as climate change, worker welfare and resource constraints which have a significant impact on businesses. Ultimately, companies that do not take action now run a higher risk of failure when these issues inevitably take effect in their industry. Sticking with the "business as usual" approach will leave companies unable to respond to issues such as rising energy costs, disruptions to supply of the raw materials or changes in legislation. Thus, an alternative approach going beyond the boundaries of cleaner production or EMS and can help to address sustainability related business drivers is required while offering opportunities for growth, cost reduction and competitive advantage.

Eco-innovation is an approach that aims to fulfil these multiple requirements by identifying the key sustainability challenges and opportunities and then using these to drive changes throughout the company and its value chain, from the business strategy and business model to the operational level.

Eco-innovation is the development and application of a business model, shaped by a new business strategy that incorporates sustainability throughout all business operations based on life-cycle thinking and in cooperation with partners across the value chain. It entails a coordinated set of modifications or novel solutions to products (goods/services), processes, market approach and organisational structure which leads to a company's enhanced performance and competitiveness.

Added value from Eco-innovation

- Access new & emerging markets
  - Increase productivity & technical capacity
- Increase profitability along the value chain
  - Stay ahead of standards & regulations
- Attract investment

UNEP project on eco-innovation

The UNEP eco-innovation project was initiated in 2014 aiming to develop local resources and capacities for eco-innovation in developing and emerging economies. It specifically targets SMEs of agri-food sector.

To reach the SMEs, the UNEP eco-innovation project cooperates with national governments and National Cleaner Production Centres as service providers. National Cleaner Production Centre, Sri Lanka (NCPCSL) is the implementing partner for the project in Sri Lanka. NCPCSL is entrusted to initiate the first pilot project on eco-innovation under agri-food sector.

Initially, 20 enterprises will be selected to conduct a feasibility study by identifying the potential to apply eco-innovation approach with desire of the industry. Finally, 8 enterprises will be provided technical assistance together with comprehensive training by international experts for the implementation of eco-innovation. The success stories of those companies will be publicised internationally.

The industries will be enabled to handle their sustainability issues in a holistic way and position as a sustainability thought leader.

Climate Technology Centre and Network

The CTCN promotes the accelerated transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries. The network provides technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to the needs of individual countries.

For more information, access:

http://ctc-n.org

Clean-tech market opportunity for small businesses in developing countries

The World Bank

http://www.worldbank.org

A new World Bank Group report quantifies significant opportunities for small- and medium-sized enterprises (SMEs) in developing countries to generate profits and create jobs by providing solutions to local climate challenges.

Much of the emphasis on climate change has been on urging countries to act to avoid environmental catastrophe. This new report, "Building Competitive Green Industries: the Climate and Clean Technology Opportunity for Developing Countries," frames responding to climate change as an extraordinary economic opportunity, particularly in developing countries. The report, published by InfoDev, a global innovation and entrepreneurship program in the Bank Group's Trade and Competitiveness Global Practice, recommends actions by the public and private sectors to foster the growing market for SMEs in the clean technology sector.

In the last decade, clean technology has emerged as a major global market. Over the next 10 years, an estimated $6.4 trillion will be invested in developing countries. Of the total market in developing countries, some $1.6 trillion will be accessible to SMEs, according to the report. China, Latin America and Sub-Saharan Africa are the top three markets in the developing world for SMEs in clean technology, with expected markets of $415 billion, $349 billion, and $235 billion, respectively, for sectors such as wastewater treatment, onshore wind, solar panels, electric vehicles, bioenergy, and small hydro.

To unlock this environmental and economic potential, more can be done to support green entrepreneurship. Clean technology SMEs face daunting challenges, particularly in accessing early and growth stage financing. Countries can help by creating targeted policy incentives to encourage their own clean technology sectors. The report provides policymakers with a range of practical instruments that help support SMEs in clean technology sectors such as innovative finance, entrepreneurship and business acceleration, market development, technology development, and the legal and regulatory framework. These policy considerations are illustrated through case studies of national programs in South Korea, India, Thailand, and Ethiopia.

The report highlights clean technology market opportunities that can have great social impact. In Kenya, for instance, roughly 80% of the population not served by the electricity grid represents a vast market for new climate solutions. Local entrepreneurs and SMEs are deriving innovative solutions in solar and biogas technologies. This not only creates jobs and improves the environment, but also provides new offerings for sustainable, off-grid electricity to the poorest 40% of the population.

Clean technology jobs compare favorably to jobs in other sectors, requiring more skill and delivering better pay and on-the-job safety. The move toward a lower carbon and more resource-efficient economy is expected to yield a double-dividend in terms of employment and environmental improvement.

InfoDev's Climate Technology Program supports local climate and clean technology SMEs and startups through its targeted Climate Innovation Centers (CICs). To date, the Kenya CIC has helped 83 small firms whose services have provided over 8,200 people access to safer water, have given almost 49,000 people access to low carbon energy sources, and have mitigated 59,675 tons of CO_2 – the equivalent of the exhaust of almost 13,000 cars annually.

The report can be accessed from: www.infodev.org/infodev-files/green-industries.pdf

Energy Sector Management Assistance Program

The Energy Sector Management Assistance Program (ESMAP) is a global knowledge and technical assistance program administered by the World Bank. It provides analytical and advisory services to low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. Supporting over a hundred activities in countries around the world at any given time, ESMAP is an integral part of the Energy and Extractives Global Practice of the World Bank.

ESMAP's services for its client countries can be grouped into two categories:

- Technical assistance and policy advice
- Knowledge products and knowledge exchange

For more information, contact:

Energy Sector Management Assistance Program

The World Bank, 1818 H Street, NW, Washington DC 20433, USA

Fax: 202.522.3018

E-mail: esmap@worldbank.org

Web: http://www.esmap.org

Cleaner production training programme for SMEs in Malaysia

Green Industry Virtual Centre, Malaysia

http://cp.doe.gov.my

Cleaner Production (CP) Training Programme for small- and medium-sized enterprise (SME) is the Department of Environment (DOE) programmes under the Tenth Malaysian Plan (RMK10). The programme started in 2009 with Malaysian SME being the target group. It is part of government initiative to get the commitment and support from SME to prevent and control pollution and subsequently increases Environmental Quality Act 1974 compliance. The objective is to enhance the capacity of all the stakeholders on CP concept which is vital for economic and sustainable development. Until 2012, CP Training Programme for SME has been conducted for 150 SMEs and out of that 30 SMEs were involved in detailed audit programme. In future, the programme will be implemented to all industrial sectors.

Benefits of CP

SMEs participated in the CP Training Programme will gain a lot of benefits such as:

- increase company productivity;
- increase company profitability;
- enhance company competitiveness;
- improve company public image;
- continuous environmental improvement;
- produce better and safer product;
- reduce workplace accident.

Objectives

The objectives of the programme involve many sectors such as processes and technology, environment, safety, and health.

- To increase the implementation of CP practices in SMEs activities;
- To increase the productivity and minimise operation cost;
- To reduce energy and resources consumption;
- To minimise waste generation;
- To avoid or minimise risk to human and environment;
- To support government initiatives in reducing country carbon emission;
- To address climate change and global warming issues.

The following list shows CP Training Programme for SME performed on a number of Malaysian local companies by Green Industry Unit, DOE, Malaysia, with the expertise and assistance of Dasar Data Sdn Bhd

- Mey Chern Chemicals Sdn Bhd;
- Percetakan Nasional Malaysia Berhad;
- Millif Industries Sdn Bhd;
- Percetakan Skyline Sdn Bhd;
- Ulision Electroplating Sdn Bhd;
- Box-Pax (Malaysia) Berhad;
- Visual Print Sdn Bhd;
- MIMOS Nano Semiconductor Technology;
- Citral (M) Sdn Bhd;
- Power Steel & Electroplating Works Sdn Bhd.

Demo project

MM Vitaoils Sdn Bhd is the first Malaysian company to participate in the DOE's Cleaner Production Demonstration Project 2009/2010. MM Vitaoils Sdn Bhd was selected by DOE, Malaysia, to showcase how CP is implemented in a Malaysian company.

MM Vitaoils Sdn Bhd is a world leader in downstream palm oil industry with full range of packaging. Founded in 1999, MM Vitaoils Sdn Bhd has penetrated 76 countries world-wide with its quality edible oil products. MM Vitaoils Sdn Bhd is the master brand with brand portfolios that are associated with high quality, palm oil-based products which promote and enhance a fitter and healthier lifestyle such as cooking oil, ghee, shortening, margarine and pastry margarine.

MM Vitaoils Sdn Bhd currently produces and exports 24 brands of quality edible oil products, with trademark registration in Malaysia, South Korea, China, India, Europe, USA, Uzbekistan, Africa and Japan, securing niche markets. The export market constitutes over 98% of total revenue. MM Vitaoils Sdn Bhd is the biggest supplier in Uzbekistan palm oil market.

Today, MM Vitaoils Sdn Bhd has the most modern plant in Malaysia with a total monthly combined capacity of 10,000 metric tonnes per month with the advantages of packing products in different packaging materials for its core business activities in manufactured oil products, salad oils, etc., working in collaboration with the Malaysian Palm Oil Board.

The Company Philosophy – "By Our Heart, To Your Heart" simply encapsulates the Brand's honest desire to provide only the best for its customers, with emphasis on our commitment to quality,

health and credibility. This is further evidenced through the accreditations that MM Vitaoils Sdn Bhd received on Quality System such as ISO 9001:2000, Hazard Analysis and Critical Control Point (HACCP) and Good Manufacturing Practice (GMP). Recently MM Vitaoils Sdn Bhd achieved ISO 22000: 2005 on 6th February 2009.

Premise Selection Factors

In order to ensure project success eight premise selection criteria were developed:

- The company must be a legal entity with sound financial standing.
- Location.
- Sufficient manpower.
- Full commitment from management and all work force especially technical staff at the premise.
- Willingness and competency of the premise to implement the developed CP options.
- Willingness of the premise to share their CP implementation experience with other premises.
- The premise have good record management (utility bills – electricity and water, raw materials and products inventory records, etc.).
- Stable and continuous production.

CP Implementation at Factory

There are 10 steps of activities for the implementation of CP at MM Vitaoils Sdn Bhd premise:

1. CP audit;
2. CP options identification;
3. Prioritization of CP options;
4. Evaluation of CP options;
5. Implementation of CP options;
6. Monitoring;
7. Audio and video documentation;
8. Staff training;
9. Promotional activities at the premise; and
10. Research & Development.

Multilingual Interface for ePCT

The World Intellectual Property Organization (WIPO) has launched the multilingual interface of ePCT, marking a major expansion of its global gateway for online filing and management of international patent applications. After an initial pilot phase that was limited to English, the ePCT user interface is now available in the other nine languages of international publication under the Patent Cooperation Treaty (PCT): Arabic, Chinese, French, German, Japanese, Korean, Portuguese, Russian and Spanish. This will contribute significantly to increased use of the ePCT system in countries where a language other than English predominates.

In 2014, users filed – by various means, including ePCT – some 215,000 international patent applications under the Patent Cooperation Treaty, which initiates the process to obtain protection for inventions in 148 member states. In eight of the top 10 PCT filing countries in 2014, applications were in a language other than English, the most common being Japanese, Chinese, German, Korean and French. With the addition of these new languages, the web-based ePCT portal is now poised for further growth with an increasingly global user base.

Among the benefits of the ePCT is an automatic checking function during the preparation phase, ensuring the validity of the data provided, and reducing and potentially eliminating errors before filing. After filing, ePCT allows both applicants and patent Offices to manage international applications in a paperless environment, saving time and money.

For more information, contact:

Media Relations Section

World Intellectual Property Organization

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Web: http://www.wipo.int

Technology Offers

CHINA

Production of human serum albumin in cow's milk

Description

As a service unit that provides TALEN/CRISPR and establishes animal model by fertilized egg, our project team has accumulated unequalled experience in humanization of bovine serum albumin gene and large scale production of human serum albumin in cow's milk. Dr. Qin Yangjun has independently designed and tested a number of TALEN/CRISPR carriers and carried out intracellular activity assay. He has long-term technical reserves for humanization of bovine serum albumin gene and large scale production of human serum albumin in cow's milk. Dr. Du Yubin has been engaged in gene knockout and establishment of transgenic animal models. Breaking through the conventional thinking to design the fastest and the best solution, we can get the desired transgenic animals in short time. Technology Roadmap: We design simple and feasible technology roadmap that differs from the traditional way of gene knockout.

Areas of Application

- Biological product

Advantages

Using this method, milk can be used for production of human serum albumin whereas bull serum can be used as human serum albumin extraction and cell culture. Conservatively estimated, a cow can produce 50 kg HAS, which values approximately $250,000. One-hundred cows may produce cumulatively value of hundreds of millions of dollars.

Development Status

Laboratory model

Legal Protection

Patent

Transfer Terms

Technology licensing, Research partnerships

Contact:

Suzhou Productivity Promotion Center,
Suzhou Innovation Plaza, No.178, East Ganjiang Road,
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Tel: 0086-512-65246015
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EGYPT

Aluminum sulfate

Description

We offer technical assistance for technology transfer aluminum sulfate plant for any capacity. From raw material rich in aluminum content: aluminum trihydrate, kaolin calcined or uncalcined, bauxite. Items covered are uses and applications; specfication of final product (liquid & solid); details of raw materials and utilities consumption figures; manufacturing process in details either using kaolin, aluminum trihydrate, or bauxite; quality assurance during production to assure that final product is according to standard specification; quality control procedure for analysis of final product; equipments needed for production line based on production capacity & technical specifications; piping specification for handling raw materials and final product; valves specification for product and raw materials; instrumentation needed for the production line; process flow sheet diagram; plant layout; land, building area requirements; feasibility of the project (complete cost economics with profitability analysis; suppliers of plant and machinery and raw materials; break even point; assistance for startup. The plant Start-up Procedure: The description of the start-up procedure for the plant/unit under consideration: The first sub-section of this section should address the readiness of the plant to be started up. By readiness it is meant that the plant/unit is ready to accept the process or utility fluid, raw materials, or reactants. Normal Operating Procedure: Description of the normal operation of the plant/unit indicates the parameters to be monitored for maintaining the product quality and operational reliability of the plant/unit. Shutdown Procedure: Description of the shutdown procedures to stop the operation of the plant emergency shutdown. In case of power failure or abnormal condition, we offer technical assistance for technology transfer for polyaluminum chloride plant with the same details as aluminum sulfate plant. We also provide feasibility study for aluminum sulfate project, polyaluminum chloride, zinc sulfate, magnesium sulfate, and calcium chloride.

Areas of Application

Water treatment

Advantages

Effective cheap cost with up-to-date technology

Environmental Aspects

Cleaner production

Development Status

Fully commercialized

Technical specifications

Any capacity according to client demand

Transfer Terms

Consultancy, Technical services, Equipment supply

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HUNGARY

Tale pillow

Description

Our partner has developed a "tale pillow" that is a small device, like an USB drive & MP3 player that can be fixed on/placed into the bed of the child, on the baby carriage/baby swing/rocking chair/feeding chair, carpet, or pillow. There are many replaceable USB sticks & MP3 players available for the tale pillow: ones that tell fairy tales/poems, ones that sing kids songs, or ones that teach the alphabet/numbers/foreign languages. Our client is looking for partners interested in buying or licensing the know-how, or optionally partners interested in investing

opportunities on innovative solution in the foreign language education of young children. It is a scientific fact that young children's conceptual thinking is not as developed as that of teenagers or adults, and therefore they use other methods, such as their senses to observe the world surrounding them and to understand its phenomena.

Areas of Application

The toy industry can be a potential area of use to reach the target group of children. Learning tools industry when we use the device with educational audio.

Advantages

One of the main advantages of the tale pillow is that it provides a much quicker learning method than traditional education. When the mind's state is lowered to alpha, the level of brain activity rises allowing details to be memorized in a more effective way. Information memorized in the alpha state is stored automatically in the long-term memory, where it can be easily recalled from later on. Children between the age of 1.5 and 5 years stay most of their time in alpha state during their consciousness; this way they are able to acquire even three languages easily. Based on the aforementioned information, the users of tale pillow will be able to effectively acquire any foreign language while lying down on an armchair or relaxing. Much time, energy, and money can be saved with this effective method of relaxed language training. Other advantage of the tale pillow is that it is a device that can be useful for each family member.

- Placing it into the baby's bed, the infant/baby will feel peace falling asleep, while listening to voices he/she heard in the uterus as a fetus. By fixing the device on the head of the back-front seat of the car the baby can be easily entertained during a long trip. There are many replaceable USB sticks & MP3 players available for the tale pillow: ones that tell fairy tales/poems, ones that sing kids songs, or ones that teach the alphabet/numbers/foreign languages.
- It offers a significant help in the learning process for students, as acquiring the curriculum by listening to it many times is quicker and more welcomed by kids than memorizing the written curriculum via reading and repetition.
- The tale pillow is highly recommended for adults as well. Regardless of whether they are about to study foreign languages or attending courses, studying will become a happy, smooth procedure that they can do whenever and wherever they want, while lying on the bed, sitting on the couch, or driving the car. Besides studying it can also be used in case of sleeping problems or relaxation. The design of the product can be tailored according to each of the target groups' needs. The sound files can be changed, and therefore there are many possibilities to listen to; it can also be attached to several objects.

Development Status

Idea, Design

Legal Protection

Trademark

Technical Specifications

Our partner has developed a "tale pillow" that is a small device, like an USB drive & MP3 player that can be fixed on/placed into the bed of the child, on the baby carriage/baby swing/rocking chair/feeding chair.

Transfer Terms

Joint Venture, Selling know-how, Others

Contact:

Laser Consult Ltd (Hungary),
H-6701 PO Box 1191,
Szeged, Hungary
Tel: +36-62/562-782
Fax: +36-62/562-783
E-mail: laserconsult@t-online.hu

Injectable biodegradable gels for delivery of drugs

Description

Hydrogels are 3-D polymer networks with a unique ability to hold water, maintaining semi-solid state giving them physical characteristics similar to soft tissues. They need to be easily administrable as preformed hydrogels and exist as flowable aqueous solutions before injection and immediately turn into standing gels upon administration. The hydrogel developed by NCL scientists can be in situ crosslinked (which makes it suitable for injectable systems), with one or more hydrophobic pocket(s) which can be used to deliver desired drugs with desired release profile (gelation time – 1–30 minutes; degradation time – 1–30 days; storage modulus from 5 to 110 Kpas). It comprises a polymer backbone, a hydrophobic pocket (moiety being triclosan), and a water soluble crosslinker (paclitaxel solubilized in alpha tocopherol).

Areas of Application

- In site specific drug delivery systems/depots (Many important drugs are hydrophobic in nature and need to be administered in a solubilized form for the expected therapeutic effect using our gel system, which has hydrophobic pockets to hold these drugs, the drugs can be delivered directly.)
- Biomedicine – cell growing depots for tissue regeneration & protective membranes for the treatment of wounds.
- Tissue engineering – space filling agents, delivery vehicles for bioactive molecules & tissue formation directing scaffolds.

Advantages

- Overcome the barrier of surgical implantation.
- Does not require solvents as other biodegradable polymers might require which are harmful to the human body/some drugs may become inactive on coming in contact with the solvent.
- In drug delivery applications, drugs can be loaded in the hydrophobic pockets present in the gels.
- Provides precise control over the chain length, sequence, and 3D arrangement of the polymer networks in the gels, and hence prevents side reactions caused which may influence their performance.

Technology Offers

Development status
Laboratory model

Legal Protection
Patent

Transfer Terms
Technology licensing

For the above two offers, contact:
National Chemical Laboratory, CSIR,
A208, PAML Building, Dr Homi Bhabha Road,
Pune 411007, India
Tel: +91-20-25902982
E-mail: dt.patel@ncl.res.in

New Technology for silk reeling

Description
India being one of the largest producers of silk is forced to import high-grade silk threads from China because of low yields and low-grade silk threads. This technology offers solutions to the existing silk-reeling industry in India. We are looking for potential business and investment partners for a semi-automatic silk thread reeling machine. The technology is open for business collaboration discussions.

Areas of Application
Sericulture industry – silk reeling

Technical specifications
Semi-automatic silk reeling machine producing A4 grade silk threads

Transfer Terms
Technology licensing, others

Contact:
SkyQuest Technology Consulting Pvt. Ltd., B-72, Parshwanath Towers Nr. Subhash Chowk, Memnagar, Ahmedabad 380052, India
Tel: +91 79 40054112
E-mail: projects@skyquestventures.com

Green stove design

Description
An improved wood burning metallic cook stove is presently designed and fabricated. During testing process, measured thermal efficiency is found 28.3%. Smoke emission is also reduced. Wood sticks, twig, etc., can be used as fuel in this stove. Power output rating of the present prototype is 2.5 KW/hour. Cost of the stove is within economical limit.

Areas of Application
For the use in rural area both for domestic and community cooking purpose according to the size of the stove.

Advantages
- High thermal efficiency with reduced rate of smoke emission.
- In the stove, primary air is supplied throughout the perforated circumferential wall at the lower part of combustion chamber for better mixing with wood fuel during combustion.
- In addition to typical preheating system of secondary air while passes through annular air passage surrounded the combustion chamber wall, primary air is also preheated in this stove while comes in contact with perforated lower circumferential wall of the combustion chamber.
- The primary air is entered through perforated wall located above the fuel rest plate, not through conventional grate at bottom so that deposited ash on fuel rest plate cannot be able to block the air passage for primary air entry.
- Ash removal is very easy, just by opening of the holding clip of fuel rest plate.
- Sliding cover plate of fuel feed opening prevents entry of outside cold air inside of combustion chamber.

Environmental Apects
Cleaner production, Energy efficiency

Legal Protection
Patent will be applied soon

Technical Specifications
- Cross-sectional area of combustion chamber = 314 cm^2.
- Cross-sectional area of solid fuel rest plate = 346.2 cm^2.
- Cross-sectional area of larger diameter portion of stove = 880.9 cm^2.

Transfer Terms
Consultancy, Joint venture, Technology licensing, Research partnerships

Contact:
Subhra Datta, Mohanta Para, Lane opp. to Senior Citizens Park, P. O. Jalpaiguri, West Bengal 735101, India
Tel: +91-9474390725
E-mail: subhradatta611@gmail.com

Prototype development using fused deposition modeling

Description
We can help in prototype development using Fused Deposition Modeling (FDM). FDM builds concept models, functional prototypes, and end-use parts in standard, engineering-grade, and high-performance thermoplastics. It is the only professional 3D printing technology that uses production-grade thermoplastics.

Areas of Application
Transport engineering, Thermoplastics

Advantages
It is the only professional 3D printing technology that uses production-grade thermoplastics.

Transfer Terms
Consultancy, Subcontracting, Joint venture, Technical services, Technology licensing, Equipment supply, Turnkey, Research partnerships

Contact:
Mr. Sanjay Dodiya, Plot No.11, Rajya Joti Nagar, Burudgaon Road, Near Aryan Lawn, Ahmednagar 414001, India
Tel: +91-024-12354041
E-mail: sanjaydodiya@hotmail.com

Technology Requests

INDIA

Micropropagation of potato cultivation

Description
We need technology for micropropagation of potato cultivation.

Areas of Application
Agriculture

Studies Available
Feasibility report

Project
Start-up

Additional information
We are looking for end-to-end solution right from R&D till commercialization

Contact:
ROC, CD 149 Salt Lake, Kolkata 700064, West Bengal, India
Tel: +91-8334006710
E-mail: pradipgamma@hotmail.com

Copper sulfate from copper scrap and waste

Description
We need consultancy for copper sulfate manufactured from copper scrap/waste/ash.

Area of Application
Many sectors including chemical industries.

Project Type
Start-up

Assistance Sought from Potential Partner
Turnkey supply of plant and machine

Contact:
Mr. J. J. Patel, 211, Akshat Tower, Nr Pakwan SG Highway, Bodakdev, Ahmedabad 380054, India
Tel: +91-09904809004
E-mail: ca.jjpatel@gmail.com

Silica from rice husk ash

Description
We are interested in equipment and technology suppliers for setting up a 10 tpd silica extraction unit from rice husk ash.

Area of Application
Silica manufacturing

Transfer Terms
Consultancy, Subcontracting, Turnkey plant, Technical services, Equipment supply, Technology licensing, Research partnerships, Others

Project Type
Diversification

Assistance Sought from Potential Partner
Need the suppliers of equipment and technology

Contact:
Mr. B. Karthik, Rajahmundry, Andhra Pradesh, India
Tel: +91-8331873337
E-mail: bikkinakarthik@gmail.com

Medical disposables

Description
We are interested in technology for medical disposables (surgical dressing).

Area of Application
Health and Medical

Project Type
Expansion/Modernization

Contact:
Drug Authority, Near Mandi Samitte, Moradabad Road, Mannagar, Kanth, Moradabad 244501, U.P., India
Tel: +91-05912220061
Fax: +91-05912220061
E-mail: shreejeekanth@gmail.com

Worldwide Renewable Energy Database

The Renewable Energy Database fosters dialogue and cooperation between universities, research institutions and companies undertaking research and development in the field of renewable energy. It is an initiative of the Research and Transfer Centre "Applications of Life Sciences" of the Hamburg University of Applied Sciences and has been produced with the assistance of the EU project "DIREKT - Small Developing Island Renewable Energy Knowledge and Technology Transfer Network", which is funded by the ACP Science and Technology Programme.The Database contains institutions which are interested in collaborating internationally in the renewable energy sector. Contact details as well as information on their current R&D activities are provided.

For more information, contact:

Prof. Dr. Dr. h.c. (mult.) Walter Leal
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Tel: +49 (0)40 428 756 354
Fax: +49 (0)40 428 756 079
E-mail: renewables@ls.haw-hamburg.de
Web: http://www.direkt-project.eu/renewable-energy-database.html

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