

Strengthening innovation-driven inclusive and sustainable development

Asia-Pacific

Tech Monitor

Vol. 36 No. 3 Jul - Sep 2019

Promoting green technologies
Innovative mechanisms and partnerships



Plus

- Technology News and Events
- Tech Ventures & Opportunities
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APCTT
Asian and Pacific Centre
for Transfer of Technology



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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;
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- 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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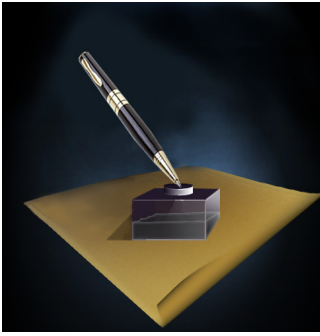
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Introductory note

Green technologies are environmentally sound technologies that “protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual waste in a more acceptable manner than the technologies for which they were substitutes”.¹ The green technologies can improve the quality of life, drive economic growth, increase industrial productivity and efficiency, and contribute to environmental protection. Therefore, these technologies offer immense potential to support

the 2030 Sustainable Development Goals. They have many innovative applications in energy production, lighting, buildings, manufacturing, metals processing, transportation, water, agriculture and waste management. The United Nations is promoting green technologies to create cleaner, greener and more efficient solutions to address the challenges of sustainable development.

Many green technologies have been adopted successfully by business firms in the developed countries. However, investments in green technologies are less in the developing and least developed countries (LDCs) for many reasons, including lack of policy support, conflicts with existing subsidies, financing constraints, and weak market competition. The LDCs, in particular, need to access and adopt suitable green technologies under affordable terms and conditions.

Through appropriate policy measures and practices, Governments can support development and utilization of green technology by funding research, providing grants for green technology start-ups, and increasing demand for green products. For example, the Republic of Korea has introduced green certification programme for technologies, products, projects and enterprises. In addition, the government has launched the energy technology acceptance project to promote development of green energy technologies. Bangladesh has taken a leading position in greening its readymade garments factories through adopting LEED (Leadership in Energy and Environmental Design) certification by US Green Building Council. In the area of agriculture, Bangladesh has successfully pioneered in implementing widescale solar-powered irrigation projects to replace diesel-based irrigation facilities.

This issue *Asia-Pacific Tech Monitor* discusses the challenges, opportunities, strategies and best practices to develop and utilize green technologies for inclusive and sustainable development in the Asia Pacific.

Michiko Enomoto
Head, APCTT-ESCAP

¹Chapter 34 of Agenda 21 (The United Nations Program of Action from Rio, 1992)

Technology Market Scan

INTERNATIONAL

Top 10 pharma R&D budgets in 2018

Earlier this year, a new report by the IQVIA Institute for Human Data Science showed that in fact, large pharma companies (those with more than \$10 billion in yearly drug sales) have seen their R&D share drop from 31% to just 20% in the past decade. And when it comes truly new, innovative, exciting drugs in the pipeline, the report found that the smaller biotechs are punching well above their weight. Last year, we saw 59 new therapies get the thumbs-up under the leadership of (now ex) FDA Commissioner Scott Gottlieb, M.D. But the report points out that large pharmas were the filing companies for fewer than half of these launches. Emerging biopharma companies, on the other hand, were the originators of 38 of the 59 therapies (64%).

The report says that the “importance of large pharma in originating molecules is decreasing,” but they “remain important partners” for biotech. Still, they see the need for smaller biopharmas to team up with Big Pharma companies—and their large sales teams—decreasing. “The dynamics of development, M&A and licensing activity seem to be shifting, and emerging companies are retaining control of their assets to a greater degree,” the report’s authors wrote.

Coupled with this is the fact that, according to the index, emerging biopharma companies (those spending less than \$200 million annually on R&D and having less than \$500 million in sales) account for 72% of all late-stage pipeline activity, up from 61% a decade ago. Roche, J&J, Novartis and the like are still the unmatched big boys when it comes to R&D budgets, with Roche once again coming out on top with a staggering \$11 billion in R&D spend last year (though this also includes its diagnostics business).

The names and numbers don’t change much over the years (in fact, Roche, which has been at the top for a few years now, is down nearly half a billion in terms of R&D spend since 2016), but there is one big exception: Sanofi, which has penned several

biotech deals and M&As, is up more than \$1 billion in two years, from \$5.45 billion in 2016 to \$6.6 billion in 2018, as it attempts to get back into oncology, which it seemed to be walking away from.

Merck also deserves a shoutout: While its R&D budget was down from last year (when it spent \$10.33 billion), its \$9.75 billion spend has put it third, ahead of Novartis, in terms of overall spend, jumping from \$7.19 billion, when it was the fifth highest Big Pharma R&D spender, in 2016. This coincides with now more than 1,000 trials for its cancer drug star Keytruda.

With more approvals and big topline numbers in R&D, it’s easy to think the big boys are doing all the heavy lifting, but as the IQVIA report found, don’t forget the smaller teams with supertight budgets that continue to outpace their Big Pharma rivals.

<https://www.fiercebiotech.com>

ASIA-PACIFIC

CHINA

New industry catalogue encouraging foreign investment

China’s National Development and Reform Commission (NDRC) and the Ministry of Commerce on Sunday jointly released a revised catalogue of industries that encourage foreign investment. The catalogue includes an industry catalogue for encouraging foreign investment nationwide and a catalogue of advantageous industries for foreign investment in the country’s central, western and northeastern regions. It is expected to give better play to the positive role of foreign investment in China’s industrial development, technological progress and structural optimization, said an official with the NDRC.

The number of listed sectors where foreign investment is encouraged see marked rise. Compared with the 2017 version, the new catalogue for encouraging foreign investment nationwide has 67 newly-added items and 45 modified items, while the catalogue of advantageous industries in central, western and northeastern regions

has introduced 54 new items. Over 80 percent of the newly-added or revised items of the nationwide catalogue point to the manufacturing industry. Foreign investment is more encouraged in sectors such as high-end manufacturing, intelligent manufacturing, and green manufacturing.

New items have been added to encourage foreign investment in 5G core components, etching machines for integrated circuits, chip packaging equipment, and cloud computing equipment. Besides, new entries have been added for artificial intelligence, clean production, carbon capture and circular economy. The catalogue for the central and western regions further adds labor-intensive as well as advanced and applicable technology industries and supporting facilities, giving the regions greater support to their embracing of industrial transfer of foreign-funded businesses.

China attracted a record high foreign direct investment (FDI) of 138.3 billion U.S. dollars last year, bucking a global trend of FDI slide. In the first five months of this year, the country saw an FDI inflow of 54.6 billion dollars, up 3.7 percent year on year.

<http://www.xinhuanet.com>

R&D spending statistics

China’s National Bureau of Statistics (NBS) has published a document to standardize the data of research and experimental development (R&D) spending. The new standard is expected to increase the quality of R&D statistics, and make the data comparable internationally, the NBS said in an online statement. Relevant departments and local officials should strictly adhere to the standard and conduct surveys and data evaluations under unified rules, the statement said.

The document came as China is seeing an increasing number of R&D activities amid the country’s shift toward an innovation-driven economy. China’s R&D spending increased to 2.18 percent of its GDP last year, up by 0.06 percentage points, previous NBS data showed. The new standard is based on China’s realities, meets the country’s developmental needs, and accords with international standard to enhance

international comparison, the NBS said.

R&D-related indexes indicate the technological capability, especially the self-innovation capability, of a country or a region. China published the first document on R&D standard in 2000, which significantly contributed to assessing the country's technological progress.

<http://www.xinhuanet.com>

R&D investment up

China's research and development investment increased by 11.6% year on year to 1.97 trillion yuan (US\$ 293.6 billion) in 2018, accounting for 2.18% of the gross domestic product, official data shows. It's the fourth consecutive year that R&D costs in China accounted for over 2% of GDP, according to a research report published by Dalian University of Technology.

China realized 19.59% average annualized growth in R&D investment after the country announced its innovation-driven development strategy, the report said. R&D investment by enterprises increased by 40 times to 1.2 trillion yuan from 1995 to 2016, while government R&D funds rose 12.8 times to about 320 billion yuan.

The research highlighted Huawei as a representative of high R&D investment. In 2016, Huawei spent more than 82 billion yuan in R&D that year, accounting for 7% of all Chinese enterprises' R&D investment, it said. In addition, the China National Petroleum Corporation tops all mainland-listed firm's R&D investment with 17.5 billion yuan, and Alibaba spent the most (17 billion yuan) among overseas listed companies. The research said while the companies are invest heavily in R&D, more efforts may be put on basic research and applied research.

<https://www.asiatimes.com>

5G patents

Chinese companies account for 34% of worldwide applications for major patents related to 5G technology, putting it in a position to drive the development of new industries that use ultrafast-communication networks. The latest wireless

communication standard can handle huge volumes of data at high speed, and is crucial to the development of technologies such as autonomous driving systems. Whoever controls the most "standard essential patents," or SEPs, for 5G will likely come out on top in the race to develop a new generation of advanced industries. As of March, China had filed for 34% of SEPs for 5G communication systems, an increase of more than 50% compared with its share of 4G patents, according to IPlytics, a German company that maintains a huge patent database. South Korea had a quarter of key 5G patents, while the share of filings by Japanese and U.S. entities fell compared with the 4G era.

The rise of China marks a clear change from when 3G and 4G were launched. Companies from the U.S. and Europe held the key SEPs at both stages, and Chinese companies had to pay large royalty fees to Western companies.

Royalties for SEPs are often determined through negotiations between patent holders and users. In the case of smartphones, 2% or so of the price of the product is the going rate. Companies with many SEPs sometimes conclude cross-licensing agreements that allow them to use competitors' technology free of charge, depending on the number of technologies and their importance.

Commercial 5G service is expected to begin in the next year or so. Companies looking to build 5G base stations or to make 5G-capable handsets will have to pay royalties to the holders of the essential patents. Huawei Technology had the largest share of filings for 5G-related SEPs, at 15%. Other top filers in China included ZTE and the China Academy of Telecommunications Technology, which ranked fifth and ninth, respectively.

The Chinese government is promoting 5G as part of "Made in China 2025," its ambitious plan to lead the world in next-generation technologies and industries. Among its goals is the development of highly automated factories that incorporate "internet of things" technology. To turn that vision into reality, 5G is essential.

Huawei and other Chinese companies began increasing their filings for 5G-related patents around 2016. The telecom equipment maker is reportedly spending \$10 billion a year on research and development related to 5G base stations, much more than Sweden's Ericsson or Nokia of Finland, its main rivals. ZTE, a domestic competitor, has also increased its market share in base stations and other equipment.

<https://asia.nikkei.com>

INDIA

India climbs five places on Global Innovation Index

India is now ranked 52nd on the Global Innovation Index (GII) 2019, a jump of 5 places over last year, and 29 places in the last five years - up from 81 in 2015. The list continues to be topped by Switzerland while Israel finds its place in the top ten for the first time. India, whose 29-place move up the GI (From 81 in 2015) represents the biggest jump by any major economy, also remains 2nd among middle-income economies in terms of the quality of innovation. The latest GI ranking also shows that the country has constantly been maintaining its leadership position as the most innovative country in Central and South Asia region every year since 2011.

Thanks to good performance in several critical economic indicators such as productivity growth and exports of services related to information and communication technologies, this year, India also grabbed the 15th spot in global companies' R&D expenditures.

Co-published by World intellectual property organisation (WIPO), Cornell University and INSEAD, the global innovation index (GII) is an annual ranking that quantifies the state of national innovation ecosystem across countries. Now in its 12th edition, the GI 2019 ranked 129 economies based on 80 wide ranging indicators. These included aspects ranging from traditional measurements like research and development investments and international patent and trademark

applications to newer indicators including mobile-phone app creation and high-tech exports.

<https://economictimes.indiatimes.com>

R&D spending

India's spending on Research and Development (R&D) as a percentage of GDP has remained at 0.7 per cent over a decade, the Lok Sabha was informed on Monday. This is much lower compared to 4.3 per cent in Israel, 2 per cent in China and 1.2 per cent in Brazil. Human Resource Development (HRD) Minister Ramesh Pokhriyal 'Nishank' said in a written reply that the low investment by the private sector was one of the reasons for the low investment in R&D. "One of the reasons is less investment by the private sector on R&D, which accounts for 65-75 per cent of the total R&D investment in most technologically advanced countries of the world as compared to only about 30 per cent in India," he added.

He said that though the country's investment in R&D had tripled in the last decade, its size as a percentage of GDP had remained at 0.7 per cent. "As per latest R&D Statistics released by the National Science and Technology Management Information System (NSTMIS) of the Department of Science and Technology (DST), R&D expenditure in India tripled from 2004-05 to 2014-15," he said.

<https://www.sify.com>

MALAYSIA

SME contribution to GDP

The Statistics Department said today Malaysia's small and medium enterprises (SMEs) contribution to the country's gross domestic product (GDP) rose to 38.3% in 2018 from 37.8% in 2017, led by expansion in the services and manufacturing sectors and as SMEs exports grew. In a statement, the department said SMEs 2018 GDP stood at RM521.7 billion versus the country's total GDP of RM1.36 trillion during the year.

"The value added of SMEs at constant 2015 prices escalated to RM521.7 billion

as compared to RM491.2 billion in 2017. SMEs activities were dominated by services sector which contributed 62.4% and manufacturing sector with a share of 20.1%. The agriculture sector contributed 10.1% to SMEs GDP followed by the construction sector which contributed 5.9%.

"Malaysia's SMEs GDP for year 2018 grew at 6.2% as compared to 7.1% in 2017. This performance exceeded Malaysia's GDP and non SMEs growth which registered 4.7% and 3.8% respectively." The structure of SMEs GDP by kind of economic activity is almost similar to the Malaysia's GDP structure with the exception of mining & quarrying sector due to structural differences between SMEs and Malaysia's GDP," it said.

The department's chief statistician Datuk Seri Dr Mohd Uzir Mahidin said in the statement that SMEs services and manufacturing sectors grew 8.1% and 5.5% respectively. "The (services sector) growth momentum was accelerated by wholesale & retail trade, food & beverages and accommodation sub-sector which grew to 8.6%. Finance, insurance, real estate and business services sub-sector which increased to 7.6% has also supported the growth momentum. "In manufacturing sector, value added of SMEs grew to 5.5% led by petroleum, chemical, rubber and plastic products with a growth of 5.8%," Mohd Uzir said.

Malaysia's SMEs' exports grew 3.4% to RM171.9 billion in 2018 from a year earlier, driven mainly by the manufacturing and services sectors' external sales. Mohd Uzir said SMEs' manufacturing and services exports grew 5.1% and 2% respectively.

<https://www.theedgemarkets.com>

PHILIPPINES

Philippine Innovation Act

President Rodrigo Duterte has signed a law which would harness innovation efforts to help the poor and the marginalized and enable micro, small and medium enterprises (MSMEs) to be part of the domestic and global supply chain. A copy of Republic Act 11293 or the Philippine Innovation

Act, which Duterte signed on April 17 this year, was released to the media.

Under the law, "the government shall adopt a broader view in developing its innovation goals and strategies covering all potential types and sources of innovation." The law establishes the National Innovation Council (NIC) to develop the country's innovation goals, priorities, and long-term national strategy.

The NIC will be tasked to develop a National Innovation Agenda and Strategy Document (NIASD) to establish the country's vision and long-term goals for innovation and provide a road map and the strategies for improving innovation governance. The NIC must identify strategies to stimulate regional capacity for development that can contribute to differentiated innovation strategy across regions in the medium term. It must develop strategies towards promoting MSMEs internationalization and participation in the local and global value chains.

Through a startup MSME innovation development program, the government shall mobilize its various agencies to work hand in hand with private organizations to provide technical and/or financial support programs for the development training of entrepreneurs.

<https://www.pna.gov.ph>

Innovative Startup Act

The Philippines has recently signed into law Republic Act 11337 or the Innovative Startup Act. This new law will help startups and start-up enablers by providing incentives that include travel grants, access to a Startup Venture Fund, as well as assistance in getting visas and business permits. As reported, the Department of Trade and Industry (DTI) is one of the lead agencies in implementing this law.

The Department commits to implementing the law to foster an environment conducive to smarter entrepreneurs. Aside from the DTI, the Department of Science and Technology (DOST) and the Department of Information and Communications Technology (DICT) are the host agencies to implement the Philippine Startup

Development Program. This is composed of programs, benefits and incentives for the start-up community.

There is so much entrepreneurial potential, talent, motivation, and optimism of the young population. With the current strong momentum for collaboration between and among government, academe, and industry, together with the comprehensive fiscal and non-fiscal support of RA 11337, the start-up ecosystem will grow and develop.

<https://www.opengovasia.com>

REPUBLIC OF KOREA

R&D spending to GDP ratio

The Republic of Korea ranked No. 1 in the world in terms of its ratio of research and development spending to gross domestic product, data showed on April 30. The latest data by the Organization for Economic Development & Cooperation showed Korea's R&D intensity rate standing at 4.55 percent as of 2017, slightly higher than the 4.54 percent for Israel, according to the Korea Institute of S&T Evaluation and Planning.

Israel spends a sizeable portion of its economic output on R&D, with the country becoming a benchmark by which other nations gauge their levels of investment. Switzerland came in third, with Sweden and Japan making the top-five list. Japan allocated 3.2 percent of its GDP into R&D for the one-year period.

Asia's fourth-largest economy reported an R&D intensity rate of 2.18 percent in 2000, but its numbers shot up to 4.15 percent in 2013 to outpace Israel's 4.08 percent for the first time. Israel again topped the global ranking in 2015 and 2016. KISTEP said that the average R&D intensity figure for all OECD member states stood at 2.37 percent in 2017, up from 2.34 percent the previous year.

<http://m.theinvestor.co.kr>

Chipmakers' R&D spending hits new high in 2018

Republic of Korea's leading memory chipmakers spent a record amount of money on research and development last year to

hold onto their leading positions and develop emerging technologies, their financial statements showed on April 2.

Samsung Electronics said it invested 18.7 trillion won (\$16.5 billion) in R&D in 2018, up 11 percent from a year earlier. The tech giant's R&D spending was equal to 7.7 percent of its 2018 sales, the highest level since 2003. In its financial report, Samsung highlighted the mass production of cutting-edge universal flash storage for smartphones, DRAM and solid-state drives based on advanced manufacturing procedures as accomplishments of its R&D efforts. Last year, Samsung said it acquired 2,055 patents in South Korea and 6,062 patents in the United States to protect its intellectual property rights on its semiconductor technologies.

SK Hynix said it spent 2.9 trillion won on R&D activities last year, a 16.4 percent rise from a year earlier. The company's R&D expenditure was above 2 trillion won for the third consecutive year. The company said its R&D is focusing on DRAM and NAND solutions as well as new products and emerging technologies to maintain growth momentum and find new business opportunities. SK hynix's intellectual property rights on its semiconductor technologies numbered 12,786 as of December, its financial statement showed.

The tech giants have been jacking up investment to maintain their dominant market position and widen gap with emerging Chinese manufacturers while developing technologies to expand their presence in the nonmemory market amid slumping memory chip prices.

<http://www.theinvestor.co.kr>

Blockchain patent-granting rate

A new report indicates that in terms of the number of patents involving blockchain being granted, Republic of Korea has the highest rate in the world. The ranking was done by IAM, a platform for intellectual property business media. According to its findings, South Korea has a 54 percent rate of blockchain patents being granted. Meanwhile, Japan is only at a measly 17

percent with the U.S. following closely behind at 16 percent. As for why this is the case, the report suggests it has to do with the system of granting patents in the respective countries.

"This could be because many of the patent publications in these countries have B1 kind code, where no previously published pre-grant publications exist. Therefore, many patents filed in Korea, Japan and the US in this dataset were already granted patents when published," the report reads. As for the matter of China's poor performance at a measly two percent, this is being attributed to the fact that patents are first published before they are examined in the country. This is why most of the inventions that were submitted for patent-granting have yet to receive it. "At present, the vast majority of invention patents are still in the examination stage and few have been granted," the report reads.

However, the rate at which blockchain patents are granted does not tell the complete story. On the matter of actual innovations involving the distributed ledger technology, China and the US lead the pack, Coin-telegraph reports. Together, they actually make up 84 percent of the developments in the nascent industry.

Patent filings for blockchain have also outstripped the rate at which patents for other technologies are being filed. This shows significant interest in the technology despite reports of investments in blockchain seeing a huge reduction for this year.

<https://thenews.asia>

R&D push shows shift toward big companies

The government will boost support for big businesses in research and development (R&D) in a bid to reduce dependence on overseas materials. After Japan's export restrictions exposed the Korean manufacturing sector's reliance on imported materials, the Ministry of Trade, Industry and Energy announced Thursday that it will make changes to government support for R&D, which has historically favored small companies.

According to the planned changes, the government will support up to 66 percent

of the cost of state-sponsored R&D projects pursued by companies with assets of over 10 trillion won (\$8.3 billion), up from the current 33 percent limit. Now large companies will be eligible to receive the same support as small companies. The government added that it will provide up to 50 percent of the funding for projects aimed at introducing overseas technology currently unavailable in Korea. It will also ease administrative processes to quickly provide the needed funding.

The government also announced that it will encourage active research in state-led projects by abolishing some annual evaluations. The announcement is the latest step in the government's efforts to help local R&D. Earlier this week, it said it will provide 7.8 trillion won over the next seven years for research. Seoul seeks to establish by 2024 a stable supply of 100 key industrial materials affected by Japan's new trade restrictions.

The aggressive support suggests an urgency to expedite the local development of industrial materials. The Korea Institute for International Economic Policy (KIEP) said in a recent report that Korea imported last year \$31.5 billion worth of materials to be affected by Japan's restrictions. This amounts to 57.7 percent of the total Japanese imports of \$54.65 billion.

According to Yuanta Securities Korea, 92 percent of photoresists, one of the three materials restricted by Tokyo last month, were from Japan this year.

<http://koreajoongangdaily.joins.com>

SRI LANKA

Entrepreneur program gets ready

To develop entrepreneurship in Sri Lanka to much greater levels, the Ministry of Industry and Commerce, with the IDB will launch the largest such program in Sri Lanka for the first time in the country's SME history. "We believe the total SMEs here to be at around one million. Nanvamu Lanka is our effort to expand this base in a big way" said the Minister of Industry, Commerce, Resettlement of Protracted

Displaced Persons, Cooperative Development, Skills Development & Vocational Training on 6 August in Colombo.

Minister Bathiudeen was in discussions with his top officials at the Ministry. "IDB and NEDA are supporting SMEs in many ways. The proposed Nanvamu Lanka will create more than 100,000 new entrepreneurs in Sri Lanka. This is the largest entrepreneur creation program launched so far in Sri Lanka.

The Enterprise Sri Lanka series pioneered by Prime Minister Ranil Wickremesinghe aims to move people away from government sector jobs to entrepreneurship. The Cabinet approved Nanvamu Lanka too will support this vision. We categorise 75% of all Sri Lankan enterprises are to be SMEs but its total is only 230,000. Nanvamu Lanka will enhance this number by 100,000 by instituting new SMEs and directly supporting other SMEs for the first time" said Minister Bathiudeen.

The State Trading Corporation (STC) under Minister Bathiudeen, with NEDA and IDB, is tasked to distribute SME material to new entrepreneurs under Nanvamu Lanka, which will also work on setting up new SMEs on allocations based on a District basis.

<http://www.asiantribune.com>

THAILAND

'Innovation Thailand' road map

The National Innovation Agency (NIA) has unveiled a mission to power Thai development under the new Ministry of Higher Education, Science, Research and Innovation. The agency will operate as the "national innovation system integrator", forging collaborations between academia, technology, industry, finance and other sectors to create real economic and social impacts. The new mission comes with a five-pronged plan: to reform innovation-related laws, build innovative regions, forge new innovative "economic warriors", strengthen financing for innovation, and create awareness of "Innovation Thailand".

"The Ministry of Higher Education, Science, Research and Innovation has

declared the NIA will be responsible for manpower development, ecosystems and innovative infrastructure," explained Pun-Arj Chairatana, executive director of the NIA. "This merging and restructuring of the new ministry is a turning point that will help drive Thailand forward. Competent manpower will help many sectors be prepared for future changes," he added.

The NIA's role as innovation integrator has two dimensions, Pun-Ari explained. First is horizontal integration of supply-side development by creating a network of agencies which support innovation development in order to strengthen collaboration within the ecosystem. Second is vertical integration of demand-side development by connecting and coordinating with the private sector, civil society and stakeholders for innovation creation with economic and social impact.

To meet this objective, a fivefold plan will unfold between 2020 and 2023 to:

1. Reform innovation laws by reducing limitations and creating a conducive environment for the growth of innovations, such as improving laws on startups law and the use of technology and innovation in business.
2. Build innovative regions to raise equality and strong development in regional innovation networks. NIA will connect local government departments, universities, private sector and communities with three goals: a) Increasing innovation in the workforce, and raising the number of innovators and innovative organisations in the region; b) Developing target industrial clusters in the region to increase investment potential; and c) Supporting the innovation identity of the region in order to expand the investment in the innovation business of the region.
3. Building new innovative economic warriors, which will focus on creating innovators and innovation – especially those with global potential – to enhance the country's competitiveness. Creating a minimum of 20,000 jobs.
4. Building financing by stimulating support and investment from government agencies, large corporations, financial

institutions, and also creating marketing plans for entrepreneurs.

5. Creating awareness of “Innovation Thailand” through cooperation and campaigns that promote global recognition for Thailand and Thais as a hotbed of high-tech and new idea.

Future-oriented strategy will be paired with concrete actions to support plans. For example, the Groom, Grant and Growth programmes will increase opportunities for innovative business development. Groom is an incubator for business entrepreneurs, Grant will support access to funding, while Growth will enhance innovation capability and create investment opportunities on the international stage. Meanwhile area-based organisation will take the form of innovation corridors, cities and districts. Lastly, the Startup Thailand programme will support new businesses by enhancing workers’ capacity for innovation via education at the NIA Academy, the Centre for Agricultural Innovation Business, and Innovation Foresight Institute.

<https://news.thaivisa.com>

VIET NAM

FDI-driven manufacturing

Fitch Solutions under Fitch Ratings, one of the world’s largest rating agencies, a few days ago released its Asian economic report, stating that foreign direct investment (FDI) which focuses largely on the manufacturing and processing, will likely remain robust over 2019. “We continue to project the Vietnamese economy to be a regional outperformer as we forecast growth to come at 6.5% in 2019, compared with an aggregate of 6.1% for Asia,” read the report. “We believe that FDI inflows into the manufacturing sector will be further supported by improved diplomatic relationships combined with the government’s open-door trade policy, alongside favourable demographics, such as Vietnam’s educated and low-cost labour force.”

According to statistics from the Ministry of Planning and Investment, the processing and manufacturing sector, which contributes to 80% of the Vietnamese industrial sector’s growth, remains the largest sector

for FDI in 2018, with a total registered capital of US\$16.6 billion in 2018, up 4.4% from US\$15.9 billion in 2017.

In the first seven months of 2019, the FDI-driven manufacturing and processing sector attracted 713 projects registered at more than US\$6 billion. Total newly-registered and newly-added capital, and capital acquisitions were worth US\$14.46 billion, up from US\$9.62 billion in the same period last year. As of July 20, 2019, Vietnam had 29,247 foreign-invested projects registered at nearly US\$352.3 billion. In the first seven months of this year, foreign-related stake acquisitions and capital contributions were valued at US\$8.52 billion, up 77.8% on-year. FDI disbursement is estimated to hit US\$10.6 billion, up 7.1% on-year.

Standard Chartered Bank released its fresh forecasts that Vietnam will “remain the fastest-growing ASEAN economy in the near term, with 2019 growth being projected at 6.9%. The FDI-driven manufacturing sector, which is poised for a fourth consecutive year of double-digit growth, will continue to be a key growth driver.”

According to the bank’s latest macro-economic research report, FDI inflows will stay robust this year, particularly in regards to the manufacturing sector, totaling US\$18 billion.

Under the General Statistics Office’s recent survey on the trend of manufacturing and processing enterprises in Vietnam in the second quarter of 2019, 52% expected that their performance will get better in the third quarter while only 11.4% believed they will run into difficulties. Some 45.2% said their second-quarter performance was better than in the first quarter, and only 16.5% claimed that they faced difficulties.

The economy grew 6.76% in the first half of 2019, lower than the 7.05% rise in the same period last year. However, it still demonstrates an upbeat outlook for the economy as it remains far higher than the average growth rate of 5.53% in the 2011-2017 period. It also affirms the timeliness and effectiveness of the government’s solutions in socio-economic development.

According to Fitch Solutions, Vietnam’s strong economic growth outlook will also

continue to attract FDI in the real estate sector as foreign developers look to capitalise on the rising affluence of the population and the desire for physical expansion among businesses. Real estate businesses attracted a total FDI of US\$6.6 billion in 2018, more than doubling the US\$3.1 billion in 2017.

<https://en.nhandan.org.vn>

Artificial intelligence development

In the development of the fourth industrial revolution, artificial intelligence (AI) has made significant progress and is expected to make breakthroughs in the next ten years. Following the global trend, the Vietnamese government aims to turn AI into a driving force of development and make it a top priority in growth policies. One of the most important tasks is developing human resources, including improving higher education training quality, building 4.0 technology training institutes, encouraging technological application, renovation at businesses; and investment in science-technology research.

According to Minister of Science and Technology Chu Ngọc Anh Việt Nam has advantages in start-up innovation and technological development, especially in AI. With an open business climate and labour force interested in technology, the application of AI in various sectors has made progress, connecting parts of the nation’s AI ecosystem. In Việt Nam, AI has been applied in a number of sectors including healthcare, education, agriculture, transport and e-commerce.

The information-telecommunication-technology group FPT Corporation has applied AI in smart traffic in HCM City. Viettel Military Industry and Telecoms Group is the first business in Việt Nam to apply AI in endoscopy, helping identify, localise and assess levels of damage in the digestive system. In the agricultural and forestry sector, Viettel has applied AI in forest status and area statistics with accuracy of 80 per cent. The firm is looking to set up forest databases and management maps. Viettel has also come up with a solution to help businesses fight cyberattacks and tighten internal security.

<https://technology.inquirer.net>

Technology Scan

Green Technology

INTERNATIONAL

Disease-resistant crops

An international team of scientists has developed a groundbreaking new resource to guide the transfer of disease-resistance genes from wild plants to domestic crops. The method, known as AgRenSeq, will revolutionize the creation of disease-resistant crops across the globe. A team of scientists at the John Innes Centre in Britain collaborated with colleagues in Australia and the United States to develop the tool. The resulting techniques will strengthen the global fight against pathogens that threaten wheat, soybean, maize, rice, and potato crops.

Study co-author Professor Harbans Bariana from the Sydney Institute of Agriculture and the School of Life and Environmental Sciences is a global expert in cereal rust genetics. He explained, "This technology will underpin fast-tracked discovery and characterization of new sources of disease resistance in plants."

AgRenSeq provides experts with a database of resistance genes discovered in wild relatives of modern crops so they can rapidly identify DNA sequences linked to disease fighting capability. Equipped with this crucial information, the researchers will use lab techniques to clone the genes and introduce them into domestic crops to protect them against pathogens and pests such as rusts, powdery mildew, and Hessian fly.

AgRenSeq has been successfully tested in a wild relative of wheat. Researchers managed to identify and clone four resistance genes for the stem rust pathogen in a matter of months. According to the experts, this process would have easily taken 10 years using conventional methods. The study is published in the journal *Nature Biotechnology*.

<https://www.earth.com>

ASIA-PACIFIC CHINA

Wastewater treatment

Chinese researchers have developed a system for the treatment of coking

wastewater from large-scale industries with lower costs and higher efficiency. Heating coal over high temperatures provides both heat and carbon (coke) required for iron production. During the process, recycled scrubber water, which is used as a coolant, contains large amounts of suspended solids and chemicals that are toxic to the environment and biological systems.

Based on the idea of whole-process pollution control, researchers from the Institute of Process Engineering (IPE), Chinese Academy of Sciences, lowered the cost of coking wastewater treatment by 20 percent in their new system, and achieved stable and efficient removal of toxic and polluting particles. So far, the system has been used in 41 water pollution control projects in large Chinese enterprises like Ansteel, Wuhan Iron and Steel Corporation and China Coal Energy.

According to the IPE researchers, the installed systems now can treat more than 55.2 million tonnes of coking wastewater every year. Over the past three years, the systems have treated 152 million tonnes of coking wastewater, recycling 750,000 tonnes of tar and reducing emissions of 240,000 tonnes of carbon dioxide as well as 90,000 tonnes of ammonia nitrogen. The researchers said the system enables the coking industries to meet the national standards for industrial wastewater discharges, achieving efficient pollution control with low-cost operation.

<http://www.xinhuanet.com>

Nanosponge for environmental protection

Chinese scientists in east China's Anhui Province have developed a kind of nanosponge that can effectively absorb diesel and remove it from contaminated water and soil. A research team from the Hefei Institutes of Physical Science of the Chinese Academy of Sciences developed the new type of hydrophobic nanosponge with amino silicon oil and silane coupling agent, which can effectively absorb diesel in water and soil under various conditions.

The sponge provided a promising and low-cost approach for diesel control and

removal, showing great potential in environmental and agricultural fields. Diesel leak poses a great threat to the environment due to its contamination to water and soil. It decreases oxygen concentration in water, affecting the growth of aquatic organisms, which also lowers soil permeability and causes harmful effects on the growth of plants.

<http://www.xinhuanet.com>

Green way to make diesel fuel, hydrogen

Chinese scientists have developed a method to convert light energy and biomass to diesel fuel and hydrogen. The study by scientists of the Dalian Institute of Chemical Physics of the Chinese Academy of Sciences provides a way to produce clean energy using solar power or artificial light source and sustainable carbon sources present on Earth's surface, according to the researchers.

Wang Feng, the chief scientist leading the research, developed technologies which can merge the process of hydrogen production and biomass conversion for creating diesel fuels with light energy. The research result was published in the latest issue of the international science journal *Nature Energy*.

<http://www.xinhuanet.com>

INDIA

Industrial wastewater treatment

Expanding the range of water treatment technologies, scientists from Indian Institute of Technology-Guwahati have developed a membrane that promises to help simultaneously remove oil and dyes from industrial and other wastes. In their new work, Scientists led by Dr. Uttam Manna have sought to tackle the problem by developing a membrane using graphene oxide, cotton fibre and dopamine, an organic chemical, which is more known for its functions as a hormone and a neurotransmitter in human body.

For developing the membrane, scientists first synthesized molecules of poly-

dopamine. They then deposited them on the surface of cotton fibers and subsequently coated the combo with graphene oxide. Scientists tested the membrane on a water sample containing two dyes - methylene blue and crystal violet. Due to their positive charge, the dyes were attracted to and adsorbed on the negatively charged membrane, leaving behind clean water. They then tried it on a sample containing a mix of water and oil. They found that the membrane was able to remove around 98% of oil from the water.

The membrane's properties remained unaffected by bending, creasing, twisting, rolling, rubbing with sand paper and treatment with water with extreme salinity. Further, it was found that it can be used for up to ten times. The study team included Upama Baruah and Avijit Das. The findings have been published in the journal *ACS Applied Materials and Interfaces*.

<https://www.thehindubusinessline.com>

'Agricopter' to eliminate manual spraying of pesticides

Students at the Indian Institute of Technology (IIT) Madras have developed a "smart agricopter" to eliminate manual spraying of pesticides in agricultural fields and help identify crop health by using an imaging camera. The innovation will be allowing spraying pesticides ten times faster and with 100% precision at the same cost as manual spraying.

Students at the Centre For Innovation, IIT Madras, identified manual pesticide spraying as an extremely hazardous activity as it endangered farmers' and labourers' health and resulted in a massive overuse of toxic chemicals. The team of three then set out to design a technological solution that would eliminate the need for farmers to come in contact with pesticides as well as intelligently identify which crops on the farm require pesticides and which did not.

The advanced multispectral imaging camera allows the hexacopter drone to make smart maps of farmland based on crop health and its completely autonomous pesticide refilling system ensures entire spraying is completely autonomous. What

really sets agricopter apart from existing products is the multispectral imaging camera which provides smart analysis of crop health and ensures that the entire spraying process is completely autonomous and that the farmer is never exposed to the pesticide.

The current version of Project Smart Agricopter is a hexacopter drone with the capacity to carry 15 liters of pesticide. Agricopter aims to spray pesticides 10 times faster and with 100 per cent precision at the same cost as manual spraying.

<https://www.livemint.com>

ISRAEL

Artificial intelligence for agriculture

Israeli and US researchers have developed an artificial intelligence (AI) method that can help crops cope with climate changes, the Ben Gurion University (BGU) reported. In the study published in the journal of *Communications Biology*, researchers at BGU and the University of California developed a method to identify metabolic pathways which are chemical reactions in the cell, allowing it to grow and multiply. "The world is facing the loss of crop yields because of climate changes, insects, and more. The identification of metabolic pathways that helps the plant deal with such problems will allow farmers to grow significantly stronger crops," the study said.

The researchers used machine learning techniques, in which systems learn to identify patterns and make decisions in conjunction with correlation-based network analysis. This analysis illustrates the connection between the molecular components and the knowledge gained in basic chemistry. Thus, the researchers collected data on known metabolic pathways from public databases and built correlation-based networks of tomato metabolites.

<https://www.timesnownews.com>

JAPAN

Battery promises green power

Researchers at the Tokyo Institute of Technology have developed a new kind

of battery that can reliably generate electric power from heat in environments with temperatures ranging from 60 degrees C to 100 degrees C—which is low enough to mimic geothermal heat. In an earlier experiment, the researchers developed sensitized thermal cells (STCs) that employed dye-sensitized solar cells to convert light into electric power. In their latest advance, team leader Sachiko Matsushita, an associate professor at Tokyo Tech, explained that they replaced the dye with a semiconductor to enable the cells to operate using heat instead of light.

Several methods for converting heat into electric power already exist, including redox batteries that employ the flow of hot and cold chemical liquids to create electricity, and thermoelectric batteries that use the Seebeck effect to generate electricity when a temperature gradient is applied along a conductor. But Matsushita points out that whereas the STC battery can literally be buried in the ground and work as is, the other devices would face major physical and operational issues if required to operate in such a way.

The STC consists of an electron transport layer of n-type silicon and a semiconductor layer of germanium that together compose the working electrode. Sandwiched between these layers and the counter electrode made of fluorine-doped tin-oxide glass is a solid electrolyte layer of copper ions in a polymer. When heat is applied, electrons in the semiconductor are thermally excited and rise from a low-energy state to a high-energy state, and are injected into the electron transport layer. From there, they pass through an external circuit and continue on via the counter electrode to the electrolyte.

An oxidation and reduction (redox) reaction involving copper ions takes place in the electrolyte. This causes some low-energy electrons to be transferred back to the semiconductor layer and so the process begins anew, completing the circuit. In testing the battery using a hot plate as the heat source, the researchers connected 10 cells in series and powered an LED light. In another test, the cells were used to run a liquid crystal display.

When the team first began practical testing using an oven as the heat source, it wasn't clear if or when the battery would stop operating. After experimenting, the device did indeed stop once the redox reaction in the electrolyte halted and equilibrium was reached at both interfaces of the electrolyte, which prevented any further transfer of electrons.

But to their surprise, the researchers discovered that by simply turning off and on the external circuit while leaving the battery in the heat source, power generation was restored. This happens because when the circuit is turned off, the reduction reaction in the electrolyte dissipates. Consequently, ion distribution in the electrolyte changes and equilibrium is no longer maintained. Thus power generation begins again.

<https://spectrum.ieee.org>

AI disaster mitigation technology

Fujitsu Limited and Fujitsu Laboratories Ltd. announced the development of a technology that draws on mathematical models built with limited data on rainfall and water levels to create flooding predictions for rivers. The solution leverages Fujitsu Human Centric AI Zinrai, a comprehensive portfolio that encompasses Fujitsu's wide range of AI technologies and techniques, and utilizes a model that incorporates insights from hydrology to produce an AI that achieves predictions with greater precision.

The new technology proves effective even for smaller rivers with limited measurement data or for areas where water level sensors have been newly installed and have yet to accumulate sufficient data. These predictions will offer authorities a vital tool for delivering faster response times and mitigating flood damage in the event of a natural disaster, including in dispatching personnel to affected areas and supporting appropriate decision-making in issuing evacuation advisories.

Fujitsu and Fujitsu Laboratories will continue to work to further perfect this technology through a field trial with local

governments across Japan with the aim of delivering a commercial solution during fiscal 2019. With the development of this solution, Fujitsu demonstrates how this and other AI technologies will play an important role in bolstering its efforts to combat the effects of climate change, and contribute to the achievement of greater sustainability in society.

<https://www.eletimes.com>

Rain-resistant wheat variety

Scientists have created a rain-resistant wheat variety using genome-editing technology, a breakthrough that could lead to the development of higher-quality flour. The research team from the National Agriculture and Food Research Organization (NARO) and Okayama University said genome editing enabled them to develop the variety in just about a year. It takes nearly 10 years to develop such a wheat species using conventional breeding technology because the plants must be bred over generations.

The wheat used for the study is not a species currently sold on the market, but the team believes the method utilized could someday succeed in developing an edible variety resistant to rain. "The variety we developed has excellent properties, so we'll use it as a parent to create new species through breeding," a team member said.

Since wheat is native to arid zones, it is vulnerable to humidity. When it rains for a long period before harvest, the plants' seeds often sprout on their ears, resulting in low-quality flour. Kazuhiro Sato, a genome research professor at Okayama University, Fumitaka Abe, a chief researcher at NARO, and others targeted Qsd1, a gene found in barley and closely associated with sprouting. Barley had been confirmed unlikely to germinate even under appropriate temperature and humidity conditions when Qsd1 didn't function properly.

Using the genome-editing technology called CRISPR/Cas9, the researchers created wheat seeds whose Qsd1 was genetically manipulated to inhibit its activity. After watering the treated seeds for seven days, they found that only 20 to 30 percent

sprouted. Almost all ordinary wheat seeds tested under the same conditions had sprouts.

The findings were published in the U.S. scientific journal *Cell Reports* on July 31.

<http://www.asahi.com>

EUROPE

BELGIUM

Solar panel splits water to produce hydrogen

A team at Katholieke Universiteit Leuven, or KU Leuven, says it has developed a solar panel that converts sunlight directly into hydrogen using moisture in the air. The prototype takes the water vapor and splits it into hydrogen and oxygen molecules. If it scales successfully, the technology could help address a major challenge facing the hydrogen economy.

Hydrogen, unlike fossil fuels, doesn't produce greenhouse gas emissions or air pollution when used in fuel-cell-powered vehicles or buildings. Yet nearly all hydrogen produced today is made using an industrial process that involves natural gas, and this ultimately pumps more emissions into the atmosphere.

A small but growing number of facilities are producing "green" hydrogen using electrolysis, which splits water molecules using electricity—ideally from renewable sources such as wind and solar. Other researchers, including the team in Belgium, are developing what's called direct solar water-splitting technologies. These use chemical and biological components to split water directly on the solar panel, forgoing the need for large, expensive electrolysis plants. "Finding a way to create hydrogen in some easier or more efficient way is maybe a Holy Grail quest," says Jim Fenton, who directs the Florida Solar Energy Center at the University of Central Florida.

KU Leuven sits on a grassy campus in Flanders, the Dutch-speaking northern region of Belgium. Earlier this month, professor Johan Martens and his team at the Centre for Surface Chemistry and

Catalysis announced their prototype could produce 250 liters of hydrogen per day on average over a full year, which they claim is a world record. A family living in a well-insulated Belgian house could use about 20 of these panels to meet their power and heating needs during an entire year, they predict.

The solar panel measures 1.65 meters long—roughly the height of a kitchen refrigerator, or this reporter—and has a rated power output of about 210 watts. The system can convert 15 percent of the solar energy it receives into hydrogen, the team says. That's a significant leap from 0.1 percent efficiency they first achieved 10 years ago. (Separately, international researchers last year said they achieved 19 percent efficiency in producing hydrogen from direct solar water splitting.)

However, Martens's lab was tight-lipped about its technology. [Tom Bosserez](#), a post-doctoral researcher, declined to disclose any specifics, citing intellectual property concerns. He says only that the lab specializes in "catalysts, membranes, and adsorbents."

Researchers plan to field test their prototype at a house in the rural town of Oud-Heverlee. Hydrogen would be stored in a small, underground pressure vessel during the summer months, then pumped throughout the house during the winter. If all goes according to plan, Martens says the team could install 20 panels at the house, or build a larger neighborhood system to allow other families to use the "green" hydrogen.

<https://spectrum.ieee.org>

SWITZERLAND

Carbon-neutral fuel from sunlight and air

Researchers from ETH Zurich have developed a novel technology that produces liquid hydrocarbon fuels exclusively from sunlight and air. For the first time worldwide they demonstrate the entire thermochemical process chain under real field conditions. The new solar mini-refinery is located on the roof of ETH's Machine Laboratory building in Zurich.

Carbon-neutral fuels are crucial for making aviation and maritime transport sustainable. ETH researchers have developed a solar plant to produce synthetic liquid fuels that release as much CO₂ during their combustion as previously extracted from the air for their production. CO₂ and water are extracted directly from ambient air and split using solar energy. This process yields syngas, a mixture of hydrogen and carbon monoxide, which is subsequently processed into kerosene, methanol or other hydrocarbons. These drop-in fuels are ready for use in the existing global transport infrastructure.

Aldo Steinfeld, Professor of Renewable Energy Carriers at ETH Zurich, and his research group developed the technology. "This plant proves that carbon-neutral hydrocarbon fuels can be made from sunlight and air under real field conditions," he explained. "The thermochemical process utilises the entire solar spectrum and proceeds at high temperatures, enabling fast reactions and high efficiency." The research plant at the heart of Zurich advances ETH's research towards sustainable fuels.

The solar mini-refinery on the roof of ETH Zurich proves that the technology is feasible, even under the climate conditions prevalent in Zurich. It produces around one decilitre of fuel per day. Steinfeld and his group are already working on a large-scale test of their solar reactor in a solar tower near Madrid, which is carried out within the scope of the EU project sun-to-liquid. The solar tower plant is presented to the public in Madrid at the same time today as the mini-refinery in Zurich.

The next project goal is to scale the technology for industrial implementation and make it economically competitive. "A solar plant spanning an area of one square kilometre could produce 20,000 litres of kerosene a day," said Philipp Furler, Director (CTO) of Synhelion and a former doctoral student in Steinfeld's group. "Theoretically, a plant the size of Switzerland -- or a third of the Californian Mojave Desert -- could cover the kerosene needs of the entire aviation industry. Our goal for the future is to efficiently produce sustainable fuels with our technology and thereby mitigate global CO₂ emissions.»

Two spin-offs already emerged from Aldo Steinfeld's research group: Synhelion, founded in 2016, commercializes the solar fuel production technology. Climeworks, founded already in 2010, commercialises the technology for CO₂ capture from air.

The process chain of the new system combines three thermochemical conversion processes: Firstly, the extraction of CO₂ and water from the air. Secondly, the solar-thermochemical splitting of CO₂ and water. Thirdly, their subsequent liquefaction into hydrocarbons. CO₂ and water are extracted directly from ambient air via an adsorption/desorption process. Both are then fed into the solar reactor at the focus of a parabolic reflector. Solar radiation is concentrated by a factor of 3,000, generating process heat at a temperature of 1,500 degrees Celsius inside the solar reactor. At the heart of the solar reactor is a ceramic structure made of cerium oxide, which enables a two-step reaction -- the redox cycle -- to split water and CO₂ into syngas. This mixture of hydrogen and carbon monoxide can then be processed into liquid hydrocarbon fuels through conventional methanol or Fischer-Tropsch synthesis.

<https://www.sciencedaily.com>

UK

Flexible, solar-powered supercapacitor

The researchers demonstrated the effectiveness of their new material by powering a series of devices, including a string of 84 light-emitting-diodes (LEDs) and a prosthetic hand, allowing it to grasp a series of object. A team led by an Indian-origin scientist has developed a flexible supercapacitor which can generate power from the Sun and store excess energy for later use. The technology developed by researchers from the University of Glasgow in the UK could pave the way for a new generation of flexible electronic devices, including solar-powered prosthetics for amputees.

The team led by Professor Ravinder Dahiya used layers of graphene and polyurethane to create the flexible supercapacitor, according to the study published in the

journal *Advanced Science*. The researchers demonstrated the effectiveness of their new material by powering a series of devices, including a string of 84 light-emitting-diodes (LEDs) and a prosthetic hand, allowing it to grasp a series of object. The top touch sensitive layer is made from graphene, a highly flexible, transparent 'super-material' form of carbon layers just one atom thick, said Dahiya. Sunlight which passes through the top layer of graphene is used to generate power via a layer of flexible photovoltaic cells below.

Any surplus power is stored in a newly-developed supercapacitor, made from a graphite-polyurethane composite. The team worked to develop a ratio of graphite to polyurethane which provides a relatively large, electroactive surface area where power-generating chemical reactions can take place, creating an energy-dense flexible supercapacitor which can be charged and discharged very quickly.

Similar supercapacitors developed previously have delivered voltages of one volt or less, making single supercapacitors largely unsuited for powering many electronic devices. The team's new supercapacitor can deliver 2.5 volts, making it more suited for many common applications, researchers said.

In laboratory tests, the supercapacitor has been powered, discharged and powered again 15,000 times with no significant loss in its ability to store the power it generates. "This is the latest development in a string of successes we have had in creating flexible, graphene based devices which are capable of powering themselves from sunlight," said Dahiya, who led the research.

<https://indianexpress.com>

NORTH AMERICA

USA

Solar technology for clean drinking water

Researchers have developed a new material that speeds the process of evaporation, enabling a small solar still to provide all the drinking water one family needs. If the

technology proves cheap enough, it could provide millions of impoverished people access to clean drinking water.

Recently, researchers have been working to upgrade solar stills as a cheap, low-tech alternative. The traditional still is little more than a black-bottomed vessel filled with water and topped with clear glass or plastic. The black bottom absorbs sunlight, heating water so that it evaporates and leaves the contaminants behind. The water vapor then condenses on the clear covering and trickles into a collector.

Guihua Yu, a materials scientist at the University of Texas in Austin, and colleagues recently reported a way around this limit. It involves hydrogels, polymer mixtures that form a 3D porous, water-absorbent network. Yu and colleagues fashioned a gellike sponge of two polymers—one a water-binding polymer called polyvinyl alcohol (PVA), the other a light absorber called polypyrrole (PPy)—which they then placed atop the water's surface in a solar still.

Inside the gel, a layer of water molecules bonded tightly to the PVA, each forming multiple chemical links known as hydrogen bonds. But with so much of their bonding ability tied up with the PVA, the bound water molecules bind only loosely to other nearby water molecules, creating what Yu calls "intermediate water." Because intermediate water molecules share fewer bonds with their neighbors, they evaporate more readily than regular water. And when they do, they're immediately replaced by other water molecules in the still. Using this technology, Yu's solar still produced 3.2 L/h/m² of water, double the theoretical limit, his team reported last year in *Nature Nanotechnology*.

<https://www.sciencemag.org>

Hydrogen fuel from seawater

Stanford researchers have devised a way to generate hydrogen fuel using solar power, electrodes and saltwater from San Francisco Bay. The findings, published March 18 in *Proceedings of the National Academy of Sciences*, demonstrate a new way of separating hydrogen and oxygen gas from seawater via electricity. Existing

water-splitting methods rely on highly purified water, which is a precious resource and costly to produce.

Theoretically, to power cities and cars, "you need so much hydrogen it is not conceivable to use purified water," said Hongjie Dai, J.G. Jackson and C.J. Wood professor in chemistry at Stanford and co-senior author on the paper. "We barely have enough water for our current needs in California." Hydrogen is an appealing option for fuel because it doesn't emit carbon dioxide, Dai said. Burning hydrogen produces only water and should ease worsening climate change problems. Dai said his lab showed proof-of-concept with a demo, but the researchers will leave it up to manufacturers to scale and mass produce the design.

As a concept, splitting water into hydrogen and oxygen with electricity -- called electrolysis -- is a simple and old idea: a power source connects to two electrodes placed in water. When power turns on, hydrogen gas bubbles out of the negative end -- called the cathode -- and breathable oxygen emerges at the positive end -- the anode. But negatively charged chloride in seawater salt can corrode the positive end, limiting the system's lifespan. Dai and his team wanted to find a way to stop those seawater components from breaking down the submerged anodes.

The researchers discovered that if they coated the anode with layers that were rich in negative charges, the layers repelled chloride and slowed down the decay of the underlying metal. They layered nickel-iron hydroxide on top of nickel sulfide, which covers a nickel foam core. The nickel foam acts as a conductor -- transporting electricity from the power source -- and the nickel-iron hydroxide sparks the electrolysis, separating water into oxygen and hydrogen. During electrolysis, the nickel sulfide evolves into a negatively charged layer that protects the anode. Just as the negative ends of two magnets push against one another, the negatively charged layer repels chloride and prevents it from reaching the core metal.

<https://www.sciencedaily.com>

ENHANCING DEVELOPMENT AND COMMERCIALIZATION OF GREEN TECHNOLOGIES IN THE REPUBLIC OF KOREA

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Abstract

Technologies should be developed for commercialization. Companies developing technologies need to understand the needs in the market prior to commercialization and make efforts to faithfully meet them. Green technology should be commercialized according to green maturity of market which shall determine its successful commercialization. It is purposed to classify and investigate the green product market by green maturity of two parties, buyer and seller. Governmental policies should focus on low green maturity to promote green technology products. In addition, two Republic of Korean policies are introduced in this article. One is green certification to boost the green maturity of companies and the other is energy technology acceptance enhancement project to eliminate the obstacles of commercialization.

Introduction

The world has been going green. Every country has tried to reduce the greenhouse gas emission to keep pace with the climate change issue. Green technology is located in the center of this movement as it can make companies green throughout applying them to their manufacturing processes as well as products and offering opportunities to purchase green products, make people green throughout purchasing green products and make the society green in the long run. Green technology can function as mentioned above in the market through commercialization. Commercialization of green technology, important as much as its R&D, depends on the market condition (Slater and Mohr 2006). All green technologies, however, are not commercialized successfully.

It needs to understand why all green products are not commercialized successfully in the market. Companies should consider the market condition in the release of green products. It is not difficult to find products, even quality products, faded out of market just after releases. One reason of market failure is the market condition.

That is to say, the market is not ready for the technology. As far as green technology concerns, the market readiness is characterized to be green maturity.

In this article, we shall classify and investigate the green maturity of market members, buyer and seller. Green maturity of consumers naturally creates the demand of green product and green market will flourish if companies try to meet the demand. On the contrary, if consumers have no interest on green product at all, even though companies release green products in the market, its market will not be successfully formed and green technology products will not be successfully commercialized. In addition, some cases shall be shown to boost the green technology development of suppliers and the green technology acceptance of consumers.

Classification of green product market

Market is typically composed of buyer and seller, in large. Buyer is the consumer and seller is the manufacturer in common. Two parties shall be classified by green maturity and four combinations are created

as shown in Figure 1: green buyer and seller, green buyer and non-green seller, non-green buyer and green seller, and non-green buyer and seller.

Green buyer

It is the ideal and most developed stage of green product market that both are green. Each party is self-motivated and motivates the other so "the greener the better" statement is realized. Green companies can survive in the market as consumers preferentially purchase green products, so make efforts to develop green or eco-friendly technologies or products to meet the needs of consumers. As investment in firms based on environmental performance is well promoted, firms' green characteristics improve the corporate financial performance in the long run. Governmental intervention or support is not mandatory, can be minimized, as market mechanism goes well.

Green seller

Considering the gap between buyer and seller, the green seller and non-green buyer is investigated first. If seller is green but buyer is not green, it is difficult to commercialize green technologies as buyers have no willingness to buy them. Furthermore, if it is more expensive than non-green technologies the preference of buyers toward them will be very weak enough to make the commercialization of green technology difficult. That is to say, buyers are reluctant to purchase more expensive green products than non-green products. Consumers are thought to have little technology acceptance.

In this stage, the third hand, governmental support is necessary focusing on improving the understanding of the public on eco-friendliness. People should understand the need of eco-friendliness and what they should behave for environment. Financial support can be effective in raising the perception toward environment and making people's behaviors green in a short period, if possible.

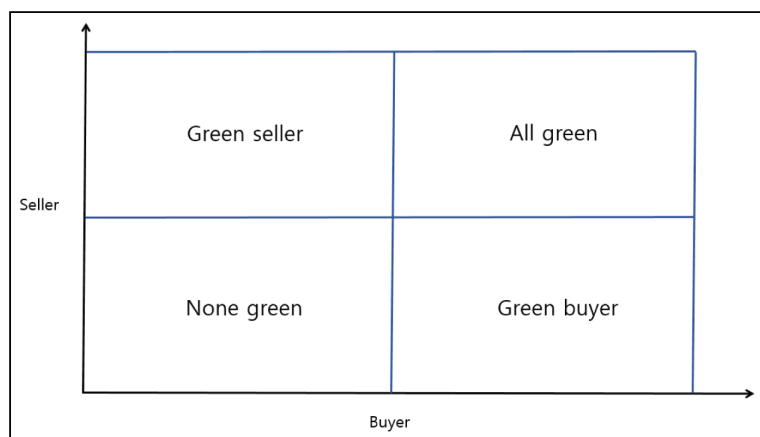


Figure 1: Four types of green market

Table 1: Ten fields of green technologies

1. Renewable energy	6. High-tech green house / city
2. Carbon reduction	7. Advanced materials
3. High-tech water resources	8. Clean production
4. Green IT	9. Eco-friendly agricultural and fishery food
5. Green vehicles and ships	10. Environmental protection and preservation

Source: www.greencertif.or.kr

Green buyer

The other case of gap between buyer and seller, green buyer and non-green seller shall be discussed. In this case, green consumer's role is very important in sustaining green products and coloring the market green. Consumers should purchase green or eco-friendly products to let companies develop and manufacture them. It can be regarded as the transition case to all green case. Consumers have the right to choose the proper manufacturer with the preference of green color in the competitive market so manufacturers should try to meet the green demand of consumers to survive in the market.

Governmental support should focus on promoting green technology development to keep pace with the demand. The role of government is to accelerate the green technology development for firms to timely provide the green technology products.

None green

If all players are not green, the government takes a crucial role in making both green. Governmental program should be launched for both to perceive the importance of green color. More specifically, the

government should induce companies to develop and manufacture green technology products and promote the green movement of people, that is, consumers. As players have no willingness to become green, financial support can be very effective to boost the green characteristics in a short period. People can be enlightened through education and training.

This stage should move toward the ultimate "all green" phase and the route should be chosen. It depends on which player should be prioritized. If seller is preferred to become green, the strategic route will be "none green-green seller-all green". Otherwise, it will be "none-green buyer-all green". Government can make efforts to expand the environmental regulation which let firms and people green though it is an enforcement. Reinforced regulation constrains non-green behaviors of both.

The Republic of Korean government initiated the green growth policies in 2008. Two players were not green, so green finance was launched, prioritizing the seller, firms, and they have made efforts to develop and commercialized the green technologies in the market introducing the green certification policy in 2010.

Policies to boost green

1. Boosting green seller: Green certification in Korea (KIAT, 2017)

The Republic of Korean government initiated the green growth as a national motto by conceptualizing the green growth as a harmonized and balanced growth of the economy and environment in 2008. The Framework Act on Low Carbon Green Growth was provided in 2008 and enacted in 2010.

Under the green growth policy, it has made efforts to make core key industries green, foster low-carbon green industry, promote a green value chain, and maximize the synergy effects of both axes of the environment and the economy through the transformation of growth patterns and economic structure.

To promote the green technology development and green industry and overcome resource and environmental risks simultaneously as economic development has been accelerated such as the risk of resource depletion, intensified water shortage, increased greenhouse gas emission, and so on, the Republic of Korean government launched the national green certification certifying a green technology or a promising green project to clearly stipulate the object and scope of supporting green investment and concentrate on investment as part of the government's low carbon green growth policy.

Green certification consists of green technology certification, green technology product certification, green project certification and specialized green enterprise certification. Ten fields of green technologies were pre-defined for certification shown in Table 1, which are mainly composed of technologies minimizing the emission of greenhouse gases and pollution. For certification, a technology is assessed mainly for technological excellence and green characteristics.

Green technology product is a commercialized product for sales that utilized green technologies and is certified by the Framework Act on Low Carbon, Green. It must utilize the green technology certified which evidently contributes to the

product function's manifestation.

Green project is defined as an economic activity related to green growth, such as installing green industry facilities and infrastructures, applying, propagating and spreading green technologies that have a significant economic and technical ripple effect. 105 businesses of nine fields were pre-chosen (Table 2). Feasibility of green technology, environmental expectancy effect and policy compatibility are assessed for certification.

Specialized green enterprise certification is a green company certification and specialized green enterprise is defined as a one-year-old or older company whose certified green technology has over 30% of the total sales turnover in the year prior to the application, where there are many certified green technologies. If the sum of individual turnover amounts is over 30%, the appropriate company may become a green company. Certification status as of August 2019 is presented in Table 3.

The benefits of green certification to companies are supporting the green industry loan, supporting the market reclamation and marketing, constructing the commercialization promotion system, and consulting the green certification. For small and medium enterprises (SMEs), green certification lets the participation in public procurement market easier than ever as a SME with a green certified product will get additional points by the recognition of green certification holding in the qualification assessment of Korean Public Procurement Service. Public procurement

market participation is a good business opportunity to SME because it can stably create sales.

2. Boost green buyer: enhancing energy technology acceptance (KETEP 2019)

Technology acceptance model originated from the theory of planned behavior of Ajzen (1991) explains that the perception influences the attitude which impacts the intention and the intention affects the acceptances, so it is very important to improve the perception toward the technology if people have reluctance to use the technology (Figure 2).

R&D with no consideration on technology

acceptance will confront the difficulty in commercialization in spite of its successful technology development. Technologies should meet the requirements from customers to be commercialized successfully (Zahra and Nielson 2002). Commercialization is very crucial in technology development for growth, so should be considered since developing the technology (Table 4).

Energy R&D recorded low commercialization rate¹ and showed the limitation of R&D focusing on technology development with no interest on commercialization. For recent decades, the budget of energy R&D has rapidly increased and the more interest of companies has improved the

Table 2: Nine fields of green projects

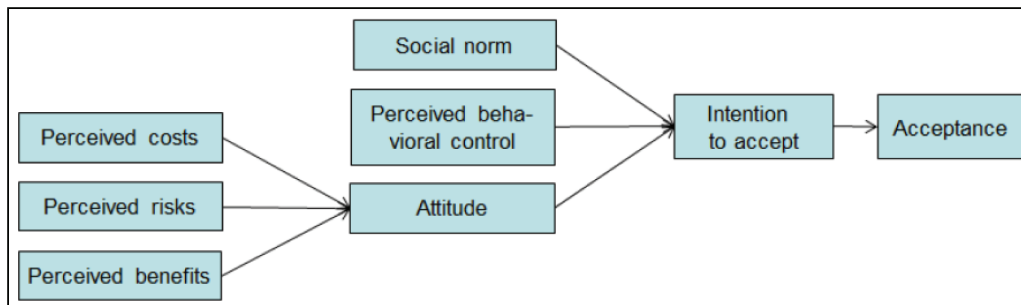
1. Propagating and spreading renewable energy
2. Building carbon reduction plants, systems
3. Developing, handling and managing high-tech water resources
4. Using and propagating green IT
5. Propagating and spreading green cars, green vehicles and systems
6. Propagating and spreading high-tech green houses, cities and infrastructure
7. Establishing the infrastructure for clean production
8. Supporting and supplying eco-friendly agricultural foods
9. Environmental protection and preservation

Source: www.greencertif.or.kr

Table 3: Status of green certification (as of August 2019)

Content	Green technology	Green technology product	Green project	Specialized green enterprise
Number of effective certifications	812	986	2	55

Source: www.greencertif.or.kr



Source: *Hujiits, Molin and Steg (2012)*

Figure 2: Technology acceptance model

¹ Average commercialization rate of energy technology is 26.6% for the period of 2009 to 2015 while the 46.5% in total (Chungangilbo, 2016).

Table 4: Differences from traditional R&D concept

	Traditional R&D	Enhancing the acceptance and R&D for commercialization
Goal	Assuring the technology competitiveness	Problem solving in the field and commercialization
Who	supplier	User & supplier
Characteristic	Indirect examination of market demand	Direct diagnosis and analysis of problems in the field
Support	Technology development	Development of technology as well as business

Source: KETEP (2019)

technology development performance of national energy R&D projects. However, commercialization outcome such as large market creation was so poor. It needed to converse the direction of R&D from competitive technology development to problem solving for commercialization. Total solution technical, political and economic is necessary to improve the commercialization rate, reflecting the field demand to R&D rather than recognizing the problem just in the laboratory.

Energy technology is a combined system with various devices, so there was a problem combination such as conflicts with local communities and economic problem during introducing and operating the system. Companies confronted the valley of death after R&D due to the failure of acceptance assurance, lack of fund, excessive marketing cost and so on (Barr, *et al* 2009). Therefore, the acceptance problem is very crucial in commercializing the energy technology.

Supplier-centered national R&D planning needed conversion to market-oriented. For the industrial technology whose market was well activated, the feedback of early adapters was utilized to product planning and improvement but energy technology market was not activated well so there were no early adapters enough to feedback.

Two types of problem solving approaches were applied for energy technology. The first one is to improve the problem of energy product or equipment on initial dissipation in the field and the other is to develop the energy product with diagnosing, analyzing and solving the acceptance problem of user or local area. For the first

type of problem solving, target local area and target people such as users and related people were set and problems they thought were collected and analyzed. Solutions finally provided based on analysis results were implemented, which includes the improvement in equipment as well as business model. In the second type of problem solving, acceptance problems including safety, site, cost burden, conflict of interests, governmental approval and so on were diagnosed and solved through operating the open platform where users participate in.

The Republic of Korean government launched the project to enhance the acceptance of energy technology besides the energy technology development project in 2016. It focused on technology development meeting the requirements of customers while the previous R&D project pursues only to ensure the technological competitiveness.

The project to enhance the energy technology acceptance showed the high ex post satisfaction score, 84.1 on average, much higher than the ex ante score, 35.1 on average. The score rose through solving mainly lack of basic information and difficulty in access to field problems that were pointed out by offering explanation and guideline documents and letting experts directly access to field problems (Table 5).

Enhancing the renewable energy acceptance

Living lab was organized and operated and developed the user-friendly DIY product design and micro credit business model in 2017. It was provided to enhance the acceptance of mini photovoltaic equipment of below 1kW capacity for home use

by finding the proper technology, education, and financing tool through citizen leading living lab. Distributed energy is still very important to enhance the renewable energy usage in the Republic of Korea as it costs less than the large scaled renewable energy generation facility in construction, installation and operation. To encourage the distributed renewable energy generation, the local government has provided the financial aid program in installing the equipment at home. Several households, however, were not willing to install the small photovoltaic power generation equipment, so it needed to eliminate the obstacles to improve the willingness and enhance the renewable energy use.

Small scale photovoltaic power generation system is normally weak in maintenance. The decline of trust towards the system due to the close of installation company, the use of poor-quality product, inappropriate execution and so on, and the rise of user complaint due to lack of information and systematic guideline to install and maintain the system were considered as the potential industrial threats. To resolve them, the complaints and opinions from users were collected first and both experts and users examined and analyzed together. Then, user manuals to install and maintain the system and malfunction case book to prevent the similar malfunction were developed and dissipated for enhancing the acceptance.

This project was progressed to develop the mini photovoltaic DIY system and the financial product with a local financial institution through citizen participation. Resident workshop was held seven times for four months and collected the village researcher who participated in three focus groups: 1) development of mini photovoltaic DIY system, 2) development of related financial product, and 3) development of education method in the kindergarten and advertisement method. Village backup center was established composed of seven village researchers who participated in the technical focus group and were thought to be highly skilled.

In the initial dissipation stage of mini photovoltaic system, several problems were

Table 5: Solutions of major projects to enhance the acceptance

Project	Problem	Solution
Improvement of the acceptance of welfare service through energy usage monitoring system	Lack of information	Providing the integrated guideline of operation and management of house energy
Enhancement of the acceptance of local citizens through high quality biogas	Difficulty in understanding the capability of product or service, in particular, facility operation	Providing the biogas guideline reflecting the requirement from users
Technology adaptation to Improve the energy efficiency and safety problem in the traditional marketplace	Lack of technological advance and explanation documents	Adapting the high efficiency technology and developing the product reflecting the opinions of people
Optimized model development to enhance the efficiency in energy usage in the facility horticulture	Lack of assurance of sustainability of maintenance and service delivery	Developing the optimized model to resolve the problems of users
Enhancement of acceptance of the dissipation of power generation system through providing the maintenance guideline of photovoltaic generation facility of small and medium scale	Lack of information	Providing the maintenance guideline
Development of guideline for installation and maintenance through diagnosis of performance of mini photovoltaic power generation system and field problems	Lack of information	Providing the guideline for problem diagnosis
Development of standard heat storage model to enhance the acceptance of photovoltaic facility	Access to field problems	Providing the standard manual for design, construction, maintenance of solar heat integrated heat storage system
Enhancement of acceptance for Building Integrated Photovoltaic System (BIPV) installation and dissipation	Lack of information, user convenience and explanation document	Providing the guideline of BIPV design and construction improvement, BIPV performance test standard and method, suggesting the policy to support the BIPV and BIPV economic feasibility evaluation standard
Dissipation of energy saving method in the small store	Difficult access to field problems	Introducing the diagnosis and monitoring system of refrigeration system
Enhancement of acceptance through small and medium scale ESS installation, operation, and maintenance	Lack of information	Developing the program to calculate the ESS capacity and expected profit. Providing the ESS guide and information system

Source: KETEP (2019)

found difficulty in citizens' information access, economic burden, lack of function and convenience in the system, which showed it was a supplier-centered business. For the purpose of diagnosing, analyzing and resolving the obstacles in dissipating the mini photovoltaic system, this project overcame the limitation of existing top-down approach through bottom-up approach where local residents directly developed mini photovoltaic system and financial product through living lab. The most distinguished one is that people participated in developing the financial product, My Home Solar Loan, together with local credit union to minimize the economic burden. It

had no interest rate on loan, so people reduced the installation cost burden. It is one of the best collaboration models with financial institution. Throughout this project, people resolved the misunderstanding toward photovoltaic system. Some worried about the electronic wave so empirically measured it altogether with experts and resolved their concern.

This project recorded the lowest ex ante satisfaction score, 13.3, before launching the project, but its ex post score skyrocketed to 98.8 after finishing the project. Thus, it is very important to resolve the inconvenience and problems of users in enhancing the acceptance.

Technology adaptation to improve the energy efficiency and safety

It was proposed to enhance the acceptance through pursuing the energy efficiency and improving the safety in the traditional marketplace and current status, problems, and requirements were examined and analyzed. Then the solution was provided: development of gas detector with Internet on Thing (IOT) based Volatile Organic Chemicals (VOCs) gas sensor to prevent the electricity fire and fire prevention system for traditional marketplace.

Merchants in the traditional marketplace used the low efficiency LED lightings due to economic burden and the marketplace is very weak to electricity fire because of old electricity facilities and disordered wire work, and non-systematic safety management. To resolve problems, high quality and low-price LED lightings and VOCs sensor module for fire detection were newly developed and installed. Developed products shall be applicable to other traditional marketplaces as they have similar circumstances, which will let the commercialization easier.

Conclusions

As we have shown above, it needs to examine the green maturity in the market prior to commercialization if you are going to commercialize green technologies. No or little needs toward green technology occurs market failure even though green technology is already developed and launched in the market. To minimize the market failure, the examination of target market is a pre-requisite before launching the products.

It also needs to develop green technology considering commercialization. Technology development due to intellec-

tual curiosity might offer developer the satisfaction in the mind but not offer the fund for further development. Therefore, commercialization should be considered to sustain the technology development as well as survive in the market.

Governmental effort is required to boost the green technology commercialization. Successful commercialization provides the internal fund to develop additional green technologies and reduces the government's budgetary burden for R&D project in the long run, so government should make efforts for companies to commercialize green products successfully.

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The Business of Greening: Policy Measures for Green Business Development in Asia

This publication examines the enormous potential for scaling up green business development in Asia and the Pacific. It reviews green markets, technologies, and practices with a focus on developing Asian countries and offers a set of policy options to enable governments and finance institutions to accelerate green business development in the region. Direct command-and-control measures and indirect market-based instruments targeted at both large and small firms are also included. The analysis suggests that advancing green businesses is a win-win for all stakeholders, but requires mobilizing vast resources of private capital and innovative management approaches.

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GREEN INDUSTRY DEVELOPMENT IN BANGLADESH

CHALLENGES AND PROSPECTS

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Abstract

Bangladesh is on the mission to achieve Sustainable Development Goals 2030, after achieving the millennium development goals successfully. Green industrialization is a positive indicator of sustainable development. The readymade garments (RMG) sector of Bangladesh has brought a breakthrough renovation in sustainable industry environment management. This paper presents an impressive illustration on the expanded success of three LEED-certified factories; one is the world's first Platinum-certified Denim factory and the others are Gold certified factories. The discussion has revealed the intention of the RMG investors behind the green transformation of the conventional industries is not only for making profit, rather it's the commitment of ethical business practice to the environment and people. This paper also recommends the mitigation scope of the challenges of green industrialization.

Background

Bangladesh is one of the fastest growing economies in Asia with a surprising growth over the last 10 years. On this journey, the readymade garments (RMG) sector has a remarkable contribution. In the last fiscal year, 2018-19, this sector earned almost \$34.133 billion (Woven wear; \$17.24, Knitwear; \$16.89). This earning contributes 84.21 percentage on overall export earnings and 11.2% on GDP. Bangladesh has become the second largest RMG exporter just after China. In addition, this sector has significant contribution to improve socioeconomic development including female empowerment, poverty alleviation, employment generation, improvement of social livelihood pattern, per-capita income, and economic up gradation.

Although the RMG industry has contributed a lot to this socio-economic uplifting, its environmental concern is still questionable. Generally, factories are using ground water, hazardous chemical and energy for production and operation. From the beginning of RMG industrialization in this country, a substantive amount of ground water and hazardous chemicals has been used for dyeing and washing. Most of the firm could not use water efficient technology in production due to lack of investment and awareness which caused misuse of water. Again, waste water treatment technology seemed to be expensive for small size factories. It seemed to be a culture of pollution by throwing waste materials and hazardous by-products here and there.

In RMG sector, environmental safe-guard is now a great concern from buyer and

entrepreneur. Even, misuse of scarce water resources and extensive environmental contamination is a great threat for sustainability (Reza et al, 2017). Now, entrepreneurs, buyers, and related stockholder have a deep concern to make the sector more environment friendly. This country now needs immediate attention for cleaner production.

Over the time, Bangladeshi entrepreneurs are realizing the adverse impacts of industrialization on the environment. They are now more concerned about the environmental effect, pollution, climate and social consideration. They are doing many things, such as running effluent treatment plants (ETPs), using energy efficient technologies and installing renewable energy technology for make the business sustainable on eco-friendly way. In this regard, going green is one of the most effective process to the entrepreneurs. Green production process is now most popular to RMG entrepreneurs where the production is eco-friendly and cost efficient. Reducing, recycling and, reusing (3R) techniques can save energy, and thereby directly reduce the environmental pollution, wastes and hazardous by-products.

Now, Bangladesh has been taking a leading position in green industrialization process. Bangladesh has the highest number of green RMG factories around the world, at most 90 LEED (Leadership in Energy and Environmental Design) green factories certified by USGBC (U.S. Green Building Council) and 250 more factories are registered with the USGBC for LEED certification. In addition, Bangladesh has 24 platinum-rated factories in which six of those have ranked among top 10 green factories of the world (The Daily Star, 2019)

According to SDG 12, positive environmental initiatives are incorporating initiatives for ensuring sustainable eco-friendly industrial production to save surrounding environment as well as to enhance the business competitiveness (Rezaei et al.

2013). It is highly expected that there are multiple benefits from green industry activities, both from environmental and business competitiveness. Green initiative approaches focus on upgrading industry and increasing productivity capacity without corresponding increases in resource use and pollution burdens.

Eco-friendly aspects of green industries

Optimum energy consumption

The present energy consumption scenario of RMG industry in Bangladesh is dominated by the use of three major energy sources: grid power, diesel power and natural gas. Factories are mostly running 24 hours and like to rely on smooth energy supply. Natural gas is the leading source among energy resources. Factories are basically dependent on captive power for continuous power supply. In the green projects, the exhaust gas of generator is further used to run other machines such as exhaust gas boilers and absorption chillers. It saves a huge amount of energy every year.

Similarly, in green factories heat exchanging device economizer is used with the boiler to reuse the heat from flue gases to raise the temperature of inlet feed water. As a result, less fuel is consumed and the overall efficiency of the boiler is improved. Practically, to ensure the optimum energy consumption, green factories are using daylight, LED instead of CFL, modern machineries with inverter technology, servo motor, etc.

Promoting renewable energy uses

For achieving green certification, production of renewable energy carries a significant credit point. The main sources of renewable energy are nature such as; solar, water, wind, biomass, etc. (Rezaei et al. 2013).

In Bangladesh, green factories are producing renewable energies mainly from solar. Bangladesh receives an average daily solar radiation in the range of 4-5 kWh/m² (Alaudin, 2014). Government of Bangladesh is also focusing on advance net metering system. At the green industrial establishments, net metering system plays a specific role

to achieve energy efficiency (Nabi, 2019).

Efficient uses of water resources

Water use efficiency means the responsible usages of water and reducing waste water (Sheth, et al., 2017). According to the United States Environmental Protection Agency (EPA), "water efficiency is the smart use of water resources through water saving technologies and essential steps that can be taken around the industrial perspective. To ensure the efficient use of water, green factories are using the water tracking system, water treatment plant (WTP), water efficient toilets, water efficient urinal, reusing the basin's water in toilet flushing, etc. For the maximum uses of water, clean used water is also using for car washing and irrigation purposes. Green factories are more concerned to ensure the water efficient technologies at everywhere of water consumption including production process.

Rain water harvesting

Rain water harvesting is an alternative way of using ground water for the industrial process to keep the environment safe and maintain sustainable industrial production. Textile and apparel industrial process requires a huge amount of ground water supply. Fortunately, Bangladesh is blessed with a long period of rainy season. Green factories are storing the rain water and by processing, using it in their production process.

Ensure indoor environmental quality

Improved indoor environmental quality ensures safe and healthy workplace in green industries. The interior designs of green industries are aware of maximum flows of natural air. As the building materials are low emitting materials, it ensures the thermal comfort at workplace. Well organized production floor and good compliance maintenance ensure safe workplace to the workers in green factories.

Case Study

Envoy Textiles Limited (ETL)

Envoy Textiles Limited is the First Scorer LEED Certified Platinum Denim Factory in the world. It was established in 2005

and launched its commercial operation in the early of 2008. The factory is located at Jamindia, Bhaluka, Mymensingh. Envoy Textile Limited is highly recognized to take the leadership in energy and environment design.

The main intention of the ETL management was to set up a green factory with less consumption of energy and water. ETL reduces 29% energy consumption, 34% water consumption, reuse and recycled 95% material waste along with ensuring 100% responsible use of natural resources (Envoy Textile, n.d.). ETL Management opined that, green building certification has promoted their branding and western consumers are giving priority to the green clothing as well. Bangladesh RMG industry faced a real crisis of existence after the Rana Plaza incidence and over the time it has overcome (Envoy Textile (n.d.).

Bay Creations Limited

Bay Creations Limited, a renowned name in manufacturing and exporting Knitting garments for last 14 years, is a sales and managing house for readymade garments, situated at Kornogop, Borpa, Narayanganj. Bay creation limited is committed to continue sustainable go green concept on its factory area. Upon considering the sustainable industrial development, Bay creation limited has achieved USGBC certified LEED Gold category certification.

Their motivation towards a green certification started from the awareness that, they need to contribute for a better future for their future generation. They want to contribute positively with their actions, and getting this seemed like the ideal way to abide to this ideology.

This company achieved significant benchmarks in terms of the LEED credits. Bay Creation Limited achieves 36% improvement in energy and atmosphere on baseline building performance rating. It has improved the quality view of 90% occupied working space. The green building project of the Bay Creation Limited was a new construction project. It has used 10% recycled content, 20% regionally extracted, recovered or manufactured materials for building construction. The green factory

Green industry development in Bangladesh: challenges and prospects

has reduced 100% water consumption for landscape watering, 40% baseline indoor water consumption and 50% wastewater generation (The Green Building Information Gateway (n.d).

According to the opinion from management level of this company, workers are highly satisfied with their activities. Most importantly, they have found appreciation from the workers due to the availability of chillers which keep the temperature down in their working section.

Nasa Hitech Style Ltd.

Nasa Hitech Style Ltd. started its journey in July 2018. The green factory is located at Gazipur, Dhaka, Bangladesh. From the very beginning, this company starts its operation with the intention of being certified by USGBC and it has achieved LEED Gold Certificate in 2019. They made plan on managing this certification with careful environmental management and by following the 4R principles in their factory.

Nasa Hitech Style Ltd. has reduced 26% energy consumption on the baseline performance rating. By fixing the water efficient fixtures, the green factory has reduced 40% of its water consumption for indoor water uses and 50% waste

water generation has reduced (The Green Building Information Gateway (n.d).

Green industrialization process of this company has increased the cost from 18% to 20% by means of new building construction, fabrication and LEED registration, certification and as consultancy fee. In addition, at least 10 persons are fully employed for Green project operation and maintenance.

According to the factory management, after initiating operation of green project, machine efficiency in terms of power consumption has increased momentarily. Moreover, they have installed Low e-glass which has increased the availability of more daylight, and decrease the cooling load as well. In this green factory 75% occupied workplace has access of day lighting.

Initially, it was not easy to cope up with green mechanism as the concept was new to them. Factory personnel had to go through the concept first. But their confidence promotes them to continue the green project successfully (The Green Building Information Gateway (n.d).

In Table 1, it has been observed that, Envoy Textiles Limited scored 80 points out of 110 points to be Platinum certified. Bay

creation has scored 71 points out of 110 points and Nasa Hitech Style Limited has scored 65 points out of 110 points. The score scale for Platinum and Gold category is also slightly different. Such as, for Platinum certification, the highest score scale of water efficiency category is 14 points but for Gold certification it is 10 points. As well as for Platinum certification the highest score scale of materials and resource category is 10 points but for Gold certification, the same category score scale is 14 points and other point's categories remain same for both certification.

Challenges of green industry development

Most of the Bangladeshi entrepreneurs are facing the challenges to establish green industries as follows:

- Green factory installation cost is 20 to 30 percent more than the traditionally designed factory because environment friendly production process, energy saving technology, water saving technology, solar panels, inverter technology, rain water harvesting requires more investment (Mirdha, 2019).
- Industries mostly depend on foreign consultancy firms due to the lack of local technology experts, which raise the construction cost. So, it becomes very challenging to go green within an estimated cost.
- Lack of price negotiation skill is another challenging issue for entrepreneurs. Buyers do not want to pay higher price from green factory compared to non-green factory.
- There is no specific declaration of green industrial policy in Bangladesh. The high rate of corporate tax and Value Added Tax are also creating an obstacle to green industrialization as well as no fiscal incentive to import technical equipment from abroad (Roy, 2018).
- Consumer behavior is also a challenging factor in green industry development. The local consumers are poorly aware of green clothing. Demand for green products is only from the western fashion world. As a result,

Table 1: Score card of the three LEED certified factories

Category	Envoy Textiles Limited (Platinum Score)	Bay Creation limited (Gold Score)	Nasa Hitech Style Limited (Gold Score)
Sustainable site	20/26	24/26	22/26
Water efficiency	14/14	10/10	13/35
Energy & atmosphere	16/35	13/35	13/35
Material & resources	10/10	5/14	6/14
Indoor environmental quality	11/15	4/15	6/15
Innovation	5/6	6/6	4/6
Regional priority credits	4/4	4/4	4/4
Integrative process credits	0/2		
Total Score	80/110	71/110	65/110

Source: Compiled from U.S. Green Building Council (2019)

only the export-oriented industries are motivated to convert in green industries (Khan et al.2017).

- High interest rate of loan facilities, land scarcity, inadequate transportation facilities, utilities supports are also some challenging issues to set up green industries.

Opportunity for green industry development

Therefore, for long term sustainability and competitiveness, this sector has no other way rather than implementing or complying with international environmental and social safety standards. Under the circumstances, entrepreneurs are willing to comply with such standards, though the lack of investment has been identified as the major limitation. Green financing in RMG of Bangladesh is a new idea of investment. International agencies, development partners, financiers like AFD, ADB, DFID, etc. may come forward in terms of technical and development assistance to provide necessary loans on green industry development. Bangladesh Bank refinances a scheme named "Green Transformation Fund" aimed to access the export-oriented industries financing facilities to implement environmentally friendly initiatives. Besides this, the national and international private banks, financial institutions have also introduced 5-10 years tenure finance scheme with the specific interest rate to set up green industries.

Creating new employment scope is an advantage of Green growth. Bangladesh government is giving priority to the technical education to meet the future challenge in the era of 4th industrial revolution. Apparently a large group of Bangladesh youth is under unemployment. Green industrialization can improve this situation by creating employment scope for the engineers, consultants and technical expert's associates.

Discussion

The future development and sustainability of the Bangladesh RMG sector largely depend on the market and product diversification, new market exploration, extending production of non-traditional products and

also high value-added items. Considering the increasing consciousness about environmental concerns, green RMG industry is a demand of time to enhance our competitiveness. This may attract more buyers throughout the globe and thus benefits the sector. This initiative needs to be supported with national and international policies, proper guidelines, provision of allocation of sufficient fund either from Bangladesh Bank or from FDI particularly in the areas of water consumption, wastewater treatment and management, efficient energy consumption and chemical use, ensure occupational and health safety, building reformation, protection of natural environment and health issue of the surrounding environment. Our industries are categorized into three categories (large, medium and small) based on investment, workers size and production volume. Large and well-established factories are focusing on green growth without relying on the profit marginality in the stipulated payback period. The prospect of long-term benefits and the possibility of branding act as the motivating factors towards green growth to the factories. In case of any investment, small and medium factory owners mainly give priority to the financial benefits. So the major challenge is that, the go green technology adoption seems just as incurring some extra costs to the factory owners as the payback period is not immediately visible (Al-Muti, 2016). Recently, the possible economic and non-economic outcomes from greening are mostly welcomed in the form of reducing production and selling costs. It also upwards the possibility of gaining higher price and own branding. In many cases, product prices receiving by the country's existing green RMG units are almost similar to non-green counter parts but to compare for firms long-term sustainability and production cost, green factories are much more viable. It also helps factories to secure long term benefits from reduced production and other operational costs (Hashim, 2018).

Conclusions

Bangladesh is critically vulnerable due to global climate change. Our natural resources are limited. Global warming

has becomes a great threat to the whole world. The more we move forward to the industrialization, the more we go far from the nature. If we don't take the appropriate initiatives immediately, in a short time a devastating situation will arise. Industrialization is the determinant of the economic development of a country. For the sustainability, we need to grip the green economic development. The entrepreneurs of Bangladesh RMG industries have already taken the "Go Green" concept into their consideration. This is the responsibility of each stakeholder to ensure a sustainable manufacturing process. At this time, sustainability is no more an option for us rather than it becomes the necessity to save the world for our future generation.

- Obviously, policy and financial supports are very important in making green industry. Here, Bangladesh government has a major role to play. Government can enforce legal action to implement green policy.
- Subsidies should be provided to those entrepreneurs who are interested to green transformation. Also government can cut out the duty on importing raw materials and machineries for those, who are promising to go green.
- It is important to promote awareness among the factory owners to encourage them for greening by showing the benefits of green industries in practical scenario.
- Readymade garments industry owners have to scale up their bargaining capacity to increase the price per unit due to the green manufacturing process.
- Financing Institutions can take initiatives to motivate industrialists to have green financing loan. Here mass and social media also can play a vital role to motivate the factory owners by promoting the success story of the existing green factories to the others.

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Global Cleantech Innovation Programme

The Global Cleantech Innovation Programme (GCIP) promotes an innovation and entrepreneur ecosystem by identifying and nurturing cleantech innovators and entrepreneurs; by building capacity within national institutions and partner organizations for the sustainable implementation of the cleantech ecosystem and accelerator approach; and by supporting and working with national policy makers to strengthen the supportive policy framework for SMEs and entrepreneurs.

Through this cleantech ecosystem and accelerator approach, the GCIP catalyzes investment to support and accelerate startup entrepreneurs towards the development and commercialization of their innovative ideas. Partnerships and close collaboration with all national stakeholders are critical to maximize synergies and share knowledge and best practices that can help in enhancing the contribution of cleantech startups towards climate change mitigation, while increasing productivity and generating growth and wealth.

A key component of the GCIP is the annual competition-based Accelerator, which identifies the most promising innovators and entrepreneurs across a country. A selected number of startups in a GCIP country participate in a rigorous, competitive national acceleration programme that trains, mentors, promotes, and connects them to potential investors, customers and partners. As the best cleantech companies progress, they are continuously developed and assessed.

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GREEN TECHNOLOGY TRENDS OF NATIONAL R&D IN THE REPUBLIC OF KOREA

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Abstract

This article examined how green technology has evolved in national research and development (R&D) since 2010 and how the effectiveness of R&D performance has improved in new and renewable energy field in the Republic of Korea. Based on social network analysis of keywords, this research presents the following findings: the chronological trends of national R&D in green technology and new and renewable energy, as well as the effectiveness of R&D performance in the technical field of new and renewable energy. At last, this study concludes with suggested policy implications to strengthen environmentally national R&D investment in green technology and to apply more outputs from R&D investment in new and renewable energy to a real market and our life.

Introduction

Green technology had been strategically promoted by the Republic of Korea since the Lee Myung-bak administration created Framework Act on Low Carbon Green Growth in 2010. The Republic of Korean government tried to boom economy through developing green technology which aimed for adapting to climate change, preparing for energy crisis, and pursuing sustainable development (Jeong 2018, Lee et al. 2012). National investment in research and development (R&D) of green technology tended to rise until 2013 when Park Geun-hye took over as the next President. Later, the Republic of Korean government has turned its focus of national R&D investment from general green technology to specific technologies such as renewable energy, LED, and electric car. Green technology can be defined as a technology developed and used for minimizing the side effects of technology, reducing carbon footprint, and protecting the environment (Jeong 2018, Schiederig et al. 2012). World-widely, green

technology has emerged officially as an essential element to achieve green innovation and sustainable development since, in 2005, 5th Ministerial Conference on Environmental and Development in Asia and Pacific hosted by the UN Economic and Social Commission for Asia and Pacific (UN ESCAP) dealt with green growth as an important agenda to promote economic growth sustainably (Jeong 2018, Yun 2009).

The purpose of this paper is to examine the periodical evolution of green technology in national R&D of the Republic of Korea through keyword network analysis. Furthermore, this article digs into national R&D of renewable energy as a typical green technology in terms of R&D performances. Reliable R&D data of this research during the period from 2010 to 2017 was collected from the National Science and Technology Information Service (NTIS).¹ Finally, policy suggestions would be presented in the article based on the results of keyword analysis on green technology R&D and performance

analysis on new and renewable energy R&D.

R&D trends in green technology

The national R&D investment in green technology had expanded greatly from 2010 to 2013; however, it had decreased continuously from 2014 to 2017 as shown in the figure 1. To be specific, national R&D budget of green technology peaked at 4.13 trillion won in 2013 and then dropped at 1.14 trillion won in 2017. The number of national R&D projects followed the similar trend to R&D budget. The number of projects has grown from 5,159 in 2010 to 13,496 in 2013; however, the projects have declined from 11,405 in 2014 won to 2,878 in 2017.

The great turnover of R&D trends in green technology was mainly due to policy changes. The Lee Myung-bak administration (2010-2012) insisted "Low Carbon, Green Growth, thus, green technology was intensively fostered as one of strategic industries. At this period, green technology was considered as a means for economic growth rather than for environmental development. The next administration of President Park Geun-hye (2013-2016) established "Creative Economy" and the present government of the President Moon Jae-in set up a top national political agenda to respond to 4th Industrial Revolution (Jeong 2018, Hermann 2015, Lee et al. 2012).

In order to find trending subjects in national R&D of green technology, this research adopted social network analysis which especially measured co-occurrence of keywords reflecting relationships between pairs of keywords in each different national R&D projects (Jeong 2018, Lee 2012). I selected around 200 keywords that had more than 40 occurrences in 2010-2013 and 2014-2017 so as to conduct

¹ The NTIS is an online system and service to provide national R&D information operated by the Korea Institute of Science and Technology Information (KISTI): programs, projects, human resources, facilities, outputs, and outcomes.

Green technology trends of national R&D in the Republic of Korea

easily the network analysis. As a result, two network matrix are visualized by using VOSviewer 1.6.5. as following conditions: resolution of 1.0, minimum cluster size of 5, and label size variation of 0.5.

The whole period of 2010-2017 is divided into two time-periods: 2010-2013 and 2014-2017. The first period represents a policy direction of green growth promoted by the Lee's administration because national R&D plans of 2013 were decided in the prior year, 2012. The second period includes two different political agendas of creative economy and 4th Industrial Revolution which commonly explain the downturn of green technology R&D.

During 2010 and 2013, the network map (Figure 2) is composed of 8 clusters. The main topic of each cluster are: solar cell, fuel cell, led, carbon dioxide, climate change, biomass, monitoring, recycling. Solar cell appeared to form the biggest cluster in

green technology R&D. The second biggest cluster includes technologies related to LED which contributes to lighting efficiency. In the cluster map, new and renewable energy was seen as a dominant technical field since there were numerous keywords related to environmental energy: solar cell, fuel cell, bioenergy, graphene, and energy monitoring. Also, climate change was a hot topic with having connection with agriculture and absorption of greenhouse gas. This result shows clearly that the Republic of Korean government placed greater emphasis on developing new energy technology which cannot be interpreted as a complete green technology.

During 2014 and 2017, the network map (Figure 3) consists of 7 clusters: solar and fuel cell, led, climate change, biomass, breeding, disease, Internet of Things (IoT) and smart grid. Similar to the former period, solar and fuel cells compose the biggest technical cluster. Agricultural

adaptation to climate change appeared larger than the previous time. LED as environmental lighting and biomass as renewable energy source stayed as important fields. However, smart grid and IoT emerged newly to be connected widely with other technologies such as solar cell, fuel cell, and LED. This new technical cluster represents the most obvious change in policy from low carbon green growth to creative economy and 4th Industrial Revolution. In consequence, the major trend in green technology R&D has rarely changed by concentrating on new and renewable energy.

R&D trends in new and renewable energy as green technology

This research tried to explore thoroughly national R&D of new and renewable energy which were the most dominant technical field during the entire period of 2010-2017. New and renewable energy includes hydrogen energy, fuel cell, coal liquefaction and gasification energy as new energy and solar thermal, solar radiation, wind power, geothermal, tidal, bio and waste energy as renewable energy according to the Act on the Promotion of the Development and Use of New and Renewable Sources of Energy in the Republic of Korea.

In order to examine trends and results of national R&D investment in new and

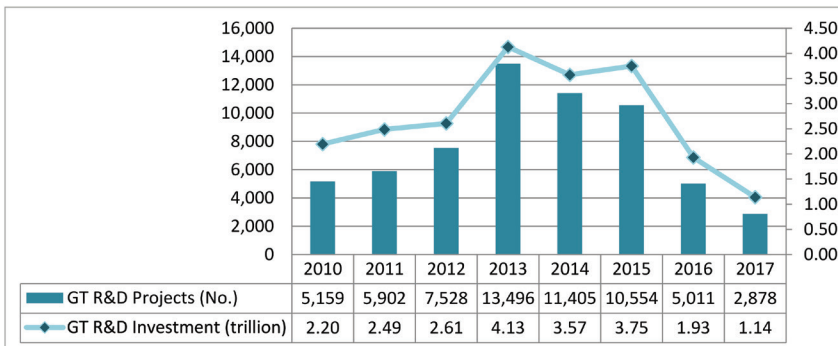


Figure 1: National R&D projects and investment of green technology (GT)

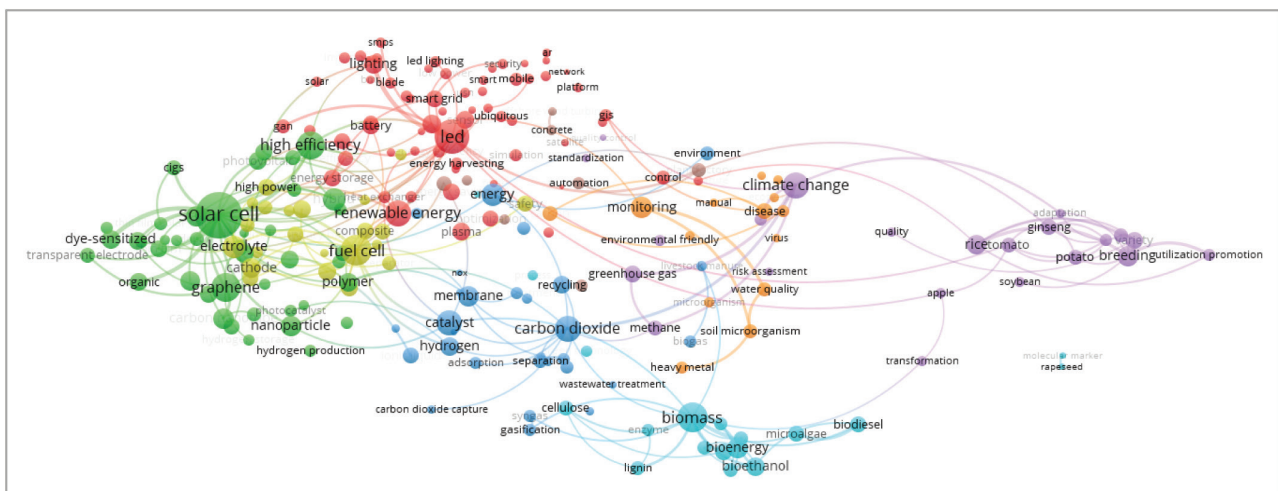


Figure 2: Network map of national R&D of green technology (2010-2013)

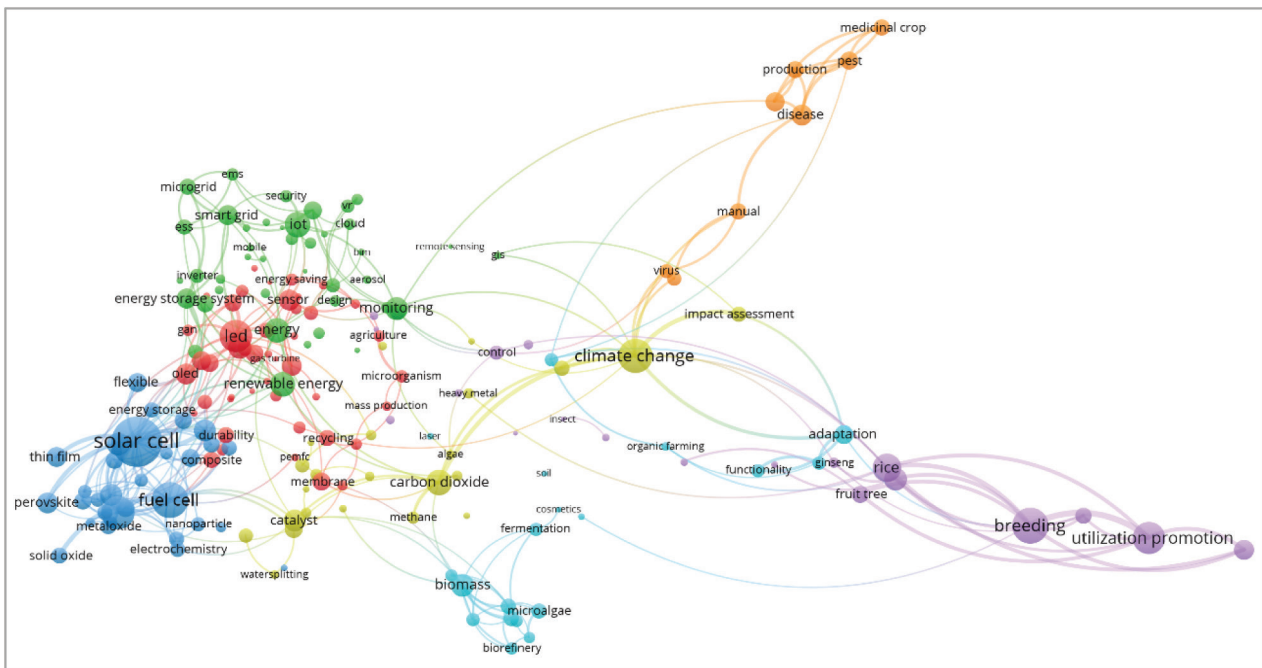


Figure 3: Network map of national R&D of green technology (2013-2017)

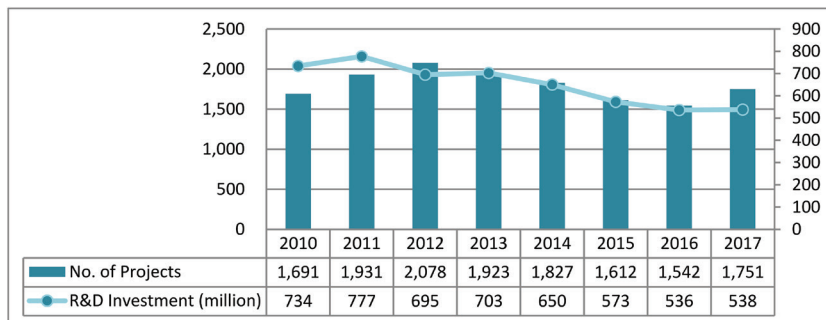


Figure 4: National R&D projects and investment of new and renewable energy

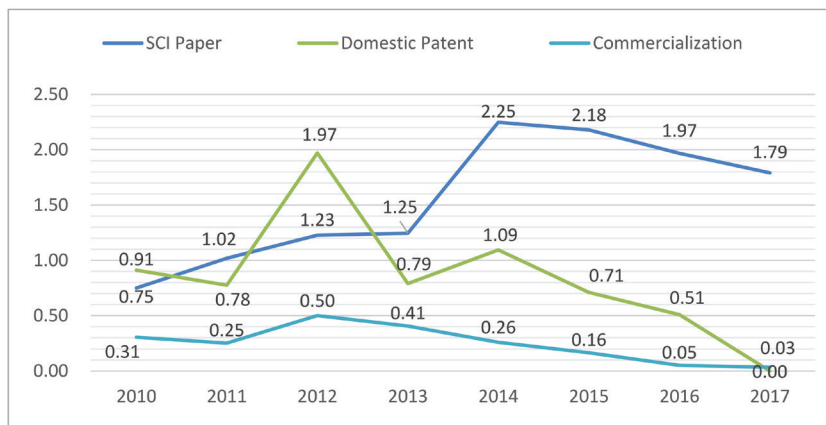


Figure 5: Effectiveness of R&D performance in new and renewable energy (per 100 million won of R&D budget)

renewable energy, R&D performance was analyzed empirically in terms of R&D effectiveness by selecting SCI papers,

patents granted in domestic, and technology commercialization as indicators. According to Figure 4, the national R&D

investment in new and renewable energy increased slightly from 734 million won in 2010 to 777 million won in 2011. However, it shows constant decrease from 695 million won in 2012 to 538 million won in 2018. The number of projects presents a similar trend to the government budget: 1,691 projects in 2010, 2,078 projects in 2012 and 1,542 projects in 2016. However, the number of projects rebounded to 1,751 in 2017. This rally means that the President Moon's administration put more attention into new and renewable energy for adapting to climate change and reducing use of nuclear energy. In contrast to the trend of green technology, the national R&D investment in new and renewable energy appeared to maintain at a constant level.

Effectiveness of R&D performance was measured yearly by dividing the average of each indicator by the average budget. As shown in Figure 5, the average number of SCI articles has increased constantly from 0.91 in 2010 to 2.25 in 2014 and then decreased slightly down to 1.79 in 2017. Conversely, the average number of domestic patents went up to 1.97 in 2012 and dramatically down to 0.03 in 2017. Commercialization showed the lowest effectiveness in R&D performance as

depicted in Figure 5. Although most experts in R&D management and renewable energy fields stressed the importance of commercialization in new and renewable energy, the empirical results proved that national R&D did not focus on technicalization or technology transfer to a market. This means that there was a technical gap between national R&D and market demand. Thus, national R&D planning in new and renewable energy should put more attention on productive outputs such as technology transfer and commercialization. Overall, continuous investment in new and renewable energy had not been connected to high value of R&D effectiveness.

Conclusion

This research was conducted empirically with reliable and rich volume of data from NTIS to comprehend how green technology has evolved in national research and development of the Republic of Korea. The major findings are the downturn of green technology R&D investment after 2013 and the dominance of new and renewable energy in green-technology-related R&D. However, national R&D in new and renewable energy has not changed greatly

in projects and budgets. Importantly and problematically, R&D effectiveness was proved to be very low in technical realization and commercialization.

As a result, this research suggests policy implications as follows. First, the Korean government should raise R&D investment in green technology as well as diversify green technological field beyond new energy. Second, the focus of R&D should go closely to more environment-friendly technology such as greenhouse gas reduction and really renewable energy which can improve the quality of environment. Third, R&D plan and management in new and renewable energy should be focused on the improvement of commercialization likelihood. Even though this research clearly and easily represented major trends of green technology and the performance effectiveness of new and renewable energy R&D, it still has some limitations that it could not explain a deeper reason of lower R&D performance and compare R&D effectiveness in various green technologies.

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Asia Pacific Energy Portal

Through the 2013 Asian and Pacific Energy Forum (APEF), ESCAP member States requested the secretariat to facilitate the dissemination and exchange of information by "increasing the coherence and availability of energy statistics and policy-related information." In response, the secretariat, with the support of the Russian Federation, developed the Asia Pacific Energy Portal.

The platform's goal is to facilitate research, analysis, and informed decision-making within the Asia-Pacific region's energy sector. It is an open-access information platform, providing data visualizations for an extensive set of energy statistics, full-text policies, and interactive infrastructure maps. The Portal offers a collection of more than 200 datasets from global institutions including UN Data, the International Energy Agency, the World Bank, UNComtrade, IRENA, and Bloomberg. More than 3,000 policy documents have been collected from hundreds of official websites. More than 6,000 power plants have been mapped. With this Portal, ESCAP aims to support research, analysis, and, ultimately, informed decision-making.

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SOLAR-POWERED IRRIGATION TECHNOLOGY IN BANGLADESH

A NEW AVENUE FOR ENHANCED AGRICULTURAL PRODUCTION

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Abstract

This article focuses on economic benefits as well as innovations in making solar-powered irrigation projects (SIP) viable in the agriculture sector in Bangladesh. Based on a recent survey conducted among 1000 beneficiary and non-beneficiary households, the results suggest that solar-powered irrigation is cheaper and reliable than traditional diesel-based irrigation facilities. The solar-powered irrigation provides farmers the opportunity to harvest in relatively higher number of plots and due to better coverage and reliability of such irrigation, yield and return per acre of land is also higher. Further, solar-powered irrigation project provides opportunity for alternative use of excess electricity it produces in an effective manner.

Introduction

If one walks through north-western remote regions of Bangladesh one can see eye-soothing green paddy fields or yellowish mustard seed flowers in vast areas. Farmers are now being able to harvest on a larger amount of land throughout the year, thanks to solar-powered irrigation facilities. This green technology in irrigation has opened up new opportunities for the farmers to use environment-friendly technologies that also contributed to higher yield.

Bangladesh, an agrarian economy, experienced green revolution in the late sixties and early seventies. Since its independence in 1971, Bangladesh has now been able to increase its rice production three-fold, thanks to mechanization in agriculture, conducive policy environment and increasing irrigation facilities. Now the country fed about 160 million people with its own crop production. Diversification of crops, use of high yield variety and use of land all the year round due to availability of irrigation facilities are some of the factors that contributed to almost self-sufficiency in rice production. Mainly irrigation is done using diesel pumps and grid electricity wherever it is available though it is fully

reliable due to power outage. Government provides subsidies on biofuels that helped farmers to use irrigation at affordable prices. In recent times, the country has stepped into solar-powered irrigation technology, which opened up a new avenue in agricultural production mainly due to some of its advantages, such as efficiency and reliability in irrigation, enhanced crop production and ensuring food security at a greater extent.

Solar-powered irrigation system is an attractive alternative for traditional irrigation practices, keeping in view, the country has huge solar potential and the fact that significant rural population lives in remote and off-grid areas. Various studies identified beneficial impacts of solar-powered irrigation technologies. Solar-powered pumps could be reliable and economically viable alternative to electric and diesel water pumps for irrigation of agriculture crops. However, the large installation costs of solar water pumps would require more incentives from the government to make the technology more attractive. Solar-powered irrigation systems are both technically and economically feasible if compared to life cycle costs of diesel and grid-based ir-

rigation systems (Kelly et al. 2010). Investments in solar pumps appear to be profitable and investment on solar pumps is less risky than diesel engine operated pumps.

Evidences from different countries suggest that solar-powered irrigation systems generate positive impacts on environment, food security and nutrition. A study in Northern Benin suggested further that solar-powered irrigation enhances diversity in crop production and therefore contributes to dietary habits, benefiting both economically and nutrition (Alaofe, et al. 2016). Other benefits of solar powered irrigation include reduction of cost of irrigation and wastage of water. Therefore, solar-powered irrigation can lead to greater economic well-being by reducing costs incurred for use of coal and diesel for irrigation and also can relax the burden of agricultural electricity subsidy from the government to some extent. However, a little is known about the implementation, financing and economic benefits of solar powered irrigation facilities in Bangladesh.

This article aims to focus on prospects and challenges of solar-powered irrigation projects (SIP) including its economic benefits as well as innovations in making it viable in the agriculture sector. The findings are mostly drawn from a survey recently conducted by Bangladesh Institute of Development Studies (BIDS) in 2018 under the author's leadership. It is to be noted that solar irrigation systems are slowly coming to prominence in terms of usage in Bangladesh. The Infrastructure Development Company Limited (IDCOL), a public non-bank financial institution has taken the lead in implementing renewable energy projects including SIPs with financing support from multilateral donors like the World Bank.

Key aspects of solar irrigation projects in Bangladesh

An overview

Solar irrigation systems are innovative and environment friendly solution for

Solar-powered irrigation technology in Bangladesh

the agro-based economies. The solar irrigation program in Bangladesh has been implemented by the Infrastructure Development Company Limited (IDCOL), a

public non-bank financial institution. The program intends to provide irrigation facility to rural off-grid areas. Solar irrigation systems reduce dependency on fossil fuel

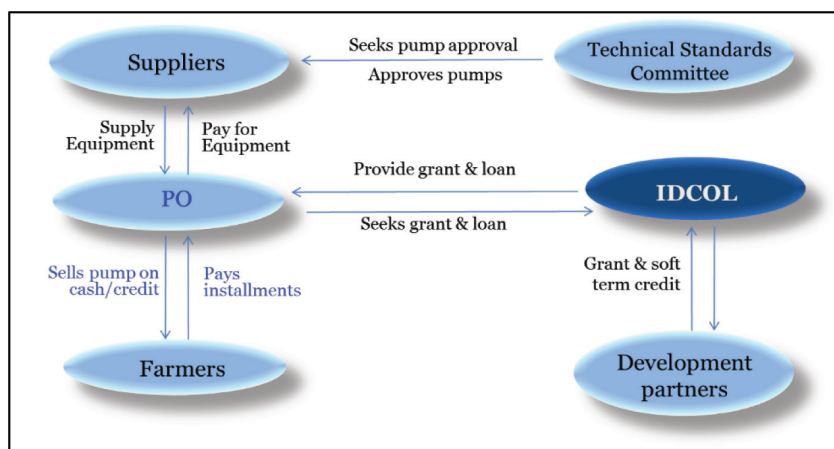
and demand for electricity from national grid in irrigation seasons. The program also reduces carbon emission and at the same time saves millions in foreign currency. Given the immense potential the IDCOL program aims to install solar PV-based irrigation systems in areas where there are possibilities to produce crops throughout the year, all the while staying safe from flooding, arsenic contamination and saline water. To work towards this end, IDCOL has set a target of installing 50,000 solar irrigation pumps by 2025. As of December 2018, IDCOL has approved 1,429 solar irrigation pumps of which 1,186 are already in operation with a cumulative capacity of about 26.59 MWp. The remaining pumps are expected to come into operation shortly. The World Bank, KfW, GPOBA, JICA, USAID, ADB and BCCRF are supporting this initiative.

The SIP of IDCOL has taken multi-prong approaches that make it more economically viable and innovative. Apart from ownership financing model, it includes capacity building of farmers, environment and social screening as well as options for using excess electricity for other purposes.

Table 1: Financing structure under 'ownership model'

	Amount in USD
Pump price without Subsidy [a]	13,271
Grant support (50%) [b]	6,635
Price to farmer [c = a - b]	6,635
Down-payment by farmer (30% of c or 15% of a) [d]	1,991
Loan from PO to farmer [e = c - d]	4,645
IDCOL loan to PO (35% of a) [f]	4,645

Source: IDCOL



Source: IDCOL

Figure 1: 'Ownership model' structure under IDCOL solar irrigation projects



Picture: The author visited a solar powered project at Dhamrai, Manikganj, Dhaka in January, 2018

SIP financing model

Similar to 'fee-for-service model', IDCOL finances the project under 'ownership model' based on debt, grant and equity ratio of 35%:50%:15%. The equity portion comes from the down payment (12%) of the farmers and partner organization's (PO's) own source (8%). The terms and conditions of the loan from IDCOL to PO are the same as the 'fee-for-service' model. The financing mechanism of a pump under 'ownership model' is shown in Table 1

Notably, the PO is expected to extend loan to farmers for a term of 5 years whereas IDCOL's loan to PO will be for 8 years. The average installment for investor will be USD 2,640 per year whereas the yearly savings in diesel cost for investor will be about USD 2,655. Notably, the investor remains in break-even point during the repayment period of 5 years but they will be benefited once the loan is fully repaid. Any private limited company/ NGO/MFI is eligible to obtain financing from IDCOL for installing solar irrigation pumps provided their financial strength to spend



Source: IDCOL

Figure 3: Use of excess electricity from SIP

Table 2: Description of trainings

Sl	Type of training	Topics covered	Number of training
1	Training of Trainers	Site selection, project implementation, crop and water management, new cultivation techniques	5
2	Farmers' Training	Crop variety, fertilizer management, pest control, alternative wetting and drying (AWD), seed preservation	212
3	Demonstration of high yield variety for Farmers	Introducing a target plot with a new high yield variety of crop and showcasing the difference of yield	128
4	Training of Pump Supervisors	Operation management, Crop and Water management and revenue collection	27
5	Training for Pump Operators	Crop and water management, land mapping and irrigation scheduling	33
6	Technical Training for Suppliers	Project designing, trouble identification and on field troubleshooting techniques	2

Source: IDCOL

required equity in the project, experience in similar nature of activities etc. are deemed to be suitable to IDCOL (Figure 1).

Economic benefits generated from installed SIPs

The SIPs have been generating several types of benefits to the economy for which the SIPs are now becoming more acceptable to the farmers. Some of the salient features of solar irrigation projects of IDCOL are highlighted below:

- 37,847 farmers cultivating 14,335 hectares of land through 1186 pumps

- Producing 148,000 Tonnes of rice per year worth USD 48 million
- Cropping pattern has improved through IDCOL trainings
- Farmers now produce multiple crops in a year against previous 1/2 crops
- Excess electricity of some pumps being used for agricultural mechanization (husking, thrashing etc.), running cold storage etc.
- Created 1600 jobs under the program

It is to be noted that SIPs open up the window of multi-purpose usages. Therefore, during off-season, the electricity generated by SIPs are used for the following

purposes that makes the projects viable to the investors.

- Excess electricity of some pumps is supplied to households
- Electricity is also used for activities like running oil press, producing hollow bricks
- Farmers now have extra time to do other activities for additional income.

However, it could be more useful if the excess electricity can be added to the national grid (Figure 3).

Environment and social screening

Before implementation of SIP, there are concerns regarding environmental issues, particularly about the deep surface water level and arsenic water contamination in irrigation. IDCOL develops a guideline towards these concerns. Arsenic contamination in water is tested in different terms of project life. Sponsors submit arsenic test results from Directorate of Public Health Engineering (DPHE) prior fund disbursement. Periodic water level data is collected and checked for water depletion. IDCOL also motivates sponsors (the investors) through training on environmental and social safe guarding aspects. However, this is now an important concern for the success of SIPs and therefore needs to be investigated by an independent authority.

Solar irrigation pump - capacity building

Another important aspect of IDCOL's SIP program in Bangladesh is that it accompanies

Table 3: Number of plots, area and yield

Category	Solar Irrigation using HHS	Non-solar using HHs	Difference
Number of plots harvested (on average)	2.60	2.38	0.22
Area (acre) (on average)	1.16	1.09	0.07
Yield of crop (maund/acre) (over the year)	198.71	203.37	-4.66

Source: BIDS Survey (2018)

Table 4: Costs and returns of crop cultivation over a year

Category	Solar Irrigation using HHS	Non-solar using HHs	Difference
Costs (in Taka)			
Irrigation (per bigha)	5270.44	6679.18	-1408.74
Total cost including all inputs	67681.4	60004.34	7677.06
Returns (in Taka)			
Main product	363745.8	190191.2	173554.7
By product	18988.63	19321.81	-333.19
Gross returns	382734.4	209513	173221.5
Net returns	315053.1	149508.6	165544.5

Source: BIDS Survey (2018).

Table 5: Availability, utilization, and intensity of irrigation

Category	Solar Irrigation using HHS	Non-solar using HHs	Difference
Area with irrigation availed (%)	88.20	91.65	-3.45
Distance between source and plot (ft.)	122.16	77.56	44.60
Number of days irrigated (days)	46.47	39.61	6.86
Number of hours irrigated per day (hours)	1.83	1.88	-0.05
Received adequate water (%)	68.55	64.99	3.56
Irrigation pumps owned (%)	55.21	65.33	-10.12

Note: The cost of irrigation per bigha for control group was calculated from the farmers who subscribe irrigation (diesel-based) from a vendor. Those who own diesel pump and irrigate own land, their cost of irrigation was not considered.

Source: BIDS Survey (2018).

some capacity building initiatives. For example, IDCOL provides training to both farmers and sponsors on irrigation water use, crop production aspects and excess electricity use. These trainings are expected to add value to SIP benefits (Table 2).

IDCOL made an assessment of the impact of training on various aspects mentioned above. Some of their findings can be outlined below.

- Introduction of new cropping pattern has increased farmer revenue.
- Introduction of crop scheduling has reduced the risk of damage by flood.
- Alternative wetting and drying (AWD) method has been introduced in sites with low water retention capacity which has increased crop yield.
- In few sites, farmers have started cultivating Boro (paddy) instead of Tobacco.

- Coverage increased through sound water management in paddling period of Boro (paddy) season.
- Management tools have been introduced for sponsors resulting increasing coverage.
- Proper handling of the system has reduced pump malfunction, troubleshooting time and enhanced opportunity of warranty enforcement.

The above findings highlight some important benefits of solar irrigation such as higher coverage, higher production, diversification of crop production, reducing wastage of water etc. Some of these issues are also highlighted in BIDS survey (2018), which is briefly discussed below.

Benefits of solar irrigation: survey results

Bangladesh Institute of Development Studies (BIDS) conducted a survey in 2018 for IDCOL on the benefits of solar-powered irrigation projects in Bangladesh. A total of 1,000 farming households were interviewed, of which 500 were solar irrigation users and the rest 500 were diesel-pump irrigation users. The results are highlighted below in brief.

The survey findings suggest that farmers those are using solar irrigation (treatment) had harvested in significantly higher number of plots and higher areas of land compared to non-solar irrigation user group. The reasons may be that reliability, accessibility and affordability of solar irrigation prompted farmers to harvest in more areas and plots. (Table 3)

From the survey, we found that, throughout the year the cost of irrigation was lower for the farmers those who are using solar irrigation compared to those using other methods of irrigation. These results strongly support the argument of reduction of cost through use of solar irrigation, especially, considering the fact that solar irrigation users harvest in higher number of plots and greater area of land (Table 3). Though, the overall cost level for solar irrigation users was higher compared to non-solar users as they harvest in higher areas of land, in term of net returns, farmers who used solar irrigation were major gainers compared to those who did not

Table 6: Perception of solar irrigation user households

Category	Solar Irrigation using HHs
Average no. of years solar irrigation is used (years)	2.82
Receive training from PO for the following (%)	
Solar irrigation machine usage	2.20
Crop management*	9.40
Time management for irrigation water use	21.40
Fertilizer/seed/insecticide use	16.40
Reasons for using Solar Irrigation (%)	
Diesel irrigation pumps are too expensive	47.54
Not satisfied with current service	7.60
Solar irrigation increases agricultural production	5.75
Friends/ relatives and neighbors have taken it	16.94
Solar irrigation is environmentally friendly	12.22
Others	9.96

Source: BIDS Survey (2018).

Table 7: Carbon dioxide (CO₂) from diesel pumps

Category	Estimated Carbon emitted by pumps (Kg)
Carbon Emission per acre	Control group
Pump age 1-5 years	17.89
Pump age 6-10 years	23.13
Pump age 11-15 years	25.17
Total average	22.06

Note: This calculation has been based upon the conversion estimates from U.S. EPA Centre for Corporate Climate Leadership, 2016 report i.e. 1 liter diesel burnt = 2.68 Kg CO₂

Source: Authors' Calculations.

Table 8: Perception about solar irrigation vs. diesel irrigation (%)

List of Statements	Solar Irrigation using HHS	Non-solar using HHs	Difference
Solar irrigation is less expensive relative to other irrigation methods	95.8	80.8	15
Solar irrigation is reliable than other irrigation methods	92.4	62	30.4
Solar irrigation system is reliable	91.6	57.8	33.8
Solar irrigation is environmentally friendly and reduces pollution	99.8	86	13.8
Solar irrigation saves time	97.8	85.2	12.6
Solar irrigation saves labor	98.4	86.6	11.8
During diesel irrigation use, there is a bad smell	95.2	94.6	0.6
There is smoke when operating diesel run irrigation machines	99.2	99.6	-0.4
There is a lot of noise while operating diesel based irrigation machines	99.4	99.4	0
The diesel used in irrigation machines/pumps contains impurities	77.4	69.8	7.6

Source: BIDS Survey (2018).

use solar irrigation (Table 4). In a year, solar-powered irrigation users gain Tk. 165544.5 over non solar-irrigation users.

The survey findings also reveal that, throughout the year, solar-pumps provide the irrigation facilities to longer distant plots which is not possible for diesel-based pumps. Even, the solar irrigation facilities provide the opportunity to avail irrigation facilities for a longer period, in terms of number of days. The greater area of land harvested by the solar irrigation user group may have contributed towards this factor too (Table 3). The solar irrigation using farmers reported that they received adequate water at a higher amount compared to non-solar modes of irrigation, which is a testament to increase of efficiency in irrigation through the use of solar-powered pumps (Table 5).

Farmers' perception towards solar irrigation

The solar-powered pump user farmers have used solar irrigation for an average of 2.82 years. Among them, around 21.40% had received training from the sponsors on time management for irrigation water use. About 48% of the farmers mentioned that solar irrigation is cheaper than diesel-pump based irrigation and about 12% thought that solar irrigation facilities are environment-friendly (Table 6).

Based on diesel use per acre of land, we have estimated carbon emission by different types of pumps based on their longevity. Our estimation results suggest that with the increase in age of the diesel pumps, their carbon emission also increases. On average, the diesel pumps emit 22.06 Kg carbon per acre over the course of a year (Table 7). So, this is the amount of carbon emission that has been saved by solar-powered irrigation.

Opinions and attitude towards solar irrigation

We also sought perception and opinion of both the solar irrigation user and non-user groups about various aspects of solar irrigation and documented their responses (Table 8). The farmers who have used solar irrigation were asked whether they found solar irrigation to be less expensive and

Solar-powered irrigation technology in Bangladesh

more efficient relative to other irrigation method or not. More than 90% of them agreed that solar irrigation was less expensive, more reliable than other methods of irrigation, environmentally friendly, and saves time and labor. In response to the same questions, non-solar users also agreed to a great extent about these positive benefits of solar irrigation. Respondents also mentioned about some negative aspects of diesel-based irrigation, such as bad smell during the use of diesel engine, excessive noise and smoke creation etc. An overwhelming majority of the respondents from both groups agreed on these negative aspects of diesel-based irrigation facilities.

Concluding remarks

Solar irrigation provides opportunity to irrigate a higher amount of land due to its

reliability, affordability and accessibility, and therefore it also contributes to higher amount of return from harvesting. Moreover, it saves carbon emission and therefore contributes to reducing air pollution. More awareness building efforts are needed in this regard so that more farmers can get benefit out of it. Also, it is important to make solar irrigation more affordable to customers as well as investors. It is important for IDCOL as well as investors to make dynamic adjustment of prices of solar irrigation related equipment. Apart from tangible benefits that we have discussed in this article, it is also important to assess the environmental impact of depletion of deep ground water due to the use of solar irrigation pumps. Since a solar irrigation project involves huge investment, the government can take initiatives to mobilize cheap finance for the

investors by introducing green bonds and green credit guarantee schemes.

References

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Selected Green Technology Funds

Adaptation Fund (AF)

<https://www.adaptation-fund.org>

The Adaptation Fund (AF) was created under the United Nations Framework Convention on Climate Change. The fund is designed to finance climate change adaptation projects and programs based on the priorities of eligible developing countries. Its primary funding comes from a 2% share of proceeds of the Certified Emission Reductions issued by Kyoto Protocol's Clean Development Mechanism.

Climate Investment Funds

<https://www.climateinvestmentfunds.org>

The \$8 billion Climate Investment Funds (CIF) accelerates climate action by empowering transformations in clean technology, energy access, climate resilience, and sustainable forests in developing and middle-income countries. The CIF's large-scale, low-cost, long-term financing lowers the risk and cost of climate financing. It tests new business models, builds track records in unproven markets, and boosts investor confidence to unlock additional sources of finance.

Global Environment Facility Trust Fund

<http://www.thegef.org>

The Global Environment Facility (GEF or the Facility) was established in the International Bank for Reconstruction and Development (IBRD or World Bank) as a pilot program in order to assist in the protection of the global environment and promote thereby environmentally sound and sustainable economic development, by resolution of the Executive Directors of the World Bank and related interagency arrangements between the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank. The GEF shall operate, on the basis of collaboration and partnership among the Implementing Agencies, as a mechanism for international cooperation for the purpose of providing new and additional grant and concessional funding to meet the agreed incremental costs of measures to achieve agreed global environmental benefits in the following focal areas: (a) biological diversity; (b) climate change; (c) international waters; (d) land degradation, primarily desertification and deforestation; (e) chemicals and wastes.

Tech Events

2019

30 Oct-1 Nov
Singapore

Asia Clean Energy Summit (ACES)
Contact: ACES Secretariat
Tel: +65 6831 1320
Web: <https://www.asiacleanenergysummit.com>

30 Oct-1 Nov
Singapore

Asia Clean Energy Summit (ACES)
Contact: Faith Tan (Ms)
ACES Secretariat
Tel: +65 6831 1392
Web: <https://www.asiacleanenergysummit.com>

30 Oct-2 Nov
Hong Kong,
China

ECO EXPO ASIA 2019
Contact: HKTDC (Hong Kong Trade Development Council)
38/F, Office Tower
Convention Plaza
1 Harbour Road
Wanchai, Hong Kong
Tel: +852 1830 668
Fax: +852 2824 0249
Web: hktdc@hktdc.org

31 Oct-2 Nov
Hong Kong,
China

IWA-ASPIRE 2019
Contact: IWA-ASPIRE 2019 Conference Secretariat
C/o International Conference Consultants Ltd.
Unit C-D, 17/F, Max Share Centre, 373 King's Road,
North Point, Hong Kong
Tel: (852) 2559 9973
Fax: (852) 2547 9528
E-mail: info@iwaaspire2019.org
Web: <http://www.iwaaspire2019.org>

6-8 Nov
Singapore

5th Annual Biopharma Development & Production Asia Pacific
Contact: Customer Service
103 Penang Road #04-01 Visioncrest Commercial
Singapore 238467
Tel: +65 6508 2401
E-mail: register@ibcasia.com.sg
Web: <https://www.ibc-asia.com>

9-11 Nov
Japan

2019 4th Asia Conference on Environment and Sustainable Development (ACESD 2019) Yokohama,
Contact: Nancy Liu
Conference Secretary
Tel: +86-28-86512185
E-mail: acesd@iacsitp.com
Web: <http://www.acesd.org>

27-29 Nov
Bangalore,
India

Intersolar India
Contact: Brijesh Nair
Project Director, India
Tel: +91 22 4255-4707
Fax: +91 22 4255-4719
Web: <https://www.intersolar.in>

2020

8-10 Jan
Mumbai,
India

South Asia Conference on Social Enterprise
Contact: Tata Institute of Social Sciences
V.N. Purav Marg, Deonar
Mumbai-400088, India
Tel: +91(22)25525000
Fax: 91-22-2552 5050

29-31 Jan
New Delhi,
India

WORLD SUSTAINABLE DEVELOPMENT SUMMIT 2020
Contact: DSDS Secretariat
New Delhi, India
Tel: +91 11 24682100
Fax: +91 11 24682144
E-mail: dsds@teri.res.in

12-14 Feb
Bangkok,
Thailand

FUTURE ENERGY ASIA 2020
Contact: FUTURE ENERGY ASIA Secretariat
E-mail: info@futureenergyasia.com
Web: <https://www.futureenergyasia.com>

13-14 Feb
Nur-Sultan
(Former Astana),
Kazakhstan

Central Asia Renewable Energy Summit 2020
Contact:
Karen Zhou | Marketing - Central Asia Renewable
Energy Summit 2020
Tel: +86 21 6667 0558 ext. 801
Mob: +86 186 2156 5342
E-mail: karen@peakevents.org
Web: <http://www.renewableasia.org>

20-21 Feb
Kuala Lumpur,
Malaysia

15th World Convention on Waste Recycling and Reuse
Contact:
Waste Recycling and Reuse Event Contact Desk
Conference Series LLC LTD Conferences
47 Churchfield Road,
W3 6AY, London, UK
Tel: +44-203-7690-972
E-mail: recyclingsummit@asiameets.com

25-26 Feb
Singapore

EmTech Asia
Contact: Secretariat
Tel: +(65) 6500 6700
E-mail: emtech@koelnmesse.com.sg
Web: <https://emtechasia.com/>

31 Mar-2 Apr
Kuala Lumpur,
Malaysia

ASIAWATER EXPO & FORUM 2020
Contact: United Business Media (M) Sdn Bhd
Suite 5-01, Level 5, Sunway VISIO Tower
Lingkaran SV, Sunway Velocity
55100 Kuala Lumpur, Malaysia
Tel: +603 9771 2688
Fax: +603 9771 2799
E-mail: info-my@ubm.com

25-27 May
Shanghai,
China

SNEC - PV POWER EXPO 2020
Contact: Shanghai Follow Me Exhibition Service Co., Ltd
Room711, No.1525
West Zhongshan Rd.
200235, Shanghai, China
Tel: +86 21 64278273
Fax: +86 21 64642653
E-mail: service@sneec.org.cn

11-13 Jun
Bangkok,
Thailand

ASEAN Sustainable Energy Week
Contact: Ms. Supanna Anantarurdee
UBM Asia (Thailand) Co., Ltd.
Ari Hill 18th Floor, 428 Phahonyothin Road. Samsen Nai,
Phayathai, Bangkok 10400, Thailand
Tel: +66 2 036 0500; Fax: +66 2 036 0588
E-mail: asew-th@informa.com
Web: <http://www.asew-expo.com>

17-19 June
Seoul,
Republic of
Korea

ENVEX 2020
Contact:
KEPA (Korean Environmental Preservation Association)
Seoul CCI Bldg., 497-66, Dapsimni 5 Dong
Dongdaemun-Ku, Seoul
Republic of Korea
Tel: +82 2-2249-5265
Fax: +82 2-2249-5267
E-mail: dkepa@chollian.net

5-9 July
Singapore

CLEANENVIRO SUMMIT SINGAPORE (CESS) 2020
Contact: Singex Exhibitions Pte Ltd
#01-01, 11 Tampines Concourse
Singapore 528729
Tel: +65 6403 2100
Fax: +65 6782 9108
E-mail: enquiries@singex.com

18-20 Sept
Noida,
India

REENERGY -RENEWABLE ENERGY INDIA EXPO 2019
Contact: Exhibitions India Group Pvt. Ltd.
217-B, Okhla Industrial Area
Phase - III, New Delhi -110020, India
Tel: +91 11 4279 5000
Fax: +91 11 4279 5098
E-mail: exhibitionsindia@vsnl.com

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Investment promotion criteria in Thailand

The Board of Investment of Thailand, Thailand

<https://www.boi.go.th>

Criteria for project approval

The Board of Investment stipulates the following criteria for project approval:

Development of competitiveness in the agricultural, industrial and services sectors

1. The value added of the project must not be less than 20% of revenues, except for projects in agriculture and agricultural products, electronic products and parts, and coil centers, all of which must have value added of at least 10% of revenues.
2. Modern production processes must be used.
3. New machinery must be used.

In case of imported used machinery, criteria are as follows:

1. In case of used machinery not over 5 years old, counting from the manufacturing year to the importing year, the machinery shall be allowed to be used in the project and counted as investment capital for the calculation of the cap on corporate income tax exemptions; however, they shall not be granted import duty exemption. A machinery performance certificate issued by a trusted institute identifying efficiency, environmental impact and energy usage for the machine, as well as its fair value, must be obtained.
2. In case of used machinery over 5 years old but not exceeding 10 years old, counting from the manufacturing year to the importing year, only press machines shall be allowed to be used in the project and counted as investment capital for the calculation of the cap on corporate income tax exemptions; however, they shall not be granted import duty exemption. A machinery performance certificate issued by a trusted institute identifying efficiency, environmental impact and energy usage for the machine, as well as its fair value, must be obtained.
3. For sea and air transport activities and molds and dies, used machinery over 10 years old, counting from the manufacturing year to the importing year, may be allowed to be used in the project as deemed appropriate, counted as investment capital for the calculation of the cap on corporate income tax exemptions and granted machinery import duty exemption. Criteria shall be as specified by the Office of the Board of Investment.

Environmental protection

1. Adequate and efficient guidelines and measures to protect environmental quality and to reduce environmental impact

must be installed. The Board will give special consideration to the location and pollution treatment of a project with potential environmental impact.

2. Projects or activities with type and size that are required to submit environmental impact assessment reports must comply with the related environmental laws and regulations or Cabinet resolutions
3. Projects located in Rayong must comply with the Office of the Board of Investment Announcement No. Por 1/2554 dated May 2, 2011 on Industrial Promotion Policy in Rayong Area.

Minimum capital investment and project feasibility

1. The minimum capital investment requirement of each project is 1 million baht (excluding cost of land and working capital) unless specified otherwise on the list of activities eligible for investment promotion that is attached to this announcement.
2. As for knowledge-based services, the minimum capital investment requirement is based on the minimum annual salaries expense specified in the list of activities eligible for investment promotion that is attached to this announcement.
3. For newly established projects, the debt-to-equity ratio must not exceed 3 to 1. Expansion projects shall be considered on a case-by-case basis.
4. For projects with investment value of over 750 million baht, (excluding cost of land and working capital), the feasibility study for projects applying for investment promotion must be submitted with details as specified by the Board.

Criteria for foreign shareholding

The Board stipulates the following criteria for foreign shareholding in projects that apply for investment promotion:

1. For projects in activities under List One annexed to the Foreign Business Act, B.E. 2542, Thai nationals must hold shares totaling not less than 51% of the registered capital.
2. For projects in activities under List Two and List Three annexed to the Foreign Business Act, B.E. 2542, there are no equity restrictions for foreign investors except as otherwise specified in other laws.
3. The Board may set foreign shareholding limits for certain activities eligible for investment promotion as deemed appropriate.

Guidelines for venture capital fund management in Bangladesh

Startup Bangladesh, Bangladesh

<http://old.startupbangladesh.gov.bd>

Bangladesh is one of the youngest countries in the world, with more than half of its population being under the age of 25. The nation is transitioning towards becoming a middle-income country by year 2021. In order to develop an innovation-centered economy and sustain its remarkable growth, Government of Bangladesh (GoB) has undertaken a pioneering initiative to create a national entrepreneurship platform and its supporting ecosystem. This effort will enable the nation to innovate faster, create new jobs, develop technical skills and realize the vision of Digital Bangladesh. In support of the above-mentioned objectives, GoB has created a fund (the Fund) under iDEA project. The Fund will provide financial support to entrepreneurs in the form of equity, convertible debt and/or grant (the Investment). The Investment will provide the necessary capital to accelerate development and achieve success. The Fund is committed to fostering innovation and entrepreneurship through a process that is equitable, transparent and accountable.

Investment objectives

The investment objectives are:

1. Support technology-based innovation
2. Create new employment opportunities
3. Provide training and develop technical skills
4. Promote groups that are under-represented in the tech sector
5. Connect Non-Resident Bangladeshis (NRBs) with the local ecosystem
6. Foster an entrepreneurship culture in Bangladesh
7. Attract foreign investment and expertise

Investment risks

Venture investment carries high inherent risks. All submitted proposals will be assessed for certain major risks that include but are not limited to:

1. Market Risks: market receptiveness to product/service; size of potential customer base; competitive dynamics & pace of competing innovations; scalability of product/service
2. Management and Execution Risks: strength and experience of management and technical teams
3. Financial Risks: ramp-up period; burn-rate, profitability; capital required to operate; additional capital required to scale and distribute
4. Other Risks: Additional risks may pertain to internal factors (i.e., legal, technical, operational) as well as external considerations (regulatory compliance, economic conditions)

Despite the risks, Venture Capital investment takes place in dynamic economies worldwide because of the potential rewards – business success, technical breakthrough, skill development, employment generation, public benefits, international branding and so on.

Detailed policies and procedures for each category of Investment are discussed below:

IDEA (Pre-Seed) support

The Fund will support innovative ideas thorough mentoring and funding:

1. Requirement: Viable business idea and an executable business plan
2. Investment amount: up to Tk. 10 lakh
3. The Investment will be provided in tranches based on achievement of defined milestones
4. Fund participation: Grant

The Fund will require regular progress reports and financial statements for performance monitoring purposes.

Venture capital

The Fund will make the following kinds of Venture Capital investments:

- a: Seed stage
 1. Requirement: Prototype and an executable business plan
 2. Investment amount: up to Tk. 1 crore
 3. The Investment will be provided in tranches based on achievement of defined milestones
 4. The Investment may be used for product development, operations, expansion, marketing and other approved purposes
 5. Fund participation: Equity and/or Convertible Debt. The equity ownership percentage may be up to 49%, based on Investment amount and company valuation. In case of Convertible Debt, the amount financed will be interest-free. The Convertible Debt may be fully or partially convertible
 6. The Fund may have representation on the Board commensurate to its equity ownership
 7. The Fund will require regular progress reports and financial statements for performance monitoring purposes.
- b: Growth stage
 1. Requirement: Minimum Viable Product, existing customer base and an executable business plan

2. Investment amount: up to Tk. 5 crore per round
 3. The Investment will be provided in tranches based on achievement of defined milestones
 4. The Investment may be used for product development, operations, expansion, marketing and other approved purposes
 5. The Investment may be made during one of the financing rounds generally known as Series A, Series B and Series C rounds
 6. Fund participation: Equity and/or Convertible Debt. The equity ownership percentage may be up to 49%, based on company valuation and Investment amount. In case of Convertible Debt, the amount financed will be interest-free. The Convertible Debt may be fully or partially convertible
 7. The Fund may have representation on the Board commensurate to its equity ownership
 8. The Fund will require regular progress reports and financial statements for performance monitoring purposes
- c: Guided Startups
1. Requirement: Specific startup ideas that the Fund considers to be in the national interest
 2. Investment amount: up to Tk. 5 crore per round
 3. The Investment will be provided in tranches based on achievement of defined milestones
 4. The Investment may be used for product development, operations, expansion, marketing and other approved purposes
 5. Fund participation: Equity and/or Convertible Debt. The equity ownership percentage may be up to 49%, based on company valuation and Investment amount. In case of Convertible Debt, the amount financed will be interest-free. The Convertible Debt may be fully or partially convertible
 6. The Fund may have representation on the Board commensurate to its equity ownership
 7. The Fund will require regular progress reports and financial statements for performance monitoring purposes.

Targeted investments

The Fund may make investments to create, support, augment or procure specific products, services, applications, and hardware or technology platforms. The Fund may also invest in training programs to create skilled resource pools in selected technology areas. Additionally, the Fund may make strategic investments in selected entities, projects or initiatives to bring about substantial public benefits. The investments may be made solely, in collaboration with other entities or following the Public-Private partnership (PPP) model.

Strategic partnerships

The Fund may invest in strategic partnerships with local and international institutions (universities, companies, governments, incubators/accelerators, research organizations, media and other suitable entities) to acquire expertise, technology, products, services and/or support entrepreneurship development.

Co-investments

The Fund may enter into joint investments with other venture capital funds or funding entities in order to scale its investments and leverage partner expertise while sharing risks. Investments may be made in a single company, in a venture fund or in a fund-of-funds.

Fund participation: Equity and/or Convertible Debt. The equity ownership percentage will be based on company valuation and Investment amount. In the case of Convertible Debt, the amount financed by GoB will be interest-free. The Convertible Debt may be fully or partially convertible.

The Fund may have representation on the Board commensurate to its equity ownership.

The Fund will require regular progress reports and financial statements for performance monitoring purposes.

WIPO Technology Trends 2019 – Artificial Intelligence

This report is the first in a new series from WIPO tracking the development of technologies through the analysis of data on innovation activities. It reveals trends in patenting of artificial intelligence (AI) innovations, the top players in AI from industry and academia, and the geographical distribution of AI-related patent protection and scientific publications. Its findings are accompanied throughout by commentary and industry perspectives from more than 20 of the world's leading experts in AI, making it of particular interest to business leaders, researchers and policymakers.

This inaugural Technology Trends report provides a common information base on AI for policy and decision makers in government and business, as well as concerned citizens across the globe, who are grappling with the ramifications of a new technology that promises to upend many areas of economic, social and cultural activity.

For more information, access:

https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055.pdf

Technology transfer in Viet Nam

Vietnam Invest Network Corp., Viet Nam

<http://www.investinvietnam.vn>

The state of Vietnam encourages technology development and transfer. All organisations, individuals as technology property owners or authorised by the technology owners in technology transfer shall be encouraged to technology transfer and entitled to capital contribution in technology in investment projects in Vietnam. Vietnam has been active in investing in basic infrastructure for technology market, providing information of, disseminating, demonstrating and introducing technology; and participating in exhibitions in country and abroad.

The government of Vietnam also pays special attention to develop and encourage technology transfer to rural, mountainous and difficult socio-economic areas, promote the advanced and hi- technology transfer. The national technology fund is used for providing favorable loan or loan with low interest, loan guarantee etc. to support small and medium enterprises in technology transfer, renovation or completion, especially in technology transfer in agricultural, forestry and hydro development in rural areas, to support the establishment or growth of technology enterprises.

Particularly the state applies different preferences/incentives to promote technology transfer:

- Exemption of income tax for organisations or individuals who have capital contribution by technology inventions
- Import tax exemption applied to goods used directly for technology research and renovation including machines, facilities, materials and transportation means which have not been possibly produced in Vietnam; and applied to technology documents or scientific publications.
- Valued added tax exemption applied to machineries, equipment, specialised transportation means which have not been possibly produced in Vietnam for the purpose of technology transfer.
- Any enterprises or manufacturers who invest in production lines upgrading, operation expansion, technology renovation, ecological environment improvement and enhancing production capacity, shall be entitled to income tax exemption for the increased income for 4 years and tax reduction of 50% for the next 7 years.
- Any enterprises investing in technology renovation in the category of encouraged technology list shall be entitled to income tax exemption for 4 years provided that total tax

exemption amount is not exceeding 50% of total investment in technology renovation.

Any enterprises in difficult socio-economic areas shall be entitled to receive the following preferences or incentives when implementing investment projects relating to technology:

- Entitled to revenue tax exemption for 4 years since the dates of having taxed income and tax reduction of 50% taxed revenue in the next 9 years provided that total tax exemption amount does not exceed total investment in technology renovation.
- Entitled to import tax exemption to goods and materials for the shake of technology renovation and alternation, and to materials, equipment or production items for the production purposes for 5 years since the application of new technology for production.
- Any organisations or individuals involved in technology transfer prioritised areas, in rural, remote and difficult socio-economic areas, shall be entitled to income tax reduction of 50% applying to income generated from technology transfer, provision of planting seeds and husbandary.
- Any organisations involved in developing or establishing technology enterprises shall be entitled to income tax exemption for 4 years and income tax reduction of 50% for next 9 years, and to land-use rights tax exemption

Technology transfer must be conducted based on contractual documents or other similar papers. Contractual documents or attached papers must be written in Vietnamese, and popular foreign languages as agreed among concerned parties.

In cases of technology transfer involved in limited technology list, the transfer must be conducted with a permission. In cases of offshore technology transfer, the technology hand-over side must apply licence or legal papers while receivers shall apply for license of technology transfer if it is transferred to Vietnam from other countries.

Foreigners, Vietnamese overseas participating in technology transfer which belong to encouraged technology list or technology transfer in difficult socio-economic areas, they shall be entitled to receive additional incentives such as visa application for their family members, multiple visa, visa expiry in line with contracts of technology transfer, and favourable conditions of residency, travelling and other preferences or incentives in accordance with laws.

Registration of transfer of patent and petty patent in Thailand

Department of Intellectual Property, Thailand

<http://www.ipthailand.go.th>

Consideration criteria

The patent transferring contract is a contract with which the assignor grants the right to the assignee right (assignment of patent/petty patent). In this regard, the right transferring shall not exceed the protection period as follows;

*The protection period of invention patent lasts 20 years.

*The protection period of petty patent lasts 6 years, or upon the petty patent renewal application according to Article 65 paragraph 2 the laws.

Conditions of application submission

1. To register a transfer of the patent/petty patent, the applicant shall submit the form as determined by the Director-General, together with the transferring contract of the invention patent/petty patent.
2. Authorization
 - 2.1 In case the applicant of the patent does not reside in the Kingdom of Thailand, he shall authorize the patent agent/patent attorney registered with the Director-General of the Department of Intellectual Property to act on his behalf. In this regard, the power of attorney shall be presented to the Director-General in accordance with the following regulations;
 - (1) If the authorization is done outside the Kingdom of Thailand, the signatures in the authorization letter or power of attorney shall be certified by the authorized official of the Thai embassy or consulate or Director of the office of the Ministry of Commerce located in the country where the principal or power grantor resides, or the person authorized to act on behalf of the said officials or the person authorized to certify the signature according to the law in that country, or
 - (2) In case the authorization is done in the Kingdom of Thailand, the applicant shall submit a copy of passport or temporary residence certificate of the principal or power grantor, or any evidence indicating that at the time the authorization was made, the principal or power grantor was in Thailand.
 - 2.2 The Power of Attorney shall be attached with the revenue stamp of 30 Baht/patent agent/patent attorney/application.

Proceeding according to the official's instruction

1. In case that the official finds a correctable defect in the application, the official shall notify the applicant or his patent

agent/patent attorney for the correction. The applicant shall finish the correction within 90 days of the notification reception date. After such period, without the correction, the applicant shall be deemed to have abandoned the application, except the Director-General extends the period for correction as deemed appropriate due to any necessity.

2. After the applicant corrected the application, the applicant shall submit the correction application and the fee to the Department of Intellectual Property or the provincial office of the Ministry of Commerce. The corrected application shall enter the consideration and initial inspection processes respectively, similarly to the re-submission of the application.
3. In case of application submission via the website of the Department of Intellectual Property, the inspecting official shall check the completeness of information and details in the patent/petty patent application, request or other applications based on information and details appearing in the e-patent filing system. In this regard, the applicant shall present the application and supporting documents to the Department of Intellectual Property within 15 days of application number reception date and patent/petty patent application filing date via internet. The inspection of application submitted via internet shall be in accordance with the Notification of the Department of Intellectual Property Re: Principles and conditions for submission of patent/petty patent application, requests or other applications via internet.

Notes:

1. The working process starts after the inspection of the documents is completed, as specified in the manual of the public service.
2. In case the application or documentary evidence is not correct or incomplete, the official shall record the defect of the document or indicate the required additional documentary evidence (Record of conditions on application reception). The applicant shall correct the document and/or submit the additional document within 90 days of the application filing date. If the applicant fails to submit all additional documents within the specific period of time, the applicant shall be deemed to have abandoned the application. The official shall return the application to the applicant and inform the reason of the return and his appeal right.
3. Any person fee paid to the Department of Intellectual Property shall not be refunded in all cases, except
 - (1) The law stipulates that the fee must be refunded, or
 - (2) The applicant double-paid or overpaid the fee, by which the faulty payment resulted from the mistake of the state

official, not the payer. In this regard, the Department of Intellectual Property shall consider the refund case by case.

4. In case the applicant is required to submit many additional documentary evidences, the applicant shall submit all additional documentary evidences in the same time.
5. In case the applicant submits the copy of the documentary evidence, the applicant shall certify the copy of the documentary evidence.
6. In case the applicant submits the document in foreign language, the applicant shall submit the document with Thai translation and the correct translation certification of the translator.
7. In case the applicant or the authorized patent agent/patent attorney does not submit the application by himself, and granted power to the other person to submit the application, the application submitter shall present a sub power of

attorney or temporary power of attorney, so that he is eligible to submit the application and sign in the record of conditions on application reception. If it appears that the application and the documentary evidence is not correct or incomplete, and the application submitter is not authorized to sign on the said record, the official shall not receive the application.

8. The working period does not include the time period when the applicant follows the official's instruction or corrects the application, or the period of temporary suspension of registration.

Relevant laws

- The Ministerial Regulation No.25 (B.E. 2542) issued by virtue of the Patent Act B.E. 2522 (Dated 24 September 1999).
- The Patent Act B.E. 2522 as amended by the Patent Act (No. 2) B.E. 2535 and the Patent Act (No. 3) B.E. 2542

Global Innovation Index 2019

Now in its 12th edition, the Global Innovation Index (GII) is a global benchmark that helps policy makers better understand how to stimulate and measure innovative activity, a main driver of economic and social development. The GI is co-published by Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO, a specialized agency of the United Nations).

The GI 2019 ranks 129 economies based on 80 indicators, from traditional measurements like research and development investments and international patent and trademark applications to newer indicators including mobile-phone app creation and high-tech exports.

The GI 2019 also looks at the economic context: Despite signs of slowing economic growth, innovation continues to blossom, particularly in Asia, but pressures are looming from trade disruptions and protectionism. Sound government planning for innovation is critical for success, the report shows.

Among notable GI key findings this year:

- The global landscape of science, innovation, and technology has undergone important shifts over the last decades. Middle-income economies, especially in Asia, are increasingly contributing to global research and development (R&D) and international patenting rates via WIPO's International Patent System;
- The GI 2019 shows that public R&D expenditures – particularly in some high-income economies – are growing slowly or not at all. This raises concerns given the public sector's central role in funding basic R&D and blue-sky research, which are key to future innovations;
- Increased protectionism poses risks. If left uncontained, it will lead to a slowdown of growth in innovation productivity and diffusion across the globe;
- Innovation inputs and outputs are still concentrated in very few economies. Divides also persist in how effectively economies obtain return on their innovation investments. Some economies achieve more with less;
- Most top science and technology clusters are in the U.S., China, and Germany, while Brazil, India, Iran, the Russian Federation, and Turkey also feature in the top 100 list. The top five clusters: Tokyo-Yokohama (Japan); Shenzhen-Hong Kong, China (China); Seoul (Republic of Korea); Beijing (China); San Jose-San Francisco (U.S.).

For more information, access:

https://www.wipo.int/global_innovation_index/en/2019/

Sustainable finance scheme in India

Startup India, Government of India, India

<https://www.startupindia.gov.in>

The Small Industries Development Bank of India (SIDBI) has introduced a new scheme called the Sustainable Finance Scheme for funding sustainable development projects that contribute energy efficiency and cleaner production but not covered under the international or bilateral lines of credit. All sustainable development projects such as renewable energy projects, Bureau of Energy Efficiency (BEE) star rating, green microfinance, green buildings and eco-friendly labelling, etc. are applicable for the scope of this scheme.

Objectives

The following are the main goals of the Sustainable Finance Scheme.

According to the definition laid down by the MSMED Act 2006, new/ existing MSME units would be eligible for assistance under the scheme.

- Existing units must have a satisfactory track record of the past performance and sound financial position and should not be in default to institutions/ banks
- The units should have a minimum credit rating of investment grade or its equivalent according to the internal credit rating model.
- Renewable energy projects such as solar power plants, wind energy generators, mini hydel power projects, biomass gasifier power plants, etc. for captive/ non-captive use.
- Any potential CP investments that include waste management
- Suitable assistance to OEMs that manufacture energy efficient/ cleaner production/ green machinery/ equipment.

Further, the OEM has to be an MSME, or it has to supply its products to a substantial number of MSMEs

Overview

The scheme develops the entire value chain of energy efficiency (EE)/ cleaner production (CP) and sustainable development projects that lead to necessary improvements in EE/ CP/ sustainable development in the MSMEs that presently not covered under the viable financing lines of credit.

Rate of interest

The rate of interest applicable would be the standard lending rate by the credit rating of MSMEs.

Criteria

The acceptable standards for this scheme are as follows:

- Renewable energy projects like solar power plants, wind energy generators, mini hydel power projects, biomass gasifier power plants, etc. for captive/ non-captive
- Any potential CP investments that include waste management
- Suitable assistance to OEMs that manufactures energy efficient/ cleaner production/ green machinery/ equipment. Either the OEM has to be an MSME, or it has to be supplying its products to a substantial number of MSMEs

Fiscal incentives

Suitable assistance using term loan or working capital is granted to the ESCOs that implements EE/ CP/ Renewable Energy Project. To be eligible for this grant, the ESCO must be an MSME or otherwise the unit to which it renders its services has to be an MSME.

Technology Bank for Least Developed Countries

The Technology Bank for the least developed countries (LDCs) has been operationalized with the signing of the Host Country Agreement and the Contribution Agreement between the Government of Turkey and the United Nations. The new Bank is expected to improve the utilization of scientific and technological solutions in the world's poorest countries and promote the integration of least developed countries into the global knowledge-based economy. The establishment of the Technology Bank marks the first Sustainable Development Goal (SDG) target to be achieved, SDG 17.8. Its achievement is highly symbolic, as it responds directly to the 2030 Agenda's principle of leaving no one behind.

For more information, access:

<http://unohrlls.org/technologybank/>

Green technology financing in Malaysia

Malaysian Green Technology Corporation, Malaysia

<https://www.gtfs.my>

As part of the effort to ensure continuous supports toward Green Technology projects, the Ministry of Finance has agreed to the recommendation proposed by Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC), with several enhancement and improvement to the scheme and known as GTFS 2.0.

Malaysian Green Technology Corporation also known as GreenTech Malaysia is an organisation under the purview of the Ministry of Energy, Science, Technology, Environment & Climate Change.

Established in 2010, our mandate is to spearhead the development and promotion of green technology as a strategic engine for socio-economic growth in line with Green Technology Master Plan 2017-2030.

GTFS 2.0 also offer a financial support (subject to only to the green technology/component cost finance by Participating Financial Institutions (PFIs)) for Producer, User and also offer a financial support to a new category, which is for Energy Services Companies (ESCOs) also offer a rebate of 2% on interest/profit, is to accelerate the expansion of green investments by providing easier access to funding via financing from Participating Financial Institutions (PFIs) with a total funding earmarked up to RM2.0 billion. The new category is to support ESCOs to finance investment or assets related to energy efficient project and/or energy performance contracting.

All applications of the Scheme are channeled to Malaysian Green Technology Corporation (GreenTech Malaysia) on which conducts the initial screening and certification prior to applying financing from financial institutions. The Scheme is made available until 31 December 2020 or upon reaching a total financing/funding approval amount of RM2.0 billion whichever is earlier or any subsequent extension on the availability date expected to facilitate the growth of local green businesses and generates new markets and job creation.

Malaysian Green Technology Corporation (GreenTech Malaysia), Credit Guarantee Corporation Malaysia Berhad (CGC) are the agencies tasked with administering the Scheme. GreenTech Malaysia is responsible for the promotion, assessment, certification and monitoring to Producers, Users & ESCOs under the Scheme, while CGC administers the rebate payments.

In April 2018, the MOF had approved an extension of the GTFS known as GTFS 2.0 with a financing amount earmarked up to RM 5.0 billion. The Scheme was later launched on 3rd May 2018 in Kudat, Sabah. However, after the 14th General Election in May 2018, the new Government administration had decided to discontinue the Scheme. Later, on 6th March 2019, MOF had approved to reinstate GTFS 2.0 with the allocation of RM 2.0 billion for the period of January 2019 until the end of 2020. The Scheme which will last for two (2) years will be offering a 2% p.a. interest/profit rate subsidy for the first seven years with 60% government guarantee on the financing.

Key areas and projects criteria

Funding will be provided for any project that qualify the PFI requirements and meets green technology project criteria under GTFS program. Evidences of proven business model and technology may be required to ensure that only viable projects will be funded.

General criteria

All products, equipment and systems which satisfy the following criteria:

- Minimize degradation of environment;
- Zero or low greenhouse gas emission;
- Safe for use and promotes healthy and improved environment for inhabitants;
- Conserve the use of energy and natural resources;
- and Promote the use of renewable energy resources.

Global Design Database

Via a single, intuitive interface, the Global Design Database enables free, simultaneous searches of more than 10,490,000 industrial designs registered under the WIPO-administered Hague System and/or in participating national collections.

For more information, contact:

Global Design Database

E-mail: gbd@wipo.int

Web: <https://www.wipo.int/reference/en/designdb/>

Innovation promotion in ICT sector of India

Ministry of Electronics & Information Technology, Government of India, India

<https://meity.gov.in>

The Ministry of Electronics and Information Technology (MeitY), Government of India has taken various initiatives and measures to improve innovation-led ecosystem with a Technology Incubation and Development of Entrepreneurs (TIDE) scheme, Centre of Excellences in IoT/ FinTech space, technology and theme based incubation centres and programmes to promote technology incubation and also to support researchers, start-ups and MSMEs protect IPRs nationally and internationally. Following schemes/ programmes are being supported to encourage innovation in ICTE sector:

Technology Incubation and Development of Entrepreneurs (TIDE 2.0)

To promote tech entrepreneurship through financial and technical support to incubators engaged in supporting ICT start-ups primarily engaged in using emerging technologies such as IoT, AI, Block-chain, Robotics etc. in seven pre-identified areas of societal relevance, Ministry of Electronics and Information Technology (MeitY) has approved a Technology Incubation and Development of Entrepreneurs (TIDE 2.0) Scheme being implemented by Innovation and IPR Division MeitY over a period of five years. The Scheme will be implemented through 51 incubators at institutes of higher learning and premier R&D organisations, eventually leading to handholding of approximately 2000 tech start-ups. The scheme also aims to provision a mechanism, whereby establishing necessary collaboration among the incubation activities so as to benefit them through complementary strengths. Efforts will be made to closely associate these incubators and through this network the complementary strengths can be leveraged and shared. This will also ensure that larger number of institutes possess matured incubation facilities, leading to technology start-ups moving out of metros to TIER 2 and 3 cities. To support tech start-ups, seven select thematic areas were identified to address societal challenges based on national priorities particularly in the realm of:

- (i) Healthcare
- (ii) Education
- (iii) Agriculture
- (iv) Financial inclusion including digital payments
- (v) Infrastructure and transportation
- (vi) Environment and clean tech
- (vii) Clean Energy Solutions

MeitY Startup Hub (MSH)

The Ministry of Electronics and Information Technology (MeitY) has approved project for establishment of "MeitY Start-up Hub" (MSH) under TIDE 2.0 scheme by Software Technology Parks of India (STPI) Hqrs at a total budget outlay of Rs. 5.18 Crore as grants-in-aid over a period of five years. In order to facilitate

MeitY's vision of promoting technology innovation, start-ups and creation of Intellectual Properties, a nodal entity called 'MeitY Start-up Hub' (MSH) is being setup under its aegis. MSH will act as a national coordination, facilitation and monitoring centre that will integrate all the incubation centres and start-up and innovation related activities of MeitY.

Vision: To build a conducive innovation ecosystem by bringing together various technology innovation stakeholders, breaking away with the culture of working in silos and paving the way towards a strong economy built on the twin engines of innovation and disruption.

Mission: MSH to act as a hub and ensure synergies among all the TIDE 2.0 Centres, theme based incubation centres, Centre of Excellences on Emerging Technologies and other existing platforms for facilitating criss-crossing of technology resources, sharing best practices and ideas across the entire innovation and startup ecosystem.

Objectives of MSH

- 1) Create vital inter-linkages/ exchanges of information among all the relevant stakeholders on-board and in sync with relevant line Ministries/ Departments
- 2) Intersection of technology and ideas leading to effective translation of R&D activities for commercial gains
- 3) Facilitation of commercialization of technology solutions for market outreach
- 4) Providing technical and business advisory through a cache of Experts and Mentors
- 5) Facilitate industry connect, fundraising through VCs/Angels and promote globalisation of Indian Tech start-ups
- 6) Provide the entire range of value added IPR support services like sensitization, protection and compliance of generated IPs

Major attributes of the MSH

- 1) Intersection of technology and ideas leading to effective translation of R&D activities for commercial gains.
- 2) Embracing experimentation for coming out with solutions to the challenges across different projects
- 3) Various stakeholders to converge under a common umbrella
- 4) Access to development resources which includes design and prototyping of services and licensing of technologies
- 5) Making business case out of the technologies or solutions developed
- 6) Spawning the dawn of an innovation ecosystem cutting across functionalities and industries for supporting tech startups
- 7) Facilitation of crisscrossing of technology resources across gamut of domains for coming out with solutions to the challenges across different projects

- 8) Capitalizing on strengths of different centers to pull out moderately weaker centres into mainstream activity

Technology Incubation and Development of Entrepreneurs (TIDE)

The Ministry of Electronics and Information Technology (MeitY) is implementing a scheme titled “Technology Incubation and Development of Entrepreneurs (TIDE)”. Initially launched in 2008 the scheme has been revised and extended till March 2017. As per the scheme provision, 27 centres are being supported at academic institutions across India.

TIDE has a multipronged approach in diverse areas of Electronics, ICT and Management. It aims to assist institutions of higher learning to strengthen their Technology Incubation Centers and enable young entrepreneurs to initiate technology startup companies for commercial exploitation of technologies developed by them.

TIDE Incubation Centers provide a gamut of services to new enterprises and facilitate linkages congenial for their survival and growth. The centres network with Angel Investors and Venture Capitalists who provide mentoring and financial support to the startups and enable tenant companies to mature over a period of 2-3 years and ultimately graduate to a commercial place to transact actual business.

MeitY is providing financial and policy support for strengthening technology incubation activities on the premise that this would in the long run result in indigenous development of products and packages in the ICTE sector.

The major objectives of the scheme are:

- 1) Setting up and strengthening Technology Incubation Centres in institutions of higher learning,

- 2) Nurture Technology Entrepreneurship Development for commercial exploitation of technologies developed by them,
- 3) Promoting product oriented research and development,
- 4) Encourage development of indigenous products and packages and bridging the gap between R&D and commercialization.

Multiplier Grant Scheme (MGS)

Ministry of Electronics and Information Technology (MeitY) is implementing Multiplier Grants Scheme (MGS). MGS aims to encourage collaborative R&D between industry and academics/ R&D institutions for development of products and packages. Under the scheme, if industry supports R&D for development of products that can be commercialized at institution level, then government will also provide financial support that is up to twice the amount provided by industry. The proposals for getting financial support under the scheme are to be submitted jointly by the industry and institutions.

The Technology Development Council (TDC) budget head will be used for implementation of this scheme. Based on this pilot implementation and feedback, the scheme would be reviewed by Working Group.

The major objectives of the scheme are:

- 1) Establish, nurture and strengthen the linkages between the Industry and Institutes;
- 2) To promote industry oriented R&D at institutes;
- 3) Encourage and accelerate development of indigenous products and packages; and
- 4) Bridge the gap between R&D / Proof-of-concept and commercialization /
- 5) globalization.

Startup India

Startup India is a flagship initiative of the Government of India (launched January 2016), intended to build a strong eco-system for nurturing innovation and Startups in the country that will drive sustainable economic growth and generate large scale employment opportunities.

The Government through this initiative aims to empower Startups to grow through innovation and design. In order to meet the objectives of the initiative, Government of India announced Startup India Action Plan that addresses all aspects of the Startup ecosystem. With this Action Plan the Government hopes to accelerate spreading of the Startup movement.

The Action Plan is divided across the following areas:

- Simplification and handholding
- Funding support and incentives
- Industry-Academia partnership and incubation

For more information, access:

<https://dipp.gov.in/programmes-and-schemes/industrial-promotion/startup-india>

Aligning SMEs to megatrends and Industrial Revolution 4.0 in Malaysia

SME Corporation Malaysia, Malaysia

<http://www.smeinfo.com.my>

Megatrends are global, sustained and macroeconomic forces of development that impacts business, economy, society, cultures and personal lives thereby defining our future world and its increasing pace of change.

Goods, capital and labour are now travelling globally at an ever-faster pace and not in the usual patterns. Technological innovation is re-shaping commerce and industry across all sectors, as well as the work and lifestyle of the people. These changes are imminent at the national level and will reshape businesses through the way they think and operate. Therefore, SMEs that seizes the opportunities arising from the Megatrends stand to gain significantly.

Thus, SMEs need to be nurtured on the importance of moving on to Industry 4.0 rather than maintaining themselves in conventional business. Benefits of industries moving on to Industry 4.0 are increase in flexibility, increase in productivity, increase in efficiency, quality and reduced time to market, more research development and demonstration (R&D&D) activities and the potential of developing new skills and talent globally.

SMEs should also know that the Government is currently formulating a national framework on IR 4.0 in order to promote the industry. In May 2017, the Cabinet tasked MITI, MOSTI and MOHE to lead this initiative. A High-Level Task Force (HLTF) led by MITI with members from relevant Ministries and Agencies has been established since March 2017 to spearhead the development of the whole of Government strategies for Industry 4.0 with strong stakeholders' feedback including from the industry.

These committees' roles are to identify challenges, analyse existing gaps and propose action to be taken accordingly. Recommendations will be included in the overall National Policy on Industry 4.0. MITI and its agencies in collaboration with relevant Ministries and

Agencies are also undertaking various outreach programmes to increase public/industry/academia/training institute's awareness on Industry 4.0. Two major outreach programmes were done nationally on 2 May 2017 and 15 June 2017. More outreach programmes are in the planning stage including at the state and regional levels.

Malaysia's manufacturing sector as a whole varies in terms of where they are currently ranging between 2.0 (mass production) and 3.0 (automation). However, there are industry leads already in the process of moving towards Industry 4.0 or becoming Industry 4.0 compliant on their own. RMK11 (2016-2020) has identified the three catalytic (E&E, M&E and Chemical) plus two new growth (Aerospace and Medical Devices) sectors as game changers for the manufacturing sector. These sectors will continue as the focus sectors together with other sectors such as automotive, petrochemicals, textiles and services.

In addition, the Government is committed in moving away from low-skilled/foreign workers dependency particularly for the manufacturing sector. Adopting new technology to ensure companies are more efficient and productive will be in tandem with global trends. SMEs should know that cheap labour is unsustainable in the long run and likely to human errors thus reducing the quality of products produced. The adoption of Industry 4.0 in this type of organization will increase efficiency and promote zero-defect output.

Thus, SMEs should not be afraid to embark on digital transformation as the global trends show companies that are not confined to the traditional way of doing things and utilise technology to its advantage have a higher chance of remaining relevant and successful in the long run.

(Original source: MITI website and SME Corp. Malaysia 2017 survey)

Global Programme to Help Boost Access to Patent System

The World Intellectual Property Organization (WIPO) programme aims to help inventors and small enterprises with limited finances to pursue the patent protection that is key to successful commercialization of a product or new solution. Qualified attorneys help by providing free legal advice to inventors who would otherwise be unable to afford the legal costs of obtaining a patent. Research shows many patent applications are rejected on procedural issues that IP lawyers can help avoid. The Program seeks to stimulate an innovative environment where all inventors are able to commercialize their products, bringing economic benefits to them, their families and communities, while ultimately boosting the pool of fee-paying clients for lawyers who helped launch this cycle by foregoing payment.

For more information, contact:

Media Relations Section
World Intellectual Property Organization (WIPO)
Tel: (+41 22) 338 81 61 / 338 72 24
Fax: (+41 22) 338 81 40
Web: <http://www.wipo.int/>

Global Cleantech Innovation Programme

United Nations Industrial Development Organization

<https://www.unido.org>

The Sustainable Development Goals and the Paris Agreement are the world's commitment to safeguarding the global commons. The United Nations Industrial Development Organization (UNIDO), with its unique mandate to support inclusive and sustainable industrial development, has partnered with the Global Environment Facility (GEF) to address the most pressing global environmental challenges of our time. Through fostering innovation and entrepreneurship ecosystems, UNIDO and GEF seek to promote affordable and scalable solutions enabling our partner countries to leapfrog to cleaner, more resilient economies.

Innovation ecosystem

The GCIP promotes an innovation and entrepreneur ecosystem by identifying and nurturing cleantech innovators and entrepreneurs; by building capacity within national institutions and partner organizations for the sustainable implementation of the cleantech ecosystem and accelerator approach; and by supporting and working with national policy makers to strengthen the supportive policy framework for SMEs and entrepreneurs.

Through this cleantech ecosystem and accelerator approach, the GCIP catalyzes investment to support and accelerate startup entrepreneurs towards the development and commercialization of their innovative ideas.

Partnerships and close collaboration with all national stakeholders are critical to maximize synergies and share knowledge and best practices that can help in enhancing the contribution of cleantech startups towards climate change mitigation, while increasing productivity and generating growth and wealth.

The GCIP accelerator

A key component of the GCIP is the annual competition-based Accelerator, which identifies the most promising innovators and entrepreneurs across a country. A selected number of startups in a GCIP country participate in a rigorous, competitive national acceleration programme that trains, mentors, promotes, and connects them to potential investors, customers and partners. As the best cleantech companies progress, they are continuously developed and assessed.

The Accelerator consists of an Official Launch, Investor Connect, National Academy, Business Clinic, and Mock Judging. In addition, the selected startups are continuously mentored and trained and access to capital and showcasing opportunities are facilitated on a regular basis in order to enhance their business skills and to connect them to potential business partners, financiers and investors.

A tailored mentoring programme is provided through an elite group of general and specialist mentors and trainers drawn from

industries, universities, and professional institutions, as well as business leaders from within the country and abroad.

Technology solutions

The GCIP started with four technology categories namely Energy Efficiency, Renewable Energy, Waste Beneficiation, and Water Efficiency; in 2016, the Green Building category was added to expand the scope of environmental challenges addressed. The 2017 Accelerator has expanded to include two new categories, Transportation as well as Advanced Materials and Chemicals.

GCIP is planning a transition to an impact-focused accelerator in order to leverage innovation and entrepreneurship to provide solutions to protect our global commons. Existing technology categories will evolve in to impact categories to accelerate transformative clean technology solutions and integrated approaches for energy systems, sustainable cities, healthy oceans and sustainable fisheries, food systems, and landscape restoration.

GCIP also supports identification and development of demand-driven solutions that can address the most pressing environmental challenges at the national levels. Through National Innovation Challenges, innovators are invited to propose technology innovations that can address a particular problem with high-impact potential. This approach allows direct market access for the technologies, ensuring efficiency and effectiveness in impact scaling.

GCIP Global Forum & Cleantech Week

The national winners are invited to the annual GCIP Global Forum & Cleantech Week, a confluence of the cleantech industry and the climate movement hosted by the Cleantech Open (CTO) in California, USA. It aims to create new business opportunities, highlight solutions, engage citizens, cultivate partnerships, and spur investment in clean technologies to address climate change.

The GCIP national winners gain exposure to the dynamic venture culture of Silicon Valley, and are connected with a community of cleantech innovators and entrepreneurs from all over the world. The GCIP national winners also meet with the national winners of the other GCIP countries, compete for the Global Prize.

The impact

The GCIP has been transforming the way we address the most pressing environmental challenges of our time, and is now a global programme making an impact in 8 countries around the world.

Between 2014 and 2016, cumulatively the GCIP received almost 3000 applications in the 8 countries of operation, and over 580 startup companies were selected as semi-finalists and benefited

from the Accelerator's training and mentoring programme, as well as the exposure to investors and the media. In 2016, the GCIP was conducted in 7 countries with 1385 applications received, of which 235 startup ventures were selected as semi-finalists. The number of applications in 2015 increased by 62.5% compared to 2014, and again in 2016 a 33% increase in applications was recorded compared to 2015. This shows the growing visibility and interest in the GCIP.

In addition to contributing to greenhouse gas emissions reductions, the technology innovations fostered under GCIP also reap positive impacts for the environment including improved water efficiency, soil protection, and waste beneficiation. Through growth of the cleantech industry, employment opportunities are created, both leading to poverty reduction through income generation.

Innovation and entrepreneurship policy frameworks

An integral part of GCIP is the development of an enabling environment for cleantech innovation and entrepreneurship, and GCIP employs a cross-sectoral and multi-tiered approach with a view to building a sustainable "ecosystem" for innovative entrepreneurship in small businesses. This entails supporting national

partners to strengthen the institutional capacities of government agencies focused on small and medium-sized enterprises (SMEs) development, clean technology and innovation.

Global Cleantech Innovation Index

The Global Cleantech Innovation Index (GCII), a biennial index and report, was first created in 2012 to investigate the question: which countries currently have the greatest potential to produce entrepreneurial cleantech startup companies and which will commercialize clean technology innovations over the next 10 years?

UNIDO has partnered with the World Wide Fund for Nature (WWF) and the Cleantech Group (CTG) to produce the Country Profiles for the eight partner countries of the GCIP, as a special addendum to the 3rd edition of the GCII for 2017.

Under the policy component of the GCIP to enhance the enabling environment in partner countries, the GCII-GCIP Country Profiles aim to further strengthen the enabling environment through national policies that promote innovation in clean technologies, and to serve as a valuable policy tool to stimulate a broader economic action plan including strategic support for cleantech solution providers.

ASEAN Network for Drugs, Diagnostics, Vaccines and Traditional Medicines Innovation

The ASEAN Network for Drugs, Diagnostics, Vaccines and Traditional Medicines Innovation (ASEAN-NDI) oversees the discovery and development of health technologies that will not only address health problems but also propel the health industry in ASEAN Member States. The ASEAN-NDI website offers the following features:

- Quick access to data regarding Governing bodies, Research Institutions, Collaborations, and current activities on the progress of the network via an online database greatly helps in bridging the gap between the health situations of the ASEAN member states.
- Accounts on the news involving the sectors for health are updated with the use of an online blog that is accessible to everyone.
- An online forum gives each participant an avenue for communication. Upon registration, one can contribute, update, and discuss with fellow members.

The following are potential areas of collaboration of ASEAN-NDI with partner institutions, researchers, agencies, and other health R&D innovation networks.

- Strengthening cooperation of ASEAN member states in health R&D
- Development of programs and projects which address public health concerns in ASEAN
- Development of strategies to strengthen ASEAN member states' capacity and competitiveness in the development and delivery of health-related products and services

For more information, access:

<http://www.asean-ndi.org>

Green manufacturing in the Philippines

Department of Trade and Industry and Board of Investments, Philippines

<http://industry.gov.ph>

Greening the Philippine Manufacturing Industry Roadmap

The manufacturing sector of the Philippines is challenged to significantly strengthen its competitiveness in order to be prepared for the challenges lying ahead. Seeing the worldwide dynamics of industrial development and the integration process of the ASEAN Economic Community, it becomes obvious that the manufacturing industry needs to successfully position itself as a globally competitive industry on domestic, regional and global markets.

Asia's economies and their businesses are increasingly becoming main drivers for Green Economic Development (GED) worldwide. It is obvious that the manufacturing industry of the Philippines is challenged to be responsive and proactive to this worldwide trend. Already today, the business community sees in the over-use of natural resources and the impacts of climate change a key challenge to do business successfully and to ensure its long-term economic growth perspective.

In a common effort, industry and government in the Philippines have launched an initiative, in which sectoral road maps have been elaborated and submitted to the Department of Trade and Industry and the Board of Investments. The so-called Road Map Process is a unique opportunity to define a well-focused stimulation and promotion for an industry driven GED that is integral part of a modernization and innovation process of the economy of the Philippines. Within the industry sectors, each company have to elaborate and implement their own strategy to unleash the specific market potential for products and service delivery.

Public policies on regulation, subsidies, incentives and information have a central role to play for the green modernization of the industry. Green investment from both the public side and the private side is an investment for immediate returns and for the future.

Worldwide experiences show that without a forceful and coordinated set of actions that removes barriers and sets favorable framework conditions, it is unlikely that even the most economically beneficial options would overcome a short-term sighted "Buy-the-Cheapest" or "Business-as-Usual" attitude. In cooperation with other government entities, the BOI and DTI should contribute to setting framework conditions and to building up capacities that support a paradigm shift towards an innovation process that results in competitiveness, good environmental performance, climate change resilience and job creation.

Promotion of Green Economic Development (ProGED) Project

ProGED is a project of the Department of Trade and Industry (DTI) with the Federal Republic of Germany through the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). It is primarily

aimed at improving the competitiveness of MSMEs while coping with climate change adaptation and mitigation requirements through the adoption of environment-friendly, climate-smart, and inclusive strategies and measures.

Interventions are implemented at the operational level through the Regional and Provincial offices of DTI (to support the enterprises in greening their operations), as well as at the policy level through the Regional Operations Group (ROG), where the green perspective is integrated into the programs and projects of DTI. A Green Growth Core Group has likewise been established within ROG to steer their initiatives on greening MSMEs within the Department.

ProGED promotes a green economy strategy founded on the five pillars of mitigation, adaptation, competitiveness, green jobs, and preserving or even improving nature's capital. The project focuses initially on the tourism sector with its high potential for investment, employment, and poverty reduction due to its linkages with upstream and downstream industries in other economic sectors.

The project is implemented from 2013 to 2016, and piloted its approach in the Provinces of Cebu and Bohol. Since 2014, it has expanded to include fourteen replication provinces in seven regions, namely: Pampanga and Tarlac (Region 3) Laguna and Cavite (Region 4A), Palawan and Occidental Mindoro (Region 4B), Albay and Camarines Sur (Region 5), Negros Occidental and Capiz (Region 6), Negros Oriental and Siquijor (Region 7), and Agusan del Norte and Surigao del Norte (Region 13). Aside from tourism, additional priority sectors are taken up according to the location's competitive advantages.

In relation to its efforts to support the greening of enterprises and upon the request by DTI, ProGED also supported the Greening the Manufacturing Industry Roadmaps process, which aims at integrating green economic development elements in selected industry roadmaps and the overall manufacturing roadmap. This will create climate smart, environment friendly, and globally competitive manufacturing industries in the Philippines.

Started in 2014, the initiative has fielded three missions by Dr. Bernd Gutterer, an international GED consultant commissioned by GIZ to the Philippines. The first mission was held in July 2014, wherein initial consultations with various industry associations and stakeholders were conducted to assess awareness of GED concepts. The second mission was held in November 2014, wherein one-on-one discussions with six industries selected by DTI (automotive, copper, furniture, mass housing, plastics, and pulp and paper) were conducted to determine how green elements could be integrated in their respective roadmaps.

Cleaner chromium tanning

A Chinese firm is offering technology of cleaner chromium tanning method, closed pickle tan loop system. The technology involves continuous recycling of spent liquors from a suitably standardized less-chrome, high exhaustion chrome tanning in pickling such that there is no discharge of exhaust liquors containing chrome tanning processes, preventing pollution due to these substances on the one hand and avoiding material loss on the other. Compared to conventional chrome tanning process, this new pickle-tan closed loop system ensures near zero discharge of potential pollutants such as chrome and neutral salts viz. sodium chloride and sodium sulphate. Since sulphate bearing streams viz. pickling and chrome tanning spent liquors are continuously recycled and not being allowed to mix with other sectional waste liquors, the anaerobic treatment of end of pipe treatment is improved. Sludge produced would be almost free chrome and hence, disposal becomes easier.

Area of Application:

Chemical industry, Tanning industry, Leather industry

Advantages:

Cleaner production: near zero discharge of chrome and neutral salts in pickle and chrome tanning processes thus preventing pollution due to these substances. Avoids material loss. Water consumption in pickle-tan stage is considerably minimized.

Technical specifications:

- Cleaner chromium tanning method
- Closed pickle tan loop system

Contact:

Polytex Chemical Engg Co.

No.317 Wenhuidong Rd, Yangzhou city, Jiangsu, China

Yangzhou

China

Zip/Pin Code:225009

Development Status:

Commercial prototype

Legal Protection:

Patent

Technical specifications:

- Requires fewer changes of grip during introduction of the catheter into the vein; therefore, accidental withdrawal of the catheter is less likely.
- The "HunCath" can be inserted into the vein

Transfer Terms:

- Subcontracting
- Technology licensing

Contact:

Laser Consult Ltd

H-6701 PO Box 1191

Szeged, Hungary

Brightness of LEDs

A device for compensating the effect of temperature variation on the brightness of LEDs has been developed. We invite interested parties to contact us for exploring the possibilities of licensing this technology.

Area of Application:

- Camera calibration
- Color printer application
- Automobile applications e.g. traffic light, signal light etc.
- LED displays in different instruments

Advantages:

- The LED driver circuit will provide bias to the LEDs to provide temperature compensated brightness without using any temperature sensors.
- No temperature sensor is required, since properties of the diodes themselves are used to achieve the temperature compensation performance.
- The temperature controlled bias voltage/current generated according to the junction temperature of the LEDs themselves, thus any temperature gradient will not affect the temperature compensation.
- Temperature changes induced by power dissipated within the diodes are also compensated.
- No trial and error method is involved to optimize the circuit performance.

Development Status:

Fully commercialized

Legal Protection:

Patent

Transfer Terms:

Technology licensing

Target Countries:

India

Central venous catheter system

A Hungarian medical research institute has developed a central venous catheter system for subclavial or jugular vein puncture. The kit contains the following items: insertion needle with the patented two-way valve system, syringe to check if the catheter is in place, the catheter itself, wrapped in sterile package and plastic adaptor to lock the catheter securely after the removal of the needle. The patented "HunCath" catheter system is a novel alternative to a safer catheter which can be widely used in techniques, such as pacemaker electrodes.

Area of Application:

Medical technologies

Advantages:

Among all catheters currently used this product bears with the lowest risk for the patient and the easiest use for the physician.

TECHNOLOGY OFFERS

Contact:

Space Applications Centre (ISRO)
33 22 / TTID / PPG, Space Applications Centre (ISRO),
Jodhpur Tekra, Ahmedabad 380 015, India

Tea catechins as anti-aging compounds

The invention relates to the preparation of consumable composition for oral administration that contains tea catechins. The composition prepared by the process of this invention is useful in providing controlled release of catechins contained therein. In a preferred embodiment of the present invention, consumable composition containing tea catechins dispersed therein is provided.

Area of Application:

Application includes antiaging agents

Environmental aspects:

Environment-friendly

Development Status:

Laboratory model

Legal Protection:

Patent

Transfer Terms:

- Consultancy
- Technical services
- Technology Licensing

Contact:

Amity University
Sector-125, Noida, Distt Gautam Buddha Nagar 201303
Uttar Pradesh, India

Zero-head hydro turbine

An Indian entrepreneur has developed the zero-head water turbine which generates electric energy from moving water and simultaneously pumps the water for irrigation or other like purposes. He has designed two variants of turbine and pump models. Initially he had developed a water turbine using bamboo for harnessing the flow energy from the river to pump water to his land way back in 1998-99. And later with the assistance from GIAN-NE, a voluntary organization working in the field of development of grass root innovations, he has developed another version of the same turbine.

Area of Application:

Areas where electric power supply is not available

Advantages:

- Novelty lies in its portability and the fact that there is no need for a dam.
- Economically it is a better as construction and installation cost is minimal as compared to hydro-electric, steam or any other power plant.

- The maintenance cost is also quite low compared to the conventional hydroelectric power plant.
- Its efficiency is greater than 50%. It can be set up anywhere be it plains or mountains.
- The turbine has a very high potential in rural areas where electric power supply is not available.

Environmental aspects:

Energy efficiency

Development Status:

Commercial prototype

Legal Protection:

Patent

Transfer Terms:

Consultancy

Contact:

National Innovation Foundation, India
PO Box 15051, Vastrapur
Ahmedabad 380 015,
Gujarat, India
Tel: +91-79-2673 2456/2095
Fax: +91-79-2673 1903
E-mail: info@nifindia.org

Herbal pesticide

The technology provides a sprayable biopesticidal composition comprising *Photorhabdus luminescens* for controlling and eradicating various agricultural pests. It is for the first time that the insecticidal activity of *P. luminescens* is used without its symbiotic carrier nematode. In the present technology, the actively growing cells of *P. luminescens* are encapsulated in sodium alginate beads and examined for their ability to infect insect hosts. Several laboratory and field testing programme were carried out to evaluate and assess the product. Elaborative and extensive field trials were conducted to study the efficacy of the product on the serious pest of sugarcane. The results obtained from these experiments have given a clear indication that the product is very effective and is novel based on the bacterium *Photorhabdus luminescence* and the plant, bacterial and insect chitinase purified to greatest extent and stabilized for longer shelf life.

Area of Application:

Agriculture

Advantages:

- Better alternatives to the conventional chemical compositions
- Extremely effective in controlling the spread of *Ceratovacuna langiera*
- Effective for both soil and aerial applications
- Useful for crops such as cabbage, cotton, pulses, peas, sugarcane, bamboo, grapes, citrus, mango and guava.

TECHNOLOGY OFFERS

- Capable of being applied with commonly used agricultural equipment like sprayers and dusters.
- Results are comparable to chemical insecticides
- Environment friendly

Development Status:

Laboratory model

Legal Protection:

Patent applied for

Transfer Terms:

Technology licensing

Contact:

SkyQuest Technology Consulting Pvt. Ltd.
501, Krishna Complex,
Opp. Devashish School,
Bodakdev, Ahmedabad 380054, India

Composting process using microbes and herbal extracts

Herbal extracts along with the microbes are used for the preparation of the compost which is quite effective in the controlling the soil pathogens and increasing the yield. We could offer an easy method of preparation using the agricultural waste.

Area of Application:

Agriculture

Environmental aspects:

Waste utilization

Development Status:

Pilot plant

Legal Protection:

Patent filed

Transfer Terms:

- Joint venture
- Technical services
- Technology licensing
- Research partnerships

Target Countries:

Worldwide

Contact:

Hiran Biotech
Research and Development Division
66 Turner Road Cantt.
Kanpur 208004, U.P.
India

Herbal termite killer formulation

This is a herbal formulation for instant termite killing. The patent application is pending for the formulation. It holds

the potential to wipe-off existing products and hold monopoly in the market. IT is equally good in fields and with furniture etc.

Area of Application:

Woodwork, furniture, agriculture, house, offices.

Advantages:

Non-toxic, cheap and highly effective

Environmental aspects:

Cleaner production

Development Status:

Commercial prototype

Legal Protection:

Patent

Transfer Terms:

Technology licensing

Contact:

Intellectual Property Lab
2/11, Vishwas Khand-2,
Gomti Nagar,
Lucknow - 226010, India

Virgin coconut oil

Virgin Coconut Oil (VCO) is the oil obtained from fresh, mature endosperm (kernel-meat) of the coconut by mechanical or natural means, with or without use of heat, no chemical refining, bleaching or deodorizing and maintain the natural aroma and nutrients.

Area of Application:

Many potential applications in food, health and cosmetics sectors.

Development Status:

Pilot plant

Commercial prototype

Transfer Terms:

- Consultancy
- Technology licensing

Chitin and chitosan

Chitin and chitosan are important byproducts from the shell of shellfishes. Chitin is the most important organic constituent of the exoskeletal material of invertebrates and the important economical source of this material is the shrimp processing industry. Chitin and its derivatives, chitosan find various industrial applications like, biotechnology, food processing, pharmacy and medicine.

Area of Application:

Various industrial applications like biotechnology, food processing, pharmacy and medicine.

TECHNOLOGY OFFERS

Advantages:

Chitin and its derivatives, particularly chitosan find industrial application in various fields namely flocculation, paper making, textile printing and sizing, ion exchange chromatography, removal of metal ions from industrial effluents, manufacture of pharmaceuticals and cosmetics and as an additive in food industry.

Environmental aspects:

Waste utilization

Development Status:

- Pilot plant
- Fully commercialized

Transfer Terms:

- Consultancy
- Technology licensing

For the above two offers, Contact:

Central Institute of Fisheries Technology
CIFT Junction, Matsyapuri,
Willingdon Island
Cochin - 682029
India

Decortication of fibrous plants

Technology allows for extraction of bast fibers from straw by so called decortication process without prior drying of the straw which considerably influences the price of the fiber and simplifies the process resulting in energy, labor and cost reduction. The key elements of the technology are decorticating device allowing for processing of non-retted hemp and flax stems and cleaning unit. High efficiency machines produce a "green" fiber of quality suitable for pulp or composite materials production. Produced fiber is baled in 300 kg bales by hydraulic press.

Area of Application:

Bast fibrous plants processing industry; Farm cooperatives focused on bast fibrous plants production

Advantages:

- High output
- Energy savings
- Purity of end-product (fiber)
- Straw can be processed without prior drying

Environmental aspects:

- Cleaner production
- Waste utilization
- Energy efficiency

Development Status:

Fully commercialized

Legal Protection:

Patent

Technical specifications:

- Processing capacity: 1.5 t of straw/h
- Energy consumption: 110 kw/h
- End purity of produced fiber: 10-15%
- Service requirements: 3 people

Transfer Terms:

Technology licensing

Contact:

Institute of Natural Fibres and Medicinal
ul. Wojska Polskiego 71B
Poznan, Poland
Zip/Pin Code: 60-630

Kitozan biofertilizer

We have five years' experience to produce Kitozan which we helped people to save environment and produce organic fruits and vegetable to feed people. which Low cost and fast result. We had more than 3 million user in Thailand.

Area of Application:

Biotechnology

Advantages:

- It can use with any chemical and fertilizer.
- It can mix with water and feed for animal.

Environmental aspects:

- Cleaner Production
- Waste utilization
- Energy efficiency
- Systems integration
- Not Applicable

Development Status:

Fully commercialized

Legal Protection:

- Trade Mark
- Copy right

Transfer Terms:

- Turnkey
- Others

Target Countries:

Worldwide

Contact:

Aloe Life Co.,Ltd Thailand
24/548 Vibhawadee Road Donmuang
Bangkok 10210
Thailand

Polyphenols from dried plant materials

We are looking to identify new processes or technologies which are able to effectively remove/extract proteins and/or polyphenols from dried plant materials, with the aim of using the remaining material in a consumable product. The currently used extraction process is technically difficult to scale up for commercial supply and uses large quantities of water making it unsustainable for long term use. The desired technology for this protein extraction can be physical, chemical or biological but should fulfil the following criteria:

- High yield of the remaining material after the extraction process
- Simple and potential to be an economic process
- Preferably the original form of the plant material is maintained after the process, but this is not critical.
- The plant material must be suitable for human contact at the end of the process

Area of Application:

Consumable product

Transfer Terms:

- Joint venture
- Technical services
- Technology licensing

Project Type:

New idea

Target Countries:

Worldwide

Contact:

Strategic Allies Ltd.

*The Red & White House 113, High Street Berkhamsted, U.K HP4 2 DJ, Berkhamsted HP4 2DJ
United Kingdom*

Syringe making plant

An Indian firm is interested in setting up a Syringe making plant. They need consultancy and price quotes for this project.

Area of Application:

Pharma industry

Project Type:

Start-up

Contact:

Mr. M.K.Sharma

Shree Cement Limited

Bangur Nagar, Beawar - 305901

Tel: +91 - 01462 - 228101 to 05

Fax: +91 - 01462 - 228117 to 19

E-mail: sharmamk@shreecementltd.com

Magnetized Fertilizer from Fly Ash

An Indian firm is interested in the technology for production of magnetized fertilizer from fly ash. The company wants the technical know-how for this technology and wish to receive technical and price quotes for the same.

TECHNOLOGY REQUESTS

Area of Application:

Agriculture industry

Project Type:

Start-up

Contact:

Biocare India Pvt Ltd.

Biocare House, M. A. 23,

Laxminagar Nagpur - 22

Tel:- +91-712 - 2224344,

Telefax :- +91-712 - 5611766

E-mail: info@biocareindia.biz

Ethanol Production Plant

We are looking for a potential partner who can provide small scale Ethanol production plant.

Area of Application:

Ethanol from sweet shorgum/sugarcane

Studies:

- Techno feasibility report

Project Type:

New idea

Target Countries:

India

Assistance from Partner:

Complete Plant on turnkey basis and equity partner

Contact:

Yugal Green Urja Solution private Limited

F-103, IRWO Classics,

Rail Vihar, Sector 57

Gurgaon 122004, India

Shoe manufacturing system or machine

We are looking for the technology that can help us to produce shoes. We also want to know detail of the technology such as, specification, price, etc.

Area of Application:

Textile industry, Manufacturing industry, Shoe manufacturing industry

Transfer Terms:

- Consultancy
- Joint venture
- Equipment supply

Project Type:

Start-up

Target Countries:

Worldwide

Contact:

Textile Development Co., Ltd.

bol Bansuan, Muang, Chonburi

Thailand 20000

Asia-Pacific Tech Monitor

Readers are requested to complete the Response Form to the best of their knowledge/opinion and return it to APCTT by fax or email. We look forward to your cooperation to serve you better.

Technology Intelligence
Asian and Pacific Centre for Transfer of Technology (APCTT)
C-2 Qutab Institutional Area, New Delhi -110016, India
Fax: +91) (11) 26856274, Email: sahus@un.org, dasm@un.org

I read Tech Monitor

Always Often Sometimes Never

1. I find the design and layout of the Tech Monitor

Excellent Very Good Good Not Good

2. I find the language used in the Tech Monitor

Easy to understand Little difficult to understand Difficult to understand

3. I find the Tech Monitor

Very valuable Generally valuable/interesting Somewhat valuable/
interesting

Little value No value

I read Tech Monitor because I appreciate

Technology Market Scan Technology Scan Special Feature (articles)
 Tech Events Technology Opportunities Business Coach

4. I find the following sections

	Very useful	Useful	Less useful	No use
Technology Market Scan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Scan	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Special Feature (articles)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tech Events	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technology Opportunities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Business Coach	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Tech Monitor facilitated/contributed to:

- Understand issues related to technology development and transfer
- Enhance my knowledge on latest technological developments and events
- Identity technology/business partners
- Negotiate technology/business transactions
- Establish contact with institutions/authors/experts
- Conclude a technology transfer
- Acquire a technology
- Selling a technology
- (Any other, please specify)

6. **To get similar information, I read other periodicals like:**

7. **I would like Tech Monitor to cover the following:**

About Myself

Name:

Gender: Female Male

Nationality:

Profession:

- Policy Maker Small and Medium-sized Enterprise (SME)
 Consultant Financier Researcher
 Professor/ Teacher Student Others (Please specify)

Contact details:

Organization:

Designation:

Street Address:

P.O Box:

Country:

Telephone:

Fax:

E-mail:

Website:

Note: *The survey results would be used for APCTT's internal purposes only.*

Selected Analytical Reports and Technology Platforms & Databases of APCTT

Analytical Reports (available online)

1. National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for Making Sustainable Energy Options Affordable and Accessible (For Indonesia and Lao People's Democratic Republic), January 2014
http://apctt.org/nis/sites/all/themes/nis/pdf/National-assessment-framework_-final_ESCAP.pdf
2. Report on the National Assessment Framework of Enabling Environment and Technology Innovation Eco-system for Making Sustainable Energy Options Affordable and Accessible – Indonesia, May 2014
http://apctt.org/nis/sites/all/themes/nis/pdf/Indonesia_Report-on-National-Assessment-of-Sustainable-Energy_optimized.pdf
3. Indonesia National Sustainable Energy Strategy Report on Enabling Environment and Technology Innovation Ecosystem for Affordable Sustainable Energy Options, May 2014
http://apctt.org/nis/sites/all/themes/nis/pdf/Indonesia-National-Strategy-Report_final.pdf
4. Report on the National Assessment Framework of Enabling Environment and Technology Innovation Ecosystem for Making Sustainable Energy Options Affordable and Accessible - LAO PDR, May 2014
http://apctt.org/nis/sites/all/themes/nis/pdf/Lao_Report-on-National-Assessment-of-Sustainable-Energy.pdf
5. Lao People's Democratic Republic National Sustainable Energy Strategy Report on Enabling Environment and Technology Innovation Ecosystem for Affordable Sustainable Energy Options, May 2014
http://apctt.org/nis/sites/all/themes/nis/pdf/Lao-National-Strategy-Report_final.pdf
6. National Innovation System (NIS) training manual - "NIS Diagnosis and STI Strategy Development to Achieve National Sustainable Development Goals", 2016
<http://apctt.org/nis/sites/all/themes/nis/pdf/NIS%20Training%20Manual.pdf>

Technology Platforms and Databases

1. APCTT's Technology4SME Database
The Technology4SME Database serves as an online platform for information exchange on the availability and sourcing of technologies for small and medium enterprises in countries in the Asia Pacific region.
<http://apctt.org/technology-transfer>
2. Renewable Energy Technology Bank
The primary objective of the Renewable Energy Cooperation-Network for the Asia Pacific (RECAP) established by APCTT is to facilitate technology transfer cooperation among countries in the Asia-Pacific region in the area of renewable energy. RET-Bank provides tested and proven renewable energy technologies (RETs) initially in the areas of solar, biomass, wind, mini-hydro power and geo-thermal energy.
<http://apctt.org/recap/renewable-energy-technology-bank>
3. Global Technology Databases
APCTT has compiled a list of global as well as country-wise technology databases that deal with the technology transfer related services for SMEs and entrepreneurs.
<http://apctt.org/apitude/>

Techmonitor.net

The website for YOU to

- Network with your potential technology partners
- Explore technology and business opportunities
- Know latest technological developments in

- Biotechnology
- Waste Technology
- Non-Conventional Energy
- Food Processing
- Ozone Layer Protection

- Read articles on

- Technology Trends
- Technology Markets
- Technology Transfer

- Gain knowledge on

- Start-up venture creation
- Venture financing
- Innovation management
- Technology transfer
- Green productivity

Website managed by

Value Added Technology Information Service
Asian and Pacific Centre for Transfer of Technology
New Delhi, India