April 2014

TECHNOLOGY

Asian Outlook on Engineering and Technology

Global Trends:
Green Technology

Sustaining Ethical Aquaculture Trade

A New Paradigm for Sustainable Urban Tourism

Water Treatment : The Clean Green Way

Biotechnology for Sustainable and Healthy Food Production

Smart Grid: A Vision of Future Energy

SPECIAL FEATURE: AIT Technology Event

[Green Technology]

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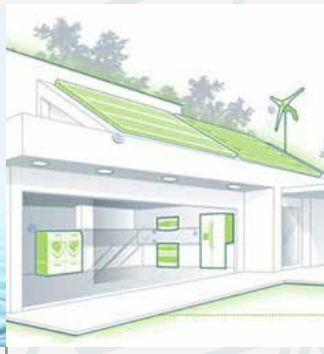

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Editorial

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DEAR READER

In this issue of "Technology", we focus on providing a glimpse of the ongoing global movement for Green Technology through selected research and ideas, all with a distinctly Asian outlook.

This issue covers original research work and results, overviews and opinions, and news covering a wide spectrum of niche knowledge areas such as biotechnology, sustainable production, and tourism, together with the revolutionary potential of smart grids. We also illustrated some of AIT's contribution to sustainability by featuring the Center of Excellence in Sustainable Development in the context of Climate Change (CoE SDCC) and an innovative Living Laboratory concept that is increasingly gaining momentum.

Several recent projects addressing seismic evaluation and building code requirements as demonstrated through the use of advanced techniques and sophisticated tools are also highlighted as a precursor to next issue's theme on disaster resilience.

As a forum for professionals and researchers to share and disseminate contributions to the technological development of the Asian region, it is hoped that this issue will stimulate open discussions and support making informed decisions on the some pressing issues we face today.

I would like to thank all the contributors for their generous involvement to ensure that what we do is communicated in the hopes that it will add to green progress.

And lastly, I would like to extend my sincerest invitation to join us in making this publication useful and valuable by sending us your feedback, contributing your own articles, achievements, and opinions on matters relevant to the true advancement of Asia.

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Global Trends: Green Technology

By Brahmanand Mohanty

"Green", just like sustainability, has become the buzzword today. Though some people tend to interpret green by the color between the blue and yellow in the spectrum, green has a very different connotation for those who are concerned about how our planet earth can continue to thrive and flourish indefinitely without compromising the ability of the future generations to meet their own needs.

Global Trends: Green Technology

"Green", just like sustainability, has become the buzzword today. Though some people tend to interpret green by the color between blue and yellow in the spectrum, green has a very different connotation for those who are concerned about how our planet earth can continue to thrive and flourish indefinitely without compromising the ability of the future generations to meet their own needs.

Green is intimately connected with the key pillars of human development: the economy, society, and the environment. Sustainability cannot be guaranteed if any of the three pillars is neglected or weakened. Green solutions that will be universally acceptable are those that are comprehensive in nature and are likely to achieve win-win outcomes. Moreover, there is no single silver bullet that can help us attain the green goal. A combination of a number of solutions is needed, and green technology happens to be just one among the many solutions.

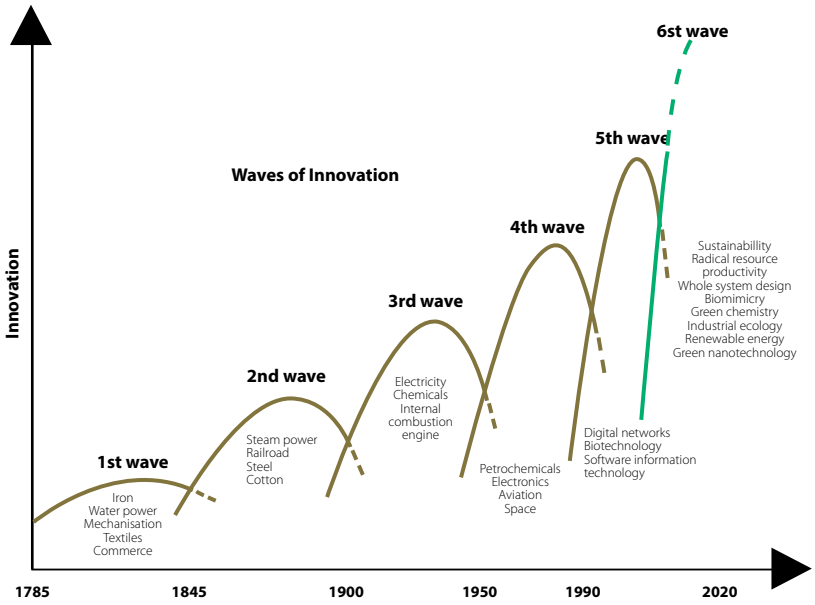

Figure 1: *Cycles of technological innovations*
Source: Ernst von Weizsacker et al, 2009

Waves of Technological Innovations

Since the beginning of the industrial innovation, the human race has witnessed several waves of technological innovations. As each wave ushered in new innovations, there was fading excitement with the old technologies, and a rising demand for affordable supplies of new goods and services. In the initial period, this wave lasted for 50-60 years, but with the advent of new exciting technologies, the duration of such waves of innovations reduced over time. The early mechanization cycle (water power, textile, and iron) during the 1780s gave way to steam power (steam, railway, and steel) in the 1840s, electricity and heavy engineering technologies (chemicals and internal combustion engines) in the 1900s, followed by the automobile and mass production cycle (petrochemicals, electronics, and aviation) in the 1950s, and the information and communication cycle (digital network, information technology, and biotechnology) in the 1990s. We are now witnessing a new wave of innovation that is distinctly different from the previous ones, the 6th wave of innovation or the "green" Kondatriev cycle named after the Russian economist who introduced the notion of the cycles of technological innovations.

While the waves of technological revolutions brought about huge changes in the lives of human beings, their comfort and well-being, there were clear signs that not everything was going well. As the world became more and more aware of the impacts of human activities on the global environment, two important factors emerged: we were consuming our earth's precious resources at a much higher rate than nature could replenish, and our industrial activities have resulted in phenomenal growth in carbon dioxide emissions, leading to global warming. With a consumption pattern that is likely to result in the bankruptcy of natural resources, we are now faced with the dual challenge of exceeding our biological footprint and contributing to climate change.

The Challenges We Face at This Juncture

Let us have a look at the challenges the humanity faces at present. The world population crossed 7 billion in 2011 and the U.N. Population Division projects the world population to exceed 9.5 billion by 2050, with 58% as Asia's share.

A recent study conducted by CSIRO (Australia) in collaboration with UNEP shows that the domestic materials consumption for the Asia-Pacific region has increased from 6.2 billion tons in 1970 to 37.8 billion tons in 2008, surpassing the rest of the world in 2005. The modest impact of the global financial slowdown on the rate of per capita domestic materials consumption reinforces the belief that there is little evidence for a tendency towards the dematerialization of growth in the Asia-Pacific region. While the population grew at a rate below 2% per annum, the extraction of four major categories of primary materials has increased significantly over the period 1970-2008: the construction minerals consumption increased 12-fold, metal ores and industrial minerals 8-fold, fossil fuels 6-fold, and biomass almost doubled. Growing affluence along with increasing materials intensity appears to be the most important driver of growing extractive pressures on the environment, while population growth is seen as the least important driver. This means any efforts to stabilize the exploitation of natural re

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sources will need to address not only materials intensity but also affluence, as stabilizing population is unlikely to grant much reprieve from growing environmental pressures.

Green Technology as an Integral part of the 6th Wave of Innovation

All the human and material progresses that we see today are the fruits of successive technological innovations. However, the scientific community has emphatically proved the strong correlation between our industrial activities and the increase of carbon dioxide concentration in the earth's atmosphere. The onus is now on us to make use of our technological prowess for seeking and adopting corrective measures in order to handle the problems we created. There is also the realization that maintaining status quo is not the answer; we need to go beyond and create a regenerative system that assists Nature in sustaining the growing population.

So what are the solutions we need to preconize? The industrial development model we adopted at the beginning of the industrial revolution needs to be revisited. At that time, our population was less and our natural resource base was very large. Today the situation has radically changed as we have to hunt further and deeper for the limited natural resources in order to meet the need of a vast population base. There is growing realization that technologies that were mobilized to exploit the resources for satisfying human needs are grossly inefficient.

Consider these facts: less than 3% of the energy in fossil fuels we consume keeps us comfortable in hot or cold climates, and less than 1% of the energy in gasoline or diesel moves us in an automobile. We can no longer afford to use our finite resources in such a wasteful manner and have to innovate in order to achieve dramatic improvement in the overall resource conversion efficiencies. Examples of technologies that are already helping us move in this direction include LED (Light Emitting Diodes) that are able to provide the desired level of lighting by dividing the energy input by a factor of 8 to 10, and the modern modes of transportation that able to move us from one point to another much faster and in utmost comfort while using only a fraction of energy that is needed for individual cars.

Nature Leading the Way

With the passage of time, we have realized that Nature is in fact a great innovator and we would benefit immensely if human technological innovations could be inspired by the way nature is able to maintain symbiotic relationships and eliminate altogether the notion of "waste" (waste of one specie being the food for another). By observing Nature carefully, scientists are able to imitate Nature's ways and redesign industrial systems to help us eliminate the very notion of waste and facilitate the shift towards "closed loop" models and "circular economy". According to the Ellen MacArthur Foundation, a circular economy ensures enhanced flows of goods and services by seeking "to rebuild capital, whether this is financial, manufactured, human, social or natural". The circular economy follows 4 basic principles:

- Create continuous cycles of both biological and technical 'nutrient' (products made from pure components that can be easily dissembled and used to create new products)
- Energy of the system must come from renewable sources

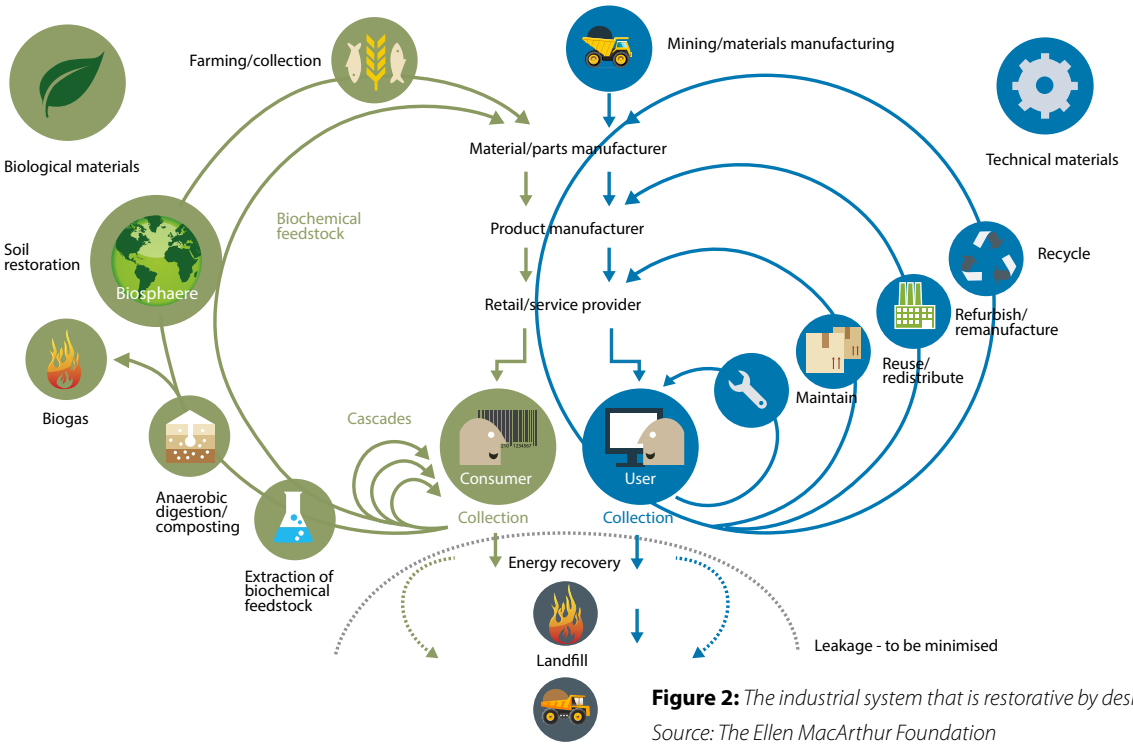


Figure 2: *The industrial system that is restorative by design*
Source: The Ellen MacArthur Foundation

- Prices should reflect the real cost of our activity
- Systems should reflect the idea that in nature all of the interdependencies feed into and benefit from one another

The system diagram (Figure 2) illustrates the continuous flow of technical and biological materials through the 'value circle'.

Examples of Biomimetic Approaches

There are many examples of the application of biomimetic approaches that have changed the way we think and innovate. The Eastgate Centre in Harare, Zimbabwe's largest office and shopping complex is an architectural marvel in its use of bio-mimicry principles. The building has no conventional air-conditioning or heating, yet stays regulated year round with dramatically less energy consumption using design methods inspired by indigenous Zimbabwean masonry and the self-cooling mounds of African termites. While the outdoor temperature changes throughout the day, the inside of a termite mound holds steady at a temperature that is comfortable for the termites.

The tubercles on the leading edge of humpback whale flippers help them to glide through the ocean with greater ease. By studying the bumps on the humpback whale's flipper against the smooth flipper found on other whales, scientists have estimated 32% less drag and 8% rise in lift from the bumpy model. This idea has been applied to wind power in order to increase efficiency.

Water is a scarce commodity in deserts. The *Onymacris ungulcularis* is a beetle found in the Namibian desert that has the most unique way of procuring water. When the dew-enriched fog settles over the dunes early in the morning, the beetle goes to the peak and positions its body in such a way that it helps in dew formation, and slurps up the water thus formed. Engineers have imitated the technique to create the "Dew Bank Bottle" that is ideal for the nomads in the desert. The steel body helps to assimilate the morning dew and channel it into the bottle immediately.

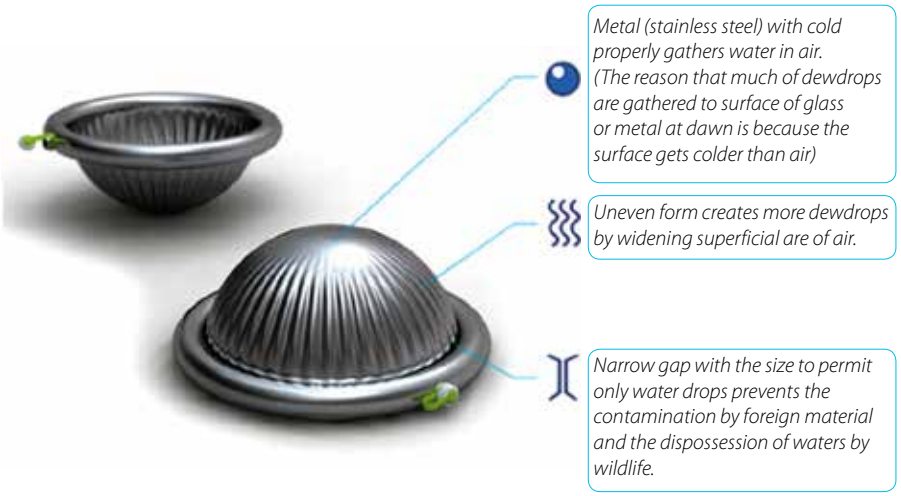


Figure 3: *Dew Bank bottle designed by Kitae Pak*
Source: Yanko Design

By using similar concept, architects can design dome shelters in deserts to capture sufficient amount of water and meet the basic water need of the population lacking access to clean water.

Can Green Technology Become the Panacea to All Our Ills?

Being aware of the fact that it is the growing affluence and not the population growth, which is the most important driver of growing extractive pressures on the environment, it would be a fallacy to believe that green technology alone can solve the key challenges that the humanity faces today. Growing affluence, per se, is not negative, especially in an inequitable world where two-thirds of the population is at the base of the wealth pyramid with only a paltry share of around 3.3% of the global wealth. But along with the growing affluence of those at the base of the pyramid, there is an urgency to make a clear distinction between the "need" and "greed", with the growing knowledge that we live in a planet with finite resources that should not be exploited and regenerated to continue sustaining the human race on earth.

References

Weiz sacker, Ernst von et al (2009) Factor Five: Transforming the Global Economy Through 80% Improvements in Resource Productivity : a Report to the Club of Rome, Earthscan

The Ellen MacArthur Foundation (July 2013) http://www.ellenmacarthurfoundation.org/circular-economy/circular-economy/interactive-system-diagram

Yanko Design (May 2010) http://www.yankodesign.com/2010/07/05/beetle-juice-inspired/

Natural Disasters in Asia

Natural disasters are extreme, sudden events caused by environmental factors that kill or injure people and damage property. Earthquakes, floods, eruptions, and typhoons all strike anywhere on earth, often without warning. These are some of the biggest natural disasters that hit Asia in 2013.

Typhoon Haiyan

September 2013

Super typhoon Haiyan made history in the Philippines as the deadliest natural disaster to ever hit the calamity-prone country with winds up to 190-195 mph, making it the fourth most intense tropical cyclone ever observed in the world.

The typhoon, known in the Philippines as Yolanda was the strongest ever recorded, it surpassed the record of the previous deadliest Philippine storm, Thelma, in which about 5,100 people died in the central Philippines in 1991.

It was late evening of 7 November when Haiyan sent storm surge and merciless winds rampaging across a huge chunk of the archipelago. One survivor akin her experience to a scene in the movie Titanic on the morning of 8 November, "the winds were banging on every side of the house. It had this shrill and scary sound to it that gave us goose bumps. The water was coming in fast - too fast. It was already knee level and we knew that it would be deeper outside. But we couldn't go outside, it was too dangerous. The winds were too strong and debris were flying around," she painfully recalled.

In the aftermath of Haiyan, the scale of destruction is so immense in Tacloban that the local government was unable to respond fast. There were scenes of mayhem as starving survivors broke into shops, homes, and gasoline stations. Before and after photos of the hardest hit areas swamped the internet sending signals to the world that the Philippines badly needed help.

On 11 November, Philippine President Benigno Aquino issued Presidential Proclamation declaring a state of national calamity.

As of 12 December, the total number of casualties reached 5,982 and the total cost of damaged is roughly estimated to $810 million according to the National Disaster Risk Reduction and Management Council. United Nation's experts estimate that it will take years to restore infrastructure and rebuild the community in Tacloban.

Sources: The Philippine Inquirer, Agence France-Presse, The Guardian

Typhoon Usagi

September 2013

A powerful storm hit the Western Pacific and smashed into Hong Kong and Southern China after sweeping past the Philippines and Taiwan, leaving a trail of destruction in its wake.

Typhoon Usagi, characterized by meteorologists as the strongest storm in the world this year caused massive destruction that killed at least 33 people in Asia. It was classified as a severe typhoon with winds of 175 kilometers (109 miles) per hour and gusts of up to 213 kph (132 mph).

In China, 25 people were reportedly killed in worst-hit city, Shanwei where winds blew cars off the road near a gas station and houses were toppled which led to the evacuation of thousands of people and widespread electricity outages.

Philippine officials reported eight casualties from drowning and landslides while Taiwan authorities said nine people were hurt by falling trees.

On 22 September, the super typhoon forced hundreds of flight cancellations and shut down shipping and train lines when it began pounding Hong Kong. Hundreds of arriving and departing flights were cancelled in Hong Kong International Airport and Ferry services between Hong Kong and nearby Macau and outlying islands were also suspended as the observatory raised the warning to No. 8 storm signal, the third highest on a five-point scale.

On 21 September, the Philippine government raised its storm warning to its highest level since 2010, according to the Wall Street Journal; while China's main meteorological service issued a "red alert" as Usagi veered towards southern China, particularly in Guangdong province, as well as neighboring Fujian province. The official Xinhua news agency reported that more than 44,000 fishing boats were asked to return to port in Guangdong while Fujian Province evacuated more than 80,000 people from flood-prone areas and deployed 50,000 disaster-relief workers.

In Taiwan, more than 3,300 people were evacuated from flood-prone areas and mountainous regions. The storm also caused a landslide that buried a rail line on Taiwan's southeast coast.

Sources: Reuters , The Guardian

Top Five Most Powerful Earthquakes in Asia in 2013

Rank	Date	Location	Magnitude	Death Toll	Depth (km)
1	24 September	Balochistan, Pakistan	7.7	825	20
2	15 October	Bohol Island, Philippines	7.2	222	20
3	20 April	Lushan County, China	6.6	193	12
4	22 July	Gansu, China	6.6	95	20
5	2 July	Aceh Indonesia	6.1	35	10

Bohol Earthquake

October 2013

A magnitude-7.2 earthquake hit three of the most popular tourist destinations in the Philippines: Bohol, Cebu, and Siquijor, on 15 October, killing at least 200 people, displacing more than 10,000 families and severely damaging some of the country's historic churches dating from the Spanish colonial period.

The Philippines' oldest church, the 16th century Basilica of the Holy Child in Cebu lost its bell tower. A 17th-century limestone church in Loboc town, crumbled to pieces, with nearly half of it reduced to rubble. Two other churches in Maribojoc and Loon were destroyed while churches in Loay, Clarin, and Baclayon as well as the belfry in Panglao were also damaged.

There were 134 reported deaths in Bohol province, while at least 15 died in nearby Cebu and one in Siquijor. The number of injured rose towards 300, with at least 23 people still missing.

In Cebu City, a number of people died when two buildings and a fish port crumbled, as did the roof of a mall under construction. Five people were crushed to death and eight were injured after a stampede caused by a crowd rushing to evacuate a gym in Cebu.

At least 250 patients of Cebu City Medical Center (CCMC) were evacuated after cracks were found in the hospital. Most of the patients were relocated to the nearby gym while others stayed under the tents placed on the sidewalk near CCMC.

Photos and videos flooded the social media showing extensive damage to old churches, roads and bridges, modern buildings, and schools, and the very famous Chocolate Hills in Bohol. The news about the quake spread quickly over Twitter and Facebook as office and schools were closed the day of the quake as it was a national holiday, Muslim festival of Eid al-Adha, in the Philippines.

On 16 October, Cebu declared a state of calamity and suspended classes in both private and public schools to allow school officials to inspect the buildings.

The Philippine Institute of Volcanology and Seismology (PHIVOLCS) recorded 1,300 aftershocks, 28 of which were felt and the strongest of which was magnitude 4.3. According to PHILVOLCS, the movement of the East Bohol Fault triggered the strongest quake in the Visayas in 23 years. The U.S. Geological Survey initially reported the quake as having a magnitude of 7.2, but shortly afterward lowered it to 7.1.

Sources: Huffington Post, Reuters, Daily Mail, BBC News, and The Guardian

7.7-magnitude Earthquake in Pakistan

September 2013

A powerful 7.7-magnitude earthquake struck north-east of Awaran in Pakistan and killed at least 328 people, wounding hundreds more in Pakistan's remote south-west province of Balochistan.

The disaster hard-hit the remote province, a conflict zone where separatists and government troops have been fighting for years. Many houses were flattened and thousands of people spent the night in the open. Most of the victims were killed when their houses collapsed. Walls of the mud brick houses were destroyed and people gathered outside because they had no homes to sleep in.

Balochistan is Pakistan's largest province in terms of land area but also the least populated and most impoverished. Relief and rescue operations encountered difficulty reaching the distant villages due to poor infrastructures and bad road conditions.

After the quake, a mountain-like island (pictured above) appeared off the coast near the port of Gwadar. Experts say the island was formed when the massive quake shook a deposit of natural gas trapped below the surface. The small island appeared 600 metres off Pakistan's Gwadar coastline in the Arabian Sea.

Sources: ABC News, Daily Mail, Fox News, and BBC News

Killer Earthquakes in China

April 2013

In April 2013, a powerful earthquake struck China's south-western Sichuan province leaving at least 190 people dead and more than 2,600 injured, nearly five years after a devastating quake caused widespread damage across the region.

The earthquake toppled buildings, prompted landslides, and caused phone and power outages in the mountainous Lushan county, the worst-hit area, which is prone to earthquakes as it is situated where Sichuan plain meets foothills leading to the Tibetan plateau, and sits atop the Longmenshan fault.

The 6.6-magnitude shock is believed to have been on the same fault as the 2008 killer earthquake with 7.9 magnitude that left 70,000 dead and another 18,000 missing in the province.

In July, another magnitude 6.6 earthquake jolted another mountain region in south-west China with at least 90 people reported dead and 887 were injured. The epicenter was calculated to be 34.5 north and 104.2 east, which is about 15 km from the Minxian County, 45 km from the Zhangxian County, 120 km from the Dingxi City and 170 km from Lanzhou, Gansu's provincial capital.

According to official reports, about 123,000 houses collapsed or severely damaged, while 138,000 houses were damaged to varying degrees, leading to direct economic loss of 3.94 billion RMB.

Sources: The Guardian, Wikipedia, and Relief Web

Volcanic Eruptions in Indonesia

September 2013

Two of the most active volcanoes in Indonesia erupted in August and September, displacing thousands of people from their villages and killing six people.

In September, Mount Sinabung, the highest mountain in North Sumatra with an altitude of about 2,600 meters spewed thick ashes into the sky after being dormant in three years. More than 6,200 were evacuated and five people were hospitalized due to breathing difficulties after inhaling volcanic ashes.

Mount Sinabung, located in western Indonesia, last erupted in August 2010 killing two people and forcing 30,000 others to flee. It caught many scientists off guard after failing to monitor the volcano, which had remained quiet for four centuries.

In August, another active volcano Mount Rokatenda in East Nusa Tenggara province erupted, sending smokes of hot ash nearly 2,000 meters into the air and killing five people as torrents of molten lava poured down the volcano's slopes.

Mount Rokatenda is one of the 129 active volcanoes in Indonesia, an archipelago of more than 17,000 islands that is home to 240 million people. It has been on high alert since October 2012 as it has been showing signs of increased volcanic activity since last year. Authorities banned people from any activity within three kilometers from the crater but some villagers refused to leave including the five people engulfed by the volcanic emission.

The country's most active volcano Mount Merapi in central Java, killed more than 350 people in a series of violent eruptions in 2010.

Indonesia, the world's largest archipelago nation, is prone to earthquake and seismic tremors as it sits along the Pacific "Ring of Fire." The so-called "Ring of Fire" is a horseshoe-shaped area of fault lines stretching from the Western Hemisphere through Japan and Southeast Asia where a large number of earthquakes and volcanic eruptions occur in the basin of the Pacific Ocean.

Sources: The Guardian

North India floods: Worst Natural Disaster since 2004 Tsunami

June 2013

In June 2013, the Northern India state of Uttarakhand experienced the worst floods and landslides in the country since the great Indian Ocean tsunami in 2004.

At least 5,700 people were "presumed dead" with more than 4,000 missing and 110,000 people displaced when the deadly flood ravaged northern India and neighboring Nepal after experiencing heavy rainfall from 14 to 17 June 2013. The downpour triggered the melting of Chorabari Glacier, with a height of 3800 metres, and the outburst of the Mandakini River.

Hundreds of roads and bridges were destroyed that left about 100,000 pilgrims and tourists trapped in the valleys leading to three of the four Hindu Chota Char Dham pilgrimage sites. This also made the job of rescue workers all the more difficult.

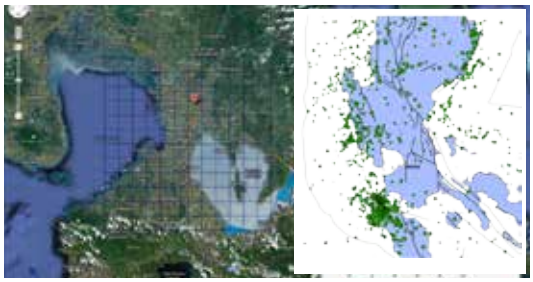
In the latest update from The Economic Times, the maximum number of people reported missing are from Uttar Pradesh (1,150), followed by Uttarakhand (852), Madhya Pradesh (542), Rajasthan (511), Delhi (216), Maharashtra (163) , Gujarat (129), Haryana (112), Nepal (92), Andhra Pradesh (86), Bihar (58), Jharkhand (40), West Bengal (36), Punjab (33) Chhattisgarh (29), Orissa (26), Tamil Nadu (14), Karnataka (14), Meghalaya (6), Chandigarh (4) Jammu and Kashmir (3), Kerala (2), Puducherry (1) and Assam (1). The list was verified in consultation with top authorities in India and Nepal.

Uttarakhand, known for its natural beauty of the Himalayas, borders the Tibet Autonomous Region on the north; the Mahakali Zone of the Far-Western Region, Nepal on the east; and the Indian states of Uttar Pradesh to the south and Himachal Pradesh to the northwest.

Sources: The Hindustan Times, The Economic Times

In focus: Selected Projects

Probabilistic Seismic Hazard Map for Manila, Philippines



Client	Sy^2 + Associates Inc.
Location	Philippines
Project Description	Development of a probabilistic seismic hazard map for the greater Manila metropolitan area

The Philippines is a seismically and volcanically active region where damaging earthquakes are annual occurrences. The greater metropolitan area of Manila, Luzon, is the largest urban center, with a population of more than 11 million. The seismically-active Marikina Valley fault system (MVFS) near Manila is a significant seismic source to the city and the region.

In order to gain a better understanding of the seismic activity of the region, Sy^2 + Associates initiated a project to develop a probabilistic seismic hazard map for greater Manila. The data from the seismic maps could be used as a future reference for structural engineers or professionals to determine the level of seismic intensity of the area on which they plan to construct a building/structure and would aid in developing more structurally reliable building designs using the latest international design codes.

AIT Consulting in coordination with the Regional Integrated Multi-Hazard Early Warning System (RIMES) center, located at the Asian Institute of Technology (AIT); and the Structural Engineering program at AIT assisted Sy^2 + Associates to develop the hazard maps. RIMES is an international and intergovernmental institution, owned and managed by its member states, for the generation and application of early warning information regarding natural disasters. Since its establishment in 2009, RIMES has been operating from its regional early warning center at AIT to support the needs and demands of its member states and enhancing capacities for end-to-end multi-hazard early warning.

Project Outcomes

The development of probabilistic seismic hazard maps was accomplished by using the same procedures developed for the formation of the latest United States' national seismic hazard maps. The maps were developed based on the combination of smoothed gridded seismicity, crustal-fault, and subduction source models. The probabilistic seismic hazard assessment quantifies the hazard at a site from all earthquakes of all possible magnitudes, at all significant distances from the site of interest as a probability by taking into account their frequency of occurrence.

A special desktop application for seismic hazard assessment was also developed for the greater Manila metropolitan area. The program displays a graphical and tabulated seismic response spectrum of selected locations within the boundary grid maximizing access to accurate maps procured from reliable sources.

Incorporating Environmental Sustainability and Disaster Resilience into Myanmar's National Building Code

Client	United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
Location	Myanmar
Project Description	Review of Myanmar's structural building codes, including wind design criteria, seismic design criteria, and other criteria relating to concrete, steel, masonry, and design

Introduction

In an attempt to prioritize protection against uncertain occurrences of the two most common natural disasters in Myanmar: earthquakes and strong winds, the Ministry of Construction (MOC) and its technical partner the Myanmar Engineering Society (MES) have been working towards developing and enforcing proper and stricter building codes through the Myanmar National Building Code (MNBC) project. The ministries are drafting the code in accordance with ASEAN building standards to bring Myanmar in line with neighboring countries and improve the structural elements of the buildings in the country.

The United Nations Human Settlements Program (UN-HABITAT) is leading this project and has selected various regional and international experts and institutions to review the seven different parts: 1) planning, environment, administration and legislation, 2) architecture and urban design, 3) structure, 4) soil and foundation, 5) building services, 6) materials and construction practices, and 7) safety. The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) together with the technical assistance of the Asian Institute of Technology (AIT) through AIT Consulting, were tasked to review the third section on structure, which included wind design criteria, seismic design criteria, and other criteria relating to concrete, steel, masonry, and design.

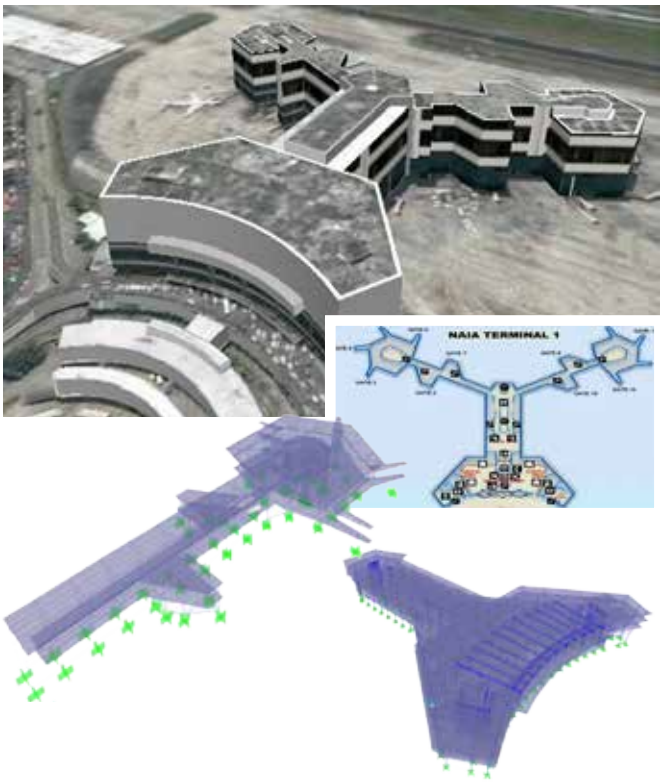
Project Outcomes

Findings identified that both challenges and opportunities exist in the process of developing the code for Myanmar. In terms of challenges, it was determined that no existing building code could be used as a starting point for developing the code, thus the design and construction practices may not be fully developed to adopt more complex or sophisticated provisions based on recent versions of international building codes. Though perceived challenging, training professionals involved in its implementation of the code will support the technically feasibility of the development and subsequent adoption of a comprehensive code. The challenges however, presented several opportunities or advantages over other countries since starting the code with a clean-slate would mean that the new code could be developed with a clear vision and objectives, considering the particular aspects of Myanmar and incorporating the best practices and relevant provisions from other codes and experiences.

The basic approach adopted to review the draft code on structures was centered on the premise that the structural code should cover and govern the typical design process of simple buildings. The review also encompassed general observations including the reorganization of the code, compatibility among the codes, enhancement of their application and conformance, amongst others.

To further expound on the changes and benefits of the code and to further collect feedback from various stakeholders, a consultation workshop on Incorporating Environmental Sustainability and Disaster Resilience on Myanmar's National Building Code, was held at the MES Hall in Yangon, Myanmar in March 2013. The workshop was jointly organized by UN-HABITAT, UNESCAP, and AIT through AIT Consulting. Representatives from the MES involved in the MNBC Thematic Working Group together with the representatives from UNHABITAT and UNESCAP participated in the workshop. A comprehensive report was subsequently submitted by AIT Consulting on behalf of the team for MES and MOC review and further development.

Seismic Performance-based Evaluation of Ninoy Aquino International Airport (NAIA Terminal 1)



Client	Sy^2 + Associates Inc.
Location	Philippines
Project Description	Seismic performance-based evaluation of 67,000 sqm building consisting of three structurally separated parts: a main building and 2 wings

Ninoy Aquino International Airport (NAIA), also known as Manila International Airport, serves Manila and the surrounding metropolitan area. Located about seven kilometers south of Manila proper, NAIA is the main international gateway for travelers to the Philippines and is the hub for Philippine Airlines. The airport is managed by the Manila International Airport Authority (MIAA), a branch of the Department of Transportation and Communications (DOTC) and consists of four terminals, 1, 2, and 3, which oversee international travelers, and 4 serving local carriers.

The Philippines is located in an area of high seismicity, due to the active motion of the tectonic plates located on both sides of the Philippine archipelago. Manila, and its surrounding region, is located in a high seismic hazard zone, making it probable that large-magnitude and high-intensity earthquakes may occur.

The airport's Terminal 1, which has a capacity of 4.5 million passengers per year, is NAIA's oldest terminal constructed in 1981. Back then, the buildings' construction could not have considered the current seismic National Structural Code of the Philippines, NSCP (2001), and thus was not initially built to withstand the immense effects that could follow if an earthquake were to strike.

In an attempt to evaluate the structural performance of the building, to ensure the protection of life, and minimize the interruption of essential services in post-earthquake events; AIT Consulting through Sy^2 + Associates, Inc., Philippines was invited to carry out the Seismic Performance-based Evaluation of Terminal 1.

Seismic performance evaluation ensures that during a defined earthquake, no damage beyond the acceptable limits occurs in any part of the structure and is assessed by designating the maximum allowable damage state (performance level) for an identified seismic hazard.

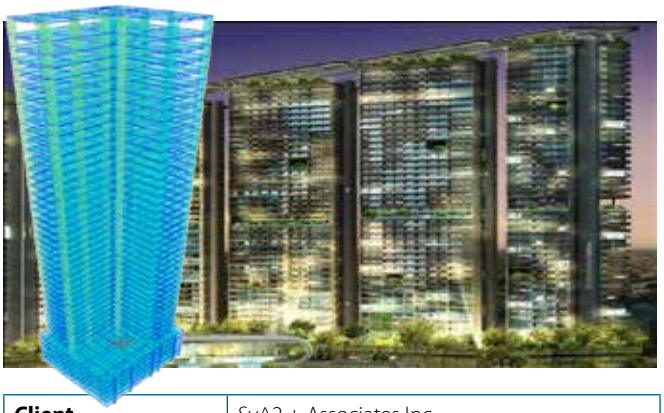
A preliminary evaluation of the terminal was conducted where the overall response and behavior of the structural systems were checked, followed by a detailed evaluation, achieved by a nonlinear seismic analysis.

Project Outcomes

Global response of the building as well as the deformation capacity and the strength of primary structural elements were checked against the demand forces under a 2475-year return period earthquake. Global structural stiffening as well as local strengthening scheme was applied to enhance the performance of structural system. Buckling restrained braces (BRB) and restraining walls were added at appropriate locations to stiffen the structure. The main purpose of the BRB system is to control the seismic responses through the energy dissipation due to axial tension and compression yielding of the brace.

The remaining members, which seemed to be overstressed after adding BRBs and restraining walls in the system, were retrofitted by Fiber Reinforced Polymer (FRP) retrofit technique. FRPs were used to enhance the flexural and shear capacity of girders and shear capacity of columns, while steel plates were used for the shear retrofit of shear walls.

Performance-based Evaluation of Acqua Private Residences: Niagara, Sutherland, Detifoss, and Livingstone Towers



Client	Sy^2 + Associates Inc.
Location	Philippines
Project Description	Six-tower master planned development

Aqua Private Residences is a magnificent multi-tower masterplanned development on a 2.4 hectare prime property, rising right on the water at a point where two cities meet. Developed by Century Properties Group, the 6-tower residential high-rise is accessible via a new bridge over the Pasig River in Manila. The six towers are named after some of the most beautiful waterfalls in world: the Niagara (42-stories), Sutherland (44-stories), Detifoss (46-stories), Livingstone (53-stories), Iguazu (56-stories), and Yosemite (40-stories). The first four towers are currently undergoing construction.

All six towers follow a nature-infused design and rest on 6-level podiums. The towers are reinforced concrete buildings supported by a pile foundation. The structural system of the buildings utilize a dual system, comprised of shear walls with a special moment-resisting frames, except for the Sutherland and Iguazu towers which are bearing wall systems.

Since 2010, Sy^2 + Associates, Inc., one of the leading groups of Structural Engineers in the Philippines, has been working with AIT Consulting to perform structural performance-based evaluation (PBE) of all six towers. PBE is conducted to determine whether the overall performance and reliability of the building under the effects of gravity and lateral loadings will satisfy public safety requirements. The PBE of the first four towers: Niagara, Sutherland, Detifoss, and Livingstone has been completed while the evaluation for the last two towers: Iguazu and Yosemite is ongoing.

Project Outcomes

The performance based evaluation for the six towers of the Aqua Private Residences is ongoing and is being implemented using state-of-the-art analyses tools and procedures with a special emphasis on the effects of earthquakes.

The Livingstone Tower: Sample Results

The Livingstone Tower was evaluated at the Maximum Considered Earthquake (MCE) level (2475-year return period) and at the Service Level (43-year return period) earthquakes.

Modal Analysis

Modal analysis was performed to determine the vibration modes of the building and to understand the structural behavior of the building. The combination of mass from 100% of the dead load and the superimposed dead load plus 25% of live load was considered during modal analysis. The principal direction of the building is shown in the figure below.

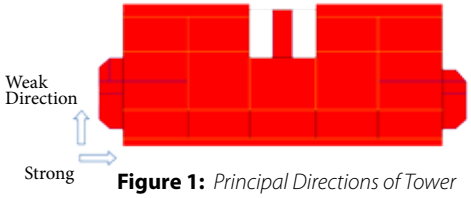


Figure 1: *Principal Directions of Tower*

It was found that 50% of the total mass was participating in the first mode of the Y-direction (Mode 1) and 58% of total mass was participating in the second mode of the X-direction (Mode 2), as shown in Table 1: Natural Period (in sec). From this table, it can be seen that the total mass participation from the first fifteen modes are 95% and 92% in X and Y direction respectively.

Table 1: Natural Period (in sec)

Mode	Natural Period	Modal participating mass ratio	
		X (%)	Y (%)
1.	5.1924	0.04%	50.56%
2.	5.1311	58.17%	0.03%
3.	3.5000	0.22%	0.00%
4.	1.6362	11.97%	0.00%
5.	1.2279	0.00%	14.60%
6.	0.9854	0.01%	0.00%
7.	0.8945	5.59%	0.00%
8.	0.6160	3.99%	0.00%
9.	0.5457	0.00%	6.80%
10.	0.4951	0.29%	0.00%

The natural periods of fundamental modes were generally acceptable as shown in Figure 2: Mode Shapes. Results showed that the first two modes are translation modes and the natural period of torsion mode is far from these translation modes, which is the preferable response under earthquakes. When the natural period of torsional mode (3rd mode) is far from natural periods of first two translation modes, the building is likely to respond in translation under earthquakes rather than provide a torsional response.

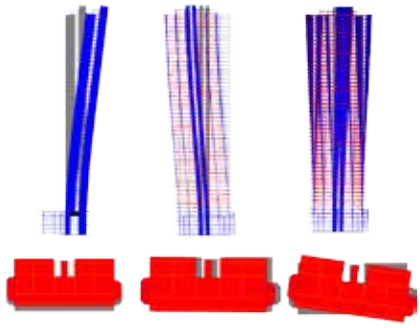


Figure 2: *Mode Shapes*

Base Shear and Base Moment

Elastic and inelastic base shears from different types of analyses were compared at the ground level and above the podium level. In the response spectrum analyses for the Design Basis Earthquake level (DBE), the elastic base shear was calculated without considering the response modification coefficient (R) to ensure an get elastic response. For the time history analysis, an average response of seven pairs of site-specific earthquake acceleration records was used. The base shear results from the wind analyses were multiplied by a load factor of 1.6 for the comparison with seismic demands.

Results show that the computed average inelastic seismic demand from nonlinear time history is about 1.7 times less than the elastic demand in Y-direction. The base moments from different types of analyses were also compared.

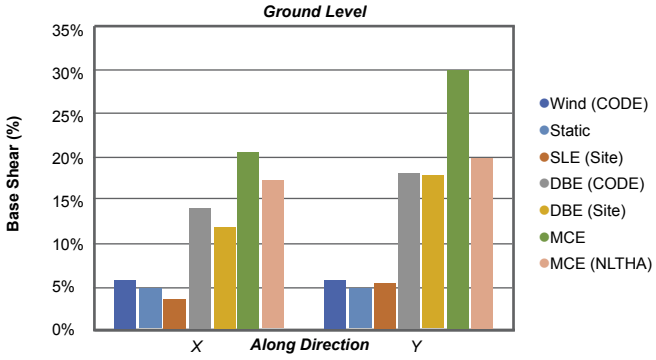


Figure 3: *Comparison of Base Shear at Ground Floor*

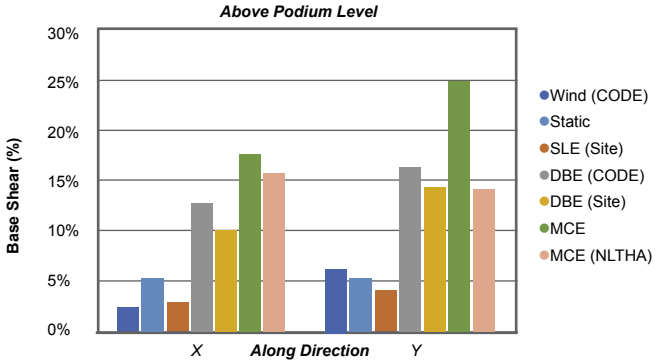


Figure 4: *Comparison of Base Shear at Podium Level (6th Floor)*

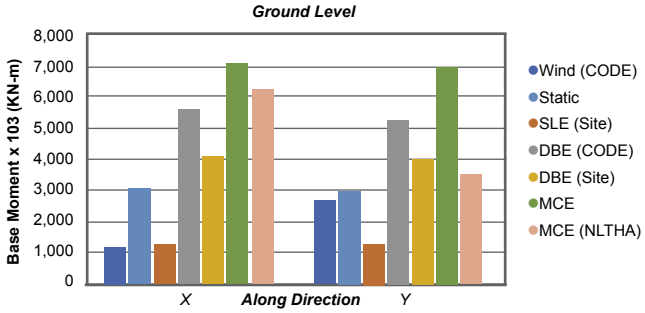


Figure 5: *Comparison of Base Moment at Ground Floor*

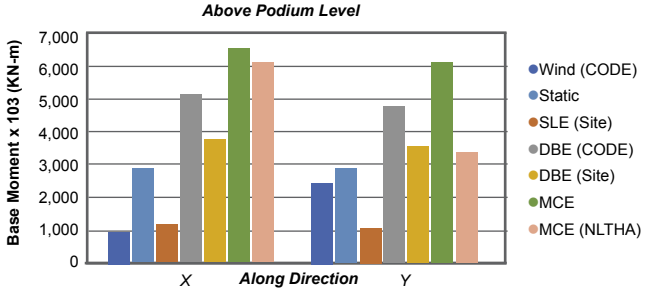


Figure 6: *Comparison of Base Moment at Podium Level (6th Floor)*

Structural Peer Review for Diamond Inya View Palace Building

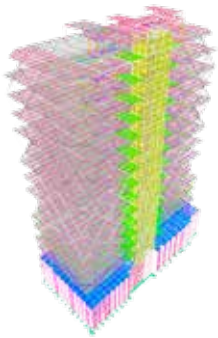
Client	Mandalay Golden Wing Construction Ltd. Co. Ltd. (MGW)
Location	Myanmar
Project Description	Structural peer review of 34-story luxury residential high rise with 106,680 sqm floor area

Diamond Inya View Palace Building, a luxurious 60 million USD residential condominium located near Inya Lake, Yangon, Myanmar, will be the tallest building in the country upon its completion at 34-stories - 9 stories higher than the current tallest building located in Mandalay.

The developer, Mandalay Golden Wing Construction Co. Ltd., (MGW) and one of the most respected construction companies in Myanmar, entrusted AIT Consulting to perform the structural peer review for Diamond Inya View Palace Building.

AIT Consulting was privileged to take part in this project by conducting a Structural Peer Review focusing on the evaluation of the structural system and design of the building with a special emphasis on conformance to building codes, standards, established engineering practices, and the effects of earthquakes and wind. The scope of work was divided into two phases: the schematic design review, followed by the structural design review.

Design Review for The Glass House



Client	Buildtrade Engineering Ltd.
Location	Bangladesh
Project Description	Design review for the construction quality and evaluation of construction progress and management for a 14-story commercial building

The Glass House by Shanta Properties, in collaboration with Buildtrade Engineering Ltd., is a 14-story commercial building in Gulshan, Dhaka featuring a striking design by an award winning architect.

Buildtrade Engineering Ltd is Bangladesh's leading diversified steel fabricator providing the construction industry with specialized services in designing, fabricating, and erecting pre-engineered steel buildings. Services encompass a wide range of fully supported steel metal roofing, cladding, galvanized structural decking, purlin, all necessary building accessories, and structural steel design.

AIT Consulting was commissioned by Buildtrade Engineering Ltd to conduct a review for the construction quality on site specifically to evaluate any design issues, construction progress and quality; provide advice on potential construction issues and solutions on planning and management. In June 2013, two experts conducted a site visit focusing on review and evaluation of construction quality, the evaluation and expert support is currently ongoing.

Quiz : BRIDGES

Part 1: True/False

1. Unlike tall buildings project, the structural engineer is the overall in-charge of a bridge project. *(True/False)*
2. Bearings do not allow independent movement of the superstructure with respect to the substructure. *(True/False)*
3. Effectively modeling of support conditions at bearing and expansion joints requires careful consideration of the continuity of each translation and rotational components of displacement. *(True/False)*
4. For continuous beams, secondary moments can be determined directly in terms of the actual cable profile using virtual work method. *(True/False)*
5. It is economical to design a bridge to resist large earthquake elastically? *(True/False)*

Part 2: Multiple Choices

1. Advantages of prestressing include:

   a. Effective use of high strength concrete and high strength steel
   b. Improved serviceability
   c. Reduced member sizes longer spans
   d. All of the above

2. Which of the following is not a modeling option for bridge deck?

   a. Beam model
   b. Grid model
   c. Thin wall model
   d. Membrane model

3. In plate element, total number of degrees of freedom per node is:

   a. 2 b. 3 c. 4 d. 6

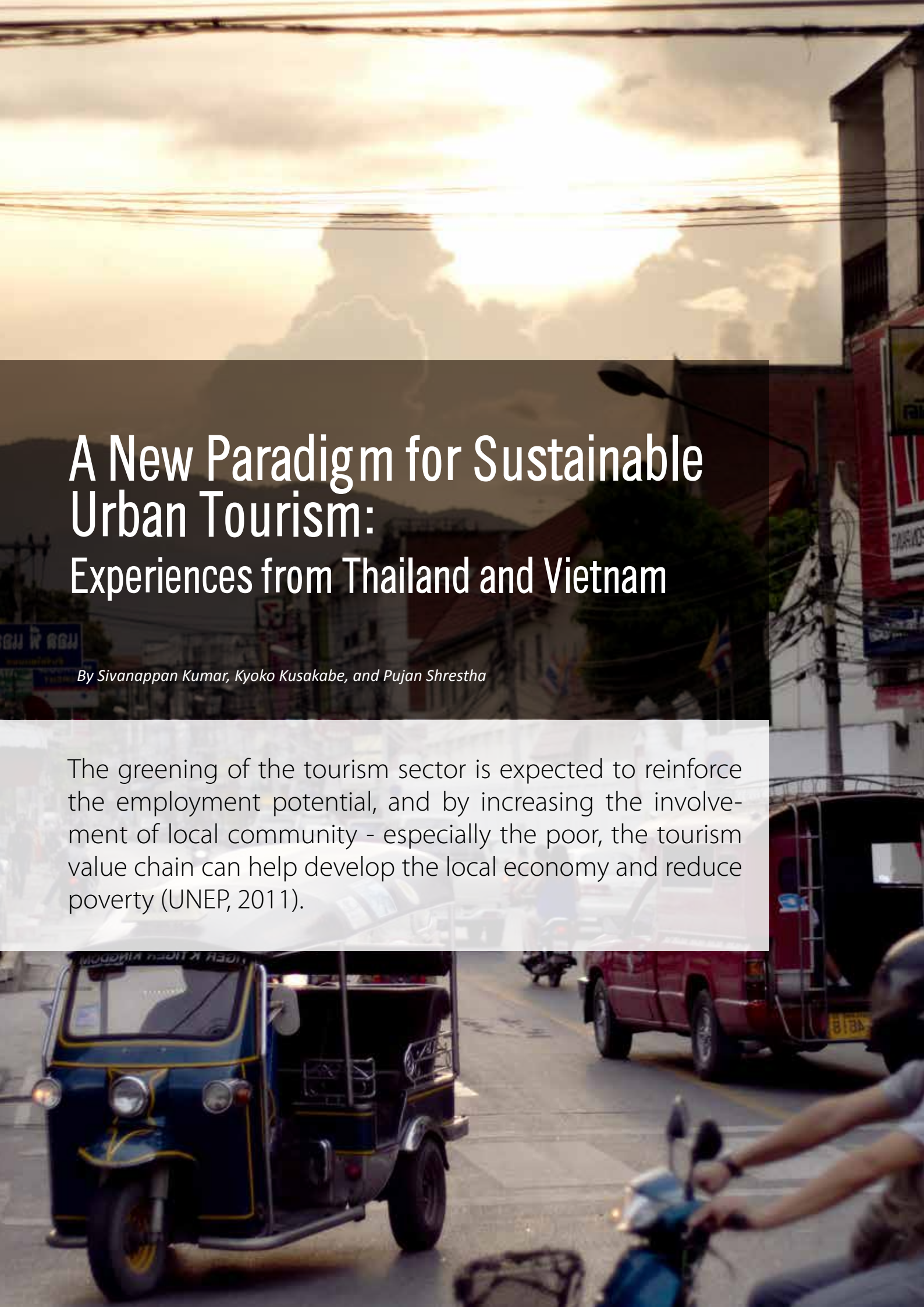
4. The overhang width is generally determined such that the moments and shears in the exterior girder are _____ to those in the interior girder.

   a. Opposite
   b. Similar
   c. Perpendicular
   d. None of the above

5. While modeling abutments as spring, the stiffness of spring support should represent the combined stiffness of the : _____

   a. Bearing, abutment, and passive resistance of the soil
   b. Bearing and girders
   c. Girders and slab
   d. Bearings, girders, and deck

Answers on page 56



A New Paradigm for Sustainable Urban Tourism:

Experiences from Thailand and Vietnam

By Sivanappan Kumar, Kyoko Kusakabe, and Pujan Shrestha

The greening of the tourism sector is expected to reinforce the employment potential, and by increasing the involvement of local community - especially the poor, the tourism value chain can help develop the local economy and reduce poverty (UNEP, 2011).

A New Paradigm for Sustainable Urban Tourism:

Experiences from Thailand and Vietnam

Garden House in Hue.

Use of NMT (cycles) by tourists in Chiang Mai.

Tourism is one of the important and fastest growing sectors; generating revenue, employment, and underpinning local development. For example, Thailand crossed 22 million tourists arrival in 2012 (The Department of Tourism). The direct contribution of Travel & Tourism to Thai GDP in 2012 was THB 825.6 billion (7.3% of GDP) generating over 2 million jobs directly (5.2% of total employment) and indirectly (considering jobs created from tourism related investment, supply chain, and induced income impacts [WTTC, 2013]) over 4.8 million jobs (12.4% of total employment). Similarly, the total international tourists arrival in Vietnam in 2012 was almost 7 million (Vietnam National Administration of Tourism) which accounted for 2.9 % of GDP and generating over 1 billion jobs directly (3.4% of total employment) and over 2.6 billion jobs (8.7% of total employment) indirectly (WTTC, 2013). Although cities around the world make great efforts to attract tourists, they are also becoming overwhelmed by impacts of tourism which includes unsustainable resource consumption, congestion, and greenhouse gas emission (GHG) to name a few. Withstanding the environmental impact of tourism, many cities have shown increased interest to change course to implement sustainable forms of urban tourism.

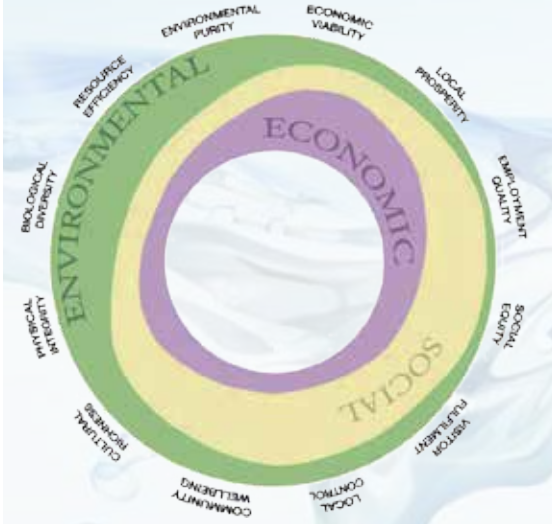
The new paradigm of sustainable urban tourism calls for holistic growth by combining economic viability and resource efficiency while maintaining the socio-cultural authenticity of host communities and alleviating poverty (UNEP & WTO, 2005). The greening of the tourism sector is expected to reinforce the employment potential; and by increasing the involvement of local community - especially the poor, the tourism value chain can help develop the local economy and reduce poverty. As countries and cities develop strategies and adapt measures for a low carbon path to reduce GHG emissions, one of the drawbacks is that it is overwhelming designed by scientists and technical support personnel without much consideration on socio-economic impact or the creation of jobs to improve the welfare of the poorest segment of the city. The project 'Sustainable Urban Tourism through Low Carbon Initiatives: Experiences from Hue, Vietnam and Chiang Mai, Thailand' by the Asian Institute of Technology (AIT) addressed this gap, through technical study results and prioritizing the well-being of the urban poor, while also achieving lower carbon emission in urban tourism sector.

The environmental impacts of tourism in the two cities selected - Hue, Vietnam and Chiang Mai, Thailand, were assessed through greenhouse gas inventory. Low carbon development options were then designed in both the cities to mitigate the impacts and create income generating opportunities to the poor.

Sustainability principles refer to the environmental, economic, and socio-cultural aspects of tourism development, and a suitable balance must be established between these three dimensions to guarantee its long-term sustainability.

Thus, sustainable tourism should:

1. Make optimal use of environmental resources that constitute a key element in tourism development, maintaining essential ecological processes, and helping to conserve natural resources and biodiversity.
2. Respect the socio-cultural authenticity of host communities, conserve their built and living cultural heritage and traditional values, and contribute to inter-cultural understanding and tolerance.
3. Ensure viable, long-term economic operations, providing socio-economic benefits to all stakeholders that are fairly distributed, including stable employment and income-earning opportunities and social services to host communities, and contributing to poverty alleviation.



Source: UNEP and WTO (2005)

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Project Details

Project Name	Sustainable Urban Tourism through Low Carbon Initiatives: Experiences from Hue and Chiang Mai
Sponsor	Sustainable Mekong Research Network (Sumernet) & Climate and Development Knowledge Network (CDKN)
Lead Institute	Asian Institute of Technology (AIT)
Partner Cities	Chiang Mai (Thailand) & Hue (Vietnam)
Objectives	1. To improve understanding and assist in the reduction of carbon emissions in urban tourism sector, and 2. To recommend greenhouse gas (GHG) mitigation policies and plans that could generate green and decent jobs for women and men, especially targeting lower income groups.

Tri-cycles in Chiang Mai.

Tourists using cycles in Chiang Mai.

Motorbikes and cycles in Hue.

Greenhouse Gas (GHG) Inventory

The urban tourism sector involves a large scope of activities including: hotels, tours and transport, small businesses catering to tourists and related operations, entertainment, buildings and heritages, energy supply, food supply, water supply and treatment, and waste and waste treatment. These activities and businesses sustain the tourism industry within the territory of municipality and city boundary and were thus identified to be part of the GHG inventory. The inventory of GHG emissions was conducted using Bilan Carbone® tool covering both direct emissions (fossil fuel combustion by entity's vehicle travel and cooking) and indirect emissions (air and road travel by visitors, food production, electricity purchase, and materials used). The emission estimation was presented in terms of emissions from transport, buildings & infrastructure, and other activities. The details calculation of GHG inventory is explained in Kumar et al., 2013.

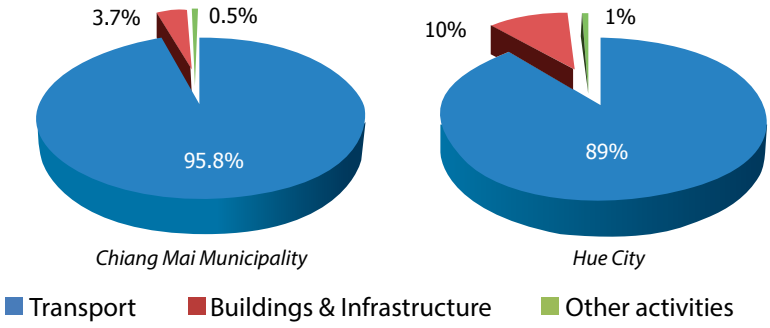


Figure 1: *Contribution of three sub-sectors to the total CO2 emissions (%)*

- **Transport sub-sector**

  This sub-sector covered emissions caused by travel of both visitors and employees of tourism industry, and travel associated with the transport of their goods and services, using various modes both within the city and outside the city, and within the country or abroad.

- **Buildings and infrastructure sub-sector**

  This sub-sector covered all emissions from electricity and fossil fuel used to produce materials for infrastructure development and to utilize them.

- **Other activities sub-sector**

  This sub-sector covered GHG emissions from other activities and sources, such as leakage of refrigerants fertilizer and other materials including paper, glass, plastic, metals, office equipment, vehicle's materials, and others used by tourist service providers.

The total GHG emissions from tourism service providers in the Chiang Mai municipality and Hue City were 4,417,590 tons CO2 equivalent and 492,260 tons CO2 equivalent, respectively. In terms of per capita, the GHG emissions were 0.8 and 0.3 tons CO2 equivalent yearly, respectively. The largest CO2 emissions were from the transport sub-sector contributing to 96% of the total emissions in Chiang Mai municipality and to 89% in Hue City. Approximately 89% and 71% of these emissions in Chiang Mai municipality and Hue City, respectively were by air transport alone. Emissions from 'building and infrastructure' and 'other materials' used were substantially lower than transport emissions. (Figure 1).

The tourism-related GHG emissions in both cities are clearly dominated by emissions from transport, with emission from air transport having the major share. The average tourist journey to Chiang Mai municipality and Hue City were estimated to generate 800 kg of CO2 equivalent and 300 kg of CO2 equivalent, respectively, and the tourist journey to Chiang Mai causes higher emissions (Table 1). In Hue City, tourists first have to travel to Ho Chi Minh or Hanoi or Da Nang City, and then travel to Hue City. Secondly, the majority of visitors stayed longer in Chiang Mai (average 3.6 days) as compared to Hue City (average 2 days). The number of visitors to Chiang Mai municipality is around 3.5 times more as compared to Hue City in the year 2011. Moreover, Chiang Mai municipality has more recreation offerings in the form of spas, massage parlors, night bazaar, night market, Sunday walking street, and temples. In Hue City, the recreational places mostly characterized by boating in the Perfume River, visiting temples and handicraft markets are few compared to Chiang Mai.

The inventory also showed that tourism per capita GHG emission from the building and infrastructure sub-sector, and other activities sub-sector is higher in Hue City than Chiang Mai municipality (as indicated in Table 1). This was due to the construction of an increased number of hotels, restaurants, and public infrastructure, which provided more other services in comparison to the total number of tourists who visited Hue City in 2011.

Hue

Chiang Mai

Table 1: *Summary of GHG emissions from tourism service providers (TSPs) and other information of Chiang Mai municipality and Hue City*

Category	Unit	Chiang Mai	Hue
Population	Number (in 2011)	137,793	339,000
Tourists (including domestic visitors)	Number (in 2011)	5,545,009	1,590,900
Average stay period	Days	3.6	2
Total GHG emissions from all TSPs	tons of CO2 equ./year	4,417,590	492,260
1. Transport sector		4,233,330	436,260
2. Buildings and Infrastructure		161,500	50,100
3. Other Activities		22,760	5,900

Low Carbon Development Options

The low carbon development options identified in both the cities to mitigate the impact of GHG emissions as well as to improve the income generating options to the poor included development of non-motorized transport (NMT) in Chiang Mai municipality and Garden Houses in Hue City.

- **Non-Motorized Transport in Chiang Mai Municipality**

Non-Motorized Transport (NMT) is any form of transportation that uses human energy or animal power for personal or goods mobility by methods other than the combustion motor engine (Adebambo, S.O., and Yetunde, S.F., 2010). It includes walking, bicycling, small wheeled transport, carts and provides flexible options to mobility. It can also reduce pollution and help in income generation of the poor. The Chiang Mai municipality, in consultation with its stakeholders (e.g. tourism authority, hotel associations, and art and culture centers), proposed the Three King Monument area close to the center of the old city in Chiang Mai municipality for developing NMT (around 600 meters) which can be connected to other boundary road around the Chiang Mai moat (around 6,000 meters). If NMT is adopted in this location, it could replace 535,800 - 1,339,600 local vehicle (diesel) km travel per year, which could then reduce 230 – 570 tons of CO2 equivalent emissions per year. This means a possible reduction of 0.6% to 1.6% of GHG emissions in land based travel within the city in the transport sub-sector of Chiang Mai municipality.

For the tourists, NMT enhances their recreational opportunities by reducing vehicle congestion. Facilitating NMT, particularly walking and cycling, will directly reduce CO_2 which would have otherwise resulted from their travel in other modes of transportation. Cycling and walking are also access modes for public transport and thus their promotion may lead to increased public transport use. The promotion of NMT can deliver important co-benefits such as noise and pollution reduction, and increased health (OECD/ITF, 2009) . On the socio-economic side, the restricted motorized transport will provide opportunities for the tourists to purchase handicrafts and other goods from local vendors thereby contributing to the local economy. It can also provide additional income generating opportunities for the cyclo drivers, bicycle shops, and related industries. Nevertheless, the city authorities need to develop parking places for motorized and non-motorized transports at different locations to promote NMT and to avoid the traffic congestion in the city center.

Chiang Mai

- **Garden Houses in Hue City**

For Hue City tourists, garden houses offer opportunities for relaxation in a serene atmosphere marked by local traditions within the city limits. More importantly, garden houses help in GHG emissions mitigation by acting as a carbon sink, lessening the amount of waste going to landfill by managing the household wastes through compositing or as animal feed. At the city scale, a garden house can help reduce GHG emissions by providing local areas to produce fruits and vegetables and reduce the use of freights to import produce to Hue. In garden houses, the use of motorized vehicles are restricted, promoting cyclo drivers as the transport mode for the visitors.

Thua Thien Hue Provincial Department of Culture, Sports and Tourism estimated that if Hue City authority promotes garden houses in the city, it could attract 20-40% more visitors. At the same time, if the city authority and garden house association encourage visitors to use cyclo or bicycle to travel to garden houses, it could replace 127,950 – 255,900 local vehicles (petrol) km travel per year which could help to reduce about 100 – 200 tons of CO^2 equivalent of GHG emissions per year. This means a possible reduction of 4% to 9% of GHG emitted by land based travel within the city in the transport sub-sector. The promotion of garden houses also has the potential to aid income generation of the owners and garden workers from the sale of products such as fruits and vegetables. In addition, by restricting motorized vehicles around the garden houses, additional income generating activities may be shifted towards cyclo drivers and street vendors.

The survey of 50 garden houses showed that high development costs and low returns, low demand, lack of essential skills, and dominance of mass tourism operators are some barriers that hinder the promotion of garden houses face to local tourists. It is then important to note that creating garden houses that are more sustainable requires interventions at different scales and involvement with different stakeholders.

New Approaches to Sustainable Urban Tourism:
Low Carbon Options and Creation of Green Jobs

Hue

Overall Concept

The project approached urban tourism in a new way by exploring opportunities for lowering GHG emission while placing the same importance to finding opportunities for the creation of green and decent jobs for the poor. It put priority to socially inclusive urban development by looking at income generation opportunities for women. In both the cities, after conducing GHG emission inventory and discussing with stakeholders, the mitigation options for low carbon tourism development were recommended. These low carbon options were not just based on the technical criterion of maximum GHG reduction but was rather inclusive in creating green and decent jobs for the poor and women. In the case of Chiang Mai, the recommended policy option for low carbon development was to develop Non-Motorized Transport (NMT), particularly in the city center. Extending and developing NMT system would not only decrease carbon emissions but also provide additional income generating opportunities to the street vendors, traditional convenience stores, bicycle shops, and tricycle operators. Similarly, in case of Hue City, the recommended policy option was the promotion of traditional Garden Houses. Garden Houses could provide more opportunities for income generation for the owners and garden workers through the sale of home-grown products. Restricting motorized vehicles around the Garden Houses will not only reduce carbon emissions but also provide additional income generating opportunities to the cyclo drivers and street vendors.

The Process

Estimating emissions and exploring opportunities for emission reduction is usually carried out independently by researchers only and usually does not involve other stakeholders. This project's uniqueness starts with a model that identifies researchers and city authorities as important partners right from project formulation phase to its completion as important stakeholders. This approach ensured multi-stakeholder partnership between researchers, local authorities, private companies, NGOs, and locals to work together for designing an efficient solution to practice sustainable urban tourism in both the cities. Stakeholders were crucial in every step of the research - providing emission data, proposing and prioritizing GHG mitigation options, and suggesting suitable policy options. The low carbon initiatives were proposed after considering inputs from the different stakeholders, such as tourism service sectors, local people, students, and research academia experience.

Earlier collaboration among the Hue City Centre for International Cooperation (Vietnam), the Chiang Mai Municipality (Thailand), and the Asian Institute of Technology (AIT) concerning estimating the carbon emissions at local authority level using the Bilan Carbone® tool with support of French Agency for Energy and Environment Management (ADEME) helped in establishing rapport on the onset of this project. Frequent communication and consultation meetings between project partners (AIT, Hue City, and Chiang Mai) were maintained to obtain clear guidance and assignment of responsibilities among the research partners.

The most unique aspect of the project was the commitment of the top management of both cities. The project generated greatest possible impact by providing policy guidance to both the cities in reducing GHG emissions and creating decent jobs which was then agreed by the top officials in both the cities; the city mayor in Chiang Mai and vice-chairman of Hue People's Committee in Hue). Although it is too early to pin point any specific policy changes in both the cities, the official commitment of the top authorities have paved way for future endeavors and facilitated some positive moves in relation to the project. For example, the Chiang Mai municipality recently initiated the Sustainable Urban Transport Project in Chiang Mai as recommended.

Conclusion

This project conducted in collaboration with AIT, Chiang Mai municipality, and Hue City permitted the analysis of the opportunities for sustainable urban tourism through low carbon options in both cities. It was suggested that if designed properly, low carbon emission strategies can also lead to a win-win situation – contribute to low carbon growth through decreased greenhouse gas emissions (GHG) and improved wellbeing of the poor through increased employment opportunities at the same time.

The GHG emission analysis showed that the transport sub-sector generated the largest proportion of CO2 emissions in both the cities with majority emissions caused by air transport alone. Emissions from building and infrastructure and other materials used were low compared to transport sub-sector emissions. On the basis of GHG emissions inventory, the cities in consultation with their stakeholder came up with set of emission reduction strategies, and selected city specific mitigation options that also support the existing government policy related to tourism sector. Chiang Mai municipality and Hue City have identified strategies to implement Non-Motorized Transport (NMT) and promote garden houses respectively. Implementation of these mitigation strategies in the cities will not only reduce emissions of GHG gases, but will also create decent occupations for local people.

Enhanced collaboration among communities, local government, and private sector is necessary to achieve GHG mitigation initiatives. In the medium to long term, it is expected that the planned activities will be put in place in both the cities to reduce GHG emission intensity in the urban tourism sector and to create more green jobs for women and men in low income groups.

References

OECD/ITF (2009) The Cost and Efficiency of Reducing Transport GHG Emissions, Preliminary Findings, Organization for Economic Co-operation and Development/International Transport Forum.

S. O. Adebambo and S. F. Yetunde (2010) "Evaluation of Non-Motorised Transport (NMT) System in the Movements of Market Wares in a Medium Sized City of a Developing Economy," American Journal of Scientific Research 11, pp. 72-85, Euro Journals Publishing.

S. Kumar, K. Kusakabe, P. Pradhan, S. Goteti, T.A. Tuan, E. Meteejaroenwong, S. Suwanprik, and K. Linh (2013 in press) "Greenhouse gas emissions from tourism service providers: case studies in Chiang Mai, Thailand and Hue, Vietnam," in L. Lebel et al (Eds), "Livelihoods, ecosystem services and the challenges of regional integration in the Mekong region," Strategic Information and Research Development Center (SIRD), Selangor, Malaysia.

The Department of Tourism, http://www.tourism.go.th/tourism/th/home/tourism.php?id=11

UNEP (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers. United Nations Environment Programme (UNEP).

UNEP and WTO (2005) Making tourism more sustainable: a guide for policy makers. United Nations Environment Programme and World Tourism Organization.

Vietnam National Administration of Tourism, http://www.vietnamtourism.com/e_pages/news/index.asp?loai=2&uid=25422

WTTC (2013a) Travel and Tourism Economic Impact 2013: Thailand. World Travel and Tourism Council.

WTTC (2013b). Travel and Tourism Economic Impact 2013: Vietnam. World Travel and Tourism Council.

The pictures are from Chiangmai municipality, Hue City Centre for International Cooperation AIT.

Sustaining Ethical Aquaculture Trade

By Kriengkrai Satapornvanit

As the global consumption of seafood and associated trade volumes have risen dramatically over the last decade due to rising population, growing affluence, and changing eating habits, more attention has been given to how the processes along the global value chains for seafood meet standards for sustainable food production and trading.

About SEAT

The Sustaining Ethical Aquaculture Trade (SEAT) Project in Thailand is a collaborative research project among 12 institutional partners in Europe and Asia, funded under the EU Framework 7 (FP7) Programme. The leading institution with a coordinating role is the Institute of Aquaculture of the University of Stirling, Scotland, United Kingdom, under Prof. David Little, a former faculty member at the Asian Institute of Technology's Aquaculture Field of Study. In Thailand, the implementing partner is the Faculty of Fisheries, Kasetsart University (KU), with Dr. Kriengkrai Satapornvanit as the Principal Investigator. Other Asian partner institutions are the Bangladesh Agricultural University, Shianghai Ocean University, and Cantho University.

For more information, please visit:
http://seatglobal.eu

SEAT Project Partners

Background

As the global consumption of seafood and associated trade volumes have risen dramatically over the last decade due to rising population, growing affluence, and changing eating habits, more attention has been given to how the processes along the global value chains for seafood meet standards for sustainable food production and trading. Today more than half of all seafood is internationally traded with net transfers from developing to developed countries. The EU is the largest single regional importer taking over 30% of all internationally traded seafood in 2008.

The contribution of farmed seafood products to this market has grown steadily; currently around half of global seafood production is of farmed origin. Most production destined for trade comes from fresh and brackish water delta and lagoon regions of South and Southeast Asia. Four key species groups are fast growing river catfishes (Pangasiidae), tilapias, shrimps, and fresh-water prawns. The rate of growth and levels of intensification of some of these systems in geographically restricted areas is unprecedented, leading to serious sustainability concerns.

Current EU policy supporting international trade between Asia and Europe concentrates on issues of food safety as measures of quality, whilst market-forces drive development of standards and labels that identify social and environmental parameters. This project proposes to establish an evidence-based framework to support current and future stakeholder dialogues organized by a third party certifier. This will contribute to harmonizing standards, helping consumers to make fully informed choices with regard to the sustainability and safety of their seafood.

The Ethical Aquatic Food Index (EAFI), a qualitative holistic measure of overall sustainability to support consumers' purchasing decisions, will be based on detailed research centered around a Life Cycle Assessment (LCA) of current processes. This, allied with a sustainable livelihoods approach and system thinking, will ensure aquatic products reach consumers, aligned with analyses from the sustainable livelihoods approach and systems thinking. Micro, Small, and Medium Enterprises (MSMEs) based in the EU will participate in this project, particularly in the action research phase, thus enhancing their relative competitiveness.

Information provided by:

Kriengkrai Satapornvanit, Ph.D.
Faculty of Fisheries,
Kasetsart University

Objectives

Research outputs will provide the evidence-base for the creation of an 'Ethical Aquatic Food Index' (EAFI). This key project outcome will be used to disseminate complex project findings to the wider public in a concise and understandable way. Collaboration will also take place with European and Asian small and medium scale-enterprises (SMEs) to address specific sustainability questions.

Running from 2009-2013, the project involved a highly interdisciplinary approach to address sustainability questions and includes a consortium of 12 internationally recognized institutions and organizations. Topics addressed during the project include environmental impacts, impacts of trade on local livelihoods and public health, food safety including contaminants and traceability concerns, and barriers to trade.

Life cycle analysis will be used to explore energy and material costs embedded in the global value-chains. Food ethicists will also examine the value-laden nature of sustainability decisions during the project such as who decides which qualities are significant in relation to sustainability.

Results

The SEAT project involves 12 Work Packages examining many areas of the aquaculture industry and trade from Asia to the EU from producers to consumers. Some key outcomes of the project are listed below:

- Creation of the Ethical Aquatic Food Index (EAFI) with values relating to food production, processing, and marketing for all relevant stakeholders.
- Development of Life Cycle Assessment (LCA) methodology for use in comparing environmental performance of products and services in the industry.
- Review and development of environmental models for quantitative investigation of environmental sustainability and quality standards of aquaculture systems.
- Examination of Global Value Chains (GVC) for relevant aquaculture products including analysis of socio-economic dimensions. Information asymmetries assessed for all actors in the GVC and the implications for market access.
- Improve safety of aquaculture produce for all stakeholders in the value chain, and improved control of occupational health and safety for farmers.
- Examination of impacts of chemical inputs to aquaculture systems and associated risk assessment development for endpoints such as ecosystem, produce, and consumers.
- Evidence-based ethical advice for policy makers, standard setting organizations, and consumers to inform participatory standards development and awareness raising.
- Provision of guidance to Asian exporters and regulatory agencies relating to policy within the EU hygiene package and implementation of the EAFI.

Can Thailand sustain its global leadership in quality shrimp exports?

The Ethical Aquatic Food Index (EAFI)

The development of the Ethical Aquatic Food Index (EAFI) is being coordinated by Dr. Jason Weeks of the UK Centre for Environment, Fisheries and Aquaculture Science (CEFAS), and Prof. David Little and Dr. Francis Murray of the Institute of Aquaculture, University of Stirling. Information from project documents and presentation materials from Dr. Weeks emphasize that EAFI is a tool for decision makers. Furthermore, it is an evidence-based decision support tool primarily for international seafood buyers and certifiers. It aims to incorporate environmental, economic, social, and ethical data. It will assess and score the sustainability of an aquaculture commodity, beyond the farm level. At the moment, it is specific to the 4 SEAT project member countries (Bangladesh, China, Thailand, and Vietnam) but can be applied to other countries as well.

SEAT project work packages generated data and identified species and country specific indicators. These indicators were developed into a tiered, hierarchical, iterative framework. EAFI is designed as a simple tool, but can become

Running from 2009-2013, the project involved a highly interdisciplinary approach to address sustainability questions and includes a consortium of 12 internationally recognized institutions and organizations.

more complex only where necessary. It utilizes the weight of evidence approach to make decisions. EAFI case studies were selected from the 48 different scenarios derived from the 4 project countries and 4 major exporting species, i.e. shrimp and prawn for Bangladesh, shrimp and/or tilapia for China, shrimp for Thailand, and striped catfish (Pangasius) for Vietnam.

All questions within the framework have a graduated range of answers or indicator of sustainability. Actual project data collected were used significantly via an interrogational approach, as well as linkages made with all models generated such as the ERA Aqua, nutrient, GIS, LCA, and so forth within the framework. It also uses a toolbox approach, the development of bias and weighting towards ethics and sustainability. There was a mixture of detailed and yes/no questions dependent on tier – different questions with greater complexity of answers at higher tiers.

The mathematics part of the EAFI development involved normalisation, aggregation, Monte Carlo simulation, bootstrapping, and weighting. It is also undergoing the Delphi process, with three iterations of testing with end users.

As part of the reiterative and consultative process for the formulation of this index, progress on EAFI is being presented whereby opinions from various stakeholders are taken into consideration. A range of aquaculture standards setters and certifiers have been consulted and been positive about the EAFI potential and the risk framework approach. For buyers, their main comment was to keep it as simple as possible. In addition, all those who have been consulted have liked very much the inclusion of ethics and the whole value chain approach into the EAFI process. The EAFI is an independent iterative process that is evidence based and focused on ethics and sustainability, the inclusion of which has been appreciated. EAFI is not an accreditation scheme but a first consideration.

Seafood processing plants follow certification standards to meet consumer requirements.

Photo: P. Wilaipun, Kasetsart University.

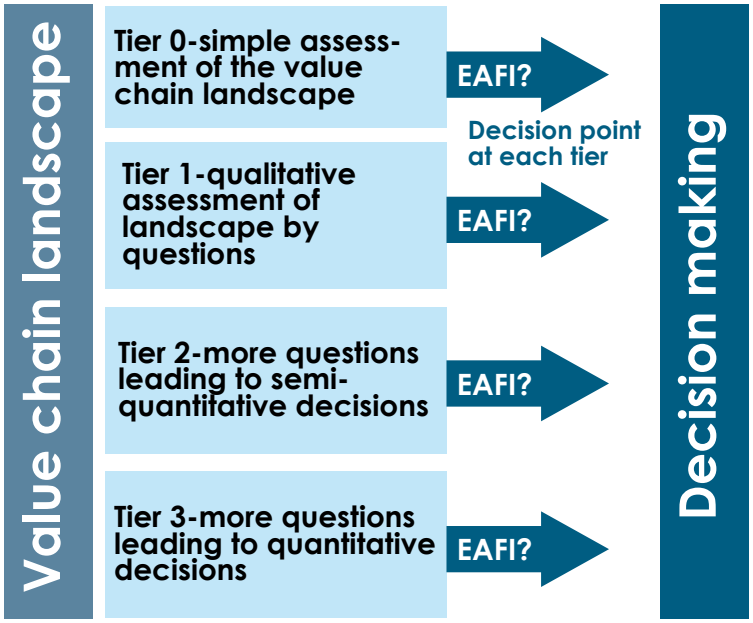


Figure 1: *Key Features of EAFI as a tiered interative hierchical framework*

Source : Dr. Jason Weeks, UK Centre for Environment, Fisheries and Aquaculture Science (CEFAS)

Life Cycle Assessment (LCA)

Dr. Jeroen Guinée of the Institute of Environmental Sciences of Leiden University, Netherlands, coordinates the Life Cycle Assessment (LCA) work package of SEAT. The doctoral research project of his student, Mr. Patrik Henriksson, involves using Life Cycle Assessments to investigate the production and distribution of the different species and countries within SEAT. Mr. Henriksson uses LCAs to highlight unsustainable "hot spots" along the value chain for the different SEAT species in the four Asian countries. He explained that LCA focuses on the life cycle of products, not on organisms. Both biological work in aquaculture and LCA have things in common in that they look at the various phases such as the hatchery, grow-out, and mortality/processing. However for LCA, in looking at the principle of cradle to grave for aquatic products, the cradle starts even before the hatchery phase, for example, a phosphorus mine in Morocco, and the grave may be in the garbage disposal of a European consumer. The SEAT-LCA work package over the last year focused on evaluating the processes which are not usually linked with aquaculture. In gathering information, many data gaps were found as well as differences in practices which were interesting. A protocol for handling inventory data has been developed and the methodology for LCA work continues to be refined.

Small scale farms are as important as large scale farms in meeting global demand for seafood.

Mr. Henriksson and the local team in Thailand, as well as in other countries, have started to communicate some of the LCA results to industry partners and stakeholders, who have given positive reactions and feedback. This is part of the active process of LCAs, and through interaction with stakeholders with their feedback, and an understanding of the real situation, assumptions can be improved, and alternatives to remedy hot-spots can be discussed. In terms of impacts, most of them focus on some processes in the production chain, which could be considered as hot-spots. Through LCA, more hot-spots can be identified, which will help in more efficient and targeted efforts in improving performance in the value chain or specific production processes, and in the long term, achieve the sustainability of operations, resulting in enhancing the reputation of farmed Asian aquatic products.

Environmental Models

As part of the environmental modelling work package, Ms. Lynne Falconer, a Ph.D. student at the University of Stirling's Institute of Aquaculture under Prof. Lindsay Ross, has conducted her research on the development of non-point source models. Her work involves developing spatial models to assess the risk of "non-point source pollution" in the form of nitrogen and phosphorus across each of the four study areas for both the dry and rainy seasons. Data on land use, soil, rainfall, topography, and hydrological conditions in each of the four Asian project sites are used for the models. These are combined within a weighted multi-criteria evaluation to produce final outputs. According to Ms. Falconer, these "non-point source pollution" models will be a useful decision making tool as they allow stakeholders to identify areas where there is a higher/lower risk of potential nutrient enrichment. Furthermore, this will provide extra information for site selection studies as planners can identify areas where there is the potential for poor water quality/ eutrophication which would be unsuitable for a new aquaculture development. The models can also be used in environmental management plans to identify areas where regular monitoring should take place. Another advantage of the models is that they can be easily updated and adapted for different scenarios, such as increased rainfall and changes in land use, or updated for other "pollutants" such as sediments.

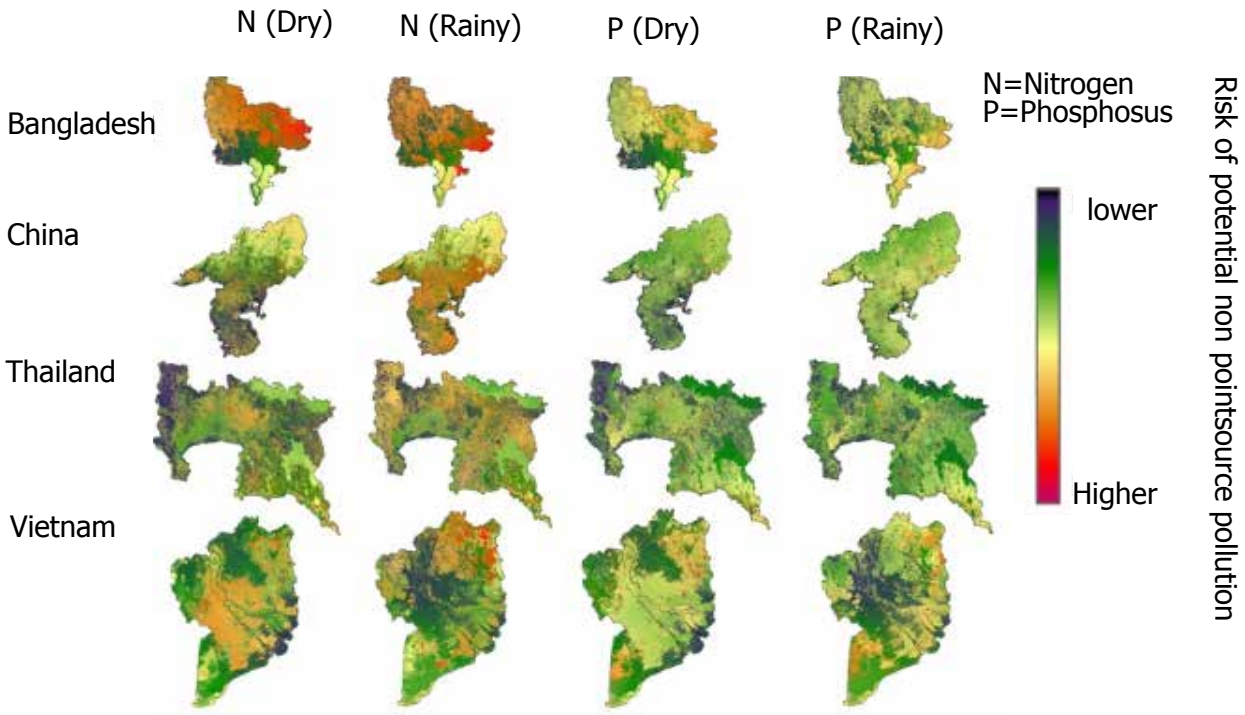


Figure 2: *Non-point source pollution models*
Source : University of Stirling, Institute of Aquaculture (http://www.aqua.stir.ac.uk/GISAP/gis-group/lynne)

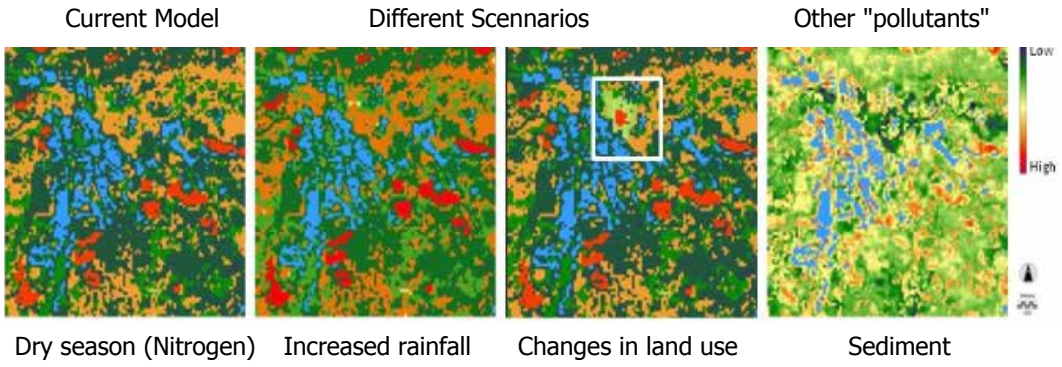


Figure 3: *Examples of how the models can be adapted for different scenarios and other pollutants (Source : University of Stirling, Institute of Aquaculture (http://www.aqua.stir.ac.uk/GISAP/gis-group/lynne))*

Environmental Contamination

SEAT partners from Wageningen University, Netherlands, were able to develop a model called ERA-AQUA, to assess the risks of using veterinary medicinal products (VMPs) in aquaculture for the following end-points: targeted produce, aquatic ecosystems receiving effluent from the ponds, consumers, and trade of the harvested aquatic products. According to Mr. Andreu Rico, a Ph.D. student at Wageningen University who is conducting his research on risk assessment and environmental contamination under Prof. Paul Van Den Brink, the model calculates risks by following a risk quotient approach, conducting exposure assessment through calculating predicted exposure concentration, and effect assessment through predicted no-effect concentrations for the endpoint being studied. Exposure assessment can be done through putting together information from various factors such as the environmental characteristics of a fish pond, characteristics of the cultured species, management practices, and physico-chemical properties of the compound being studied. The ERA-AQUA model predicts concentrations of VMPs in the pond water, pond sediment, cultured species, water body receiving pond effluent discharges, through mass balance equations. The effect assessment is conducted by putting together ecotoxicological information and food safety threshold concentrations for the studied compound. The ERA-AQUA model is a decision-support system for the environmental risk assessment of veterinary medicines applied in aquaculture.

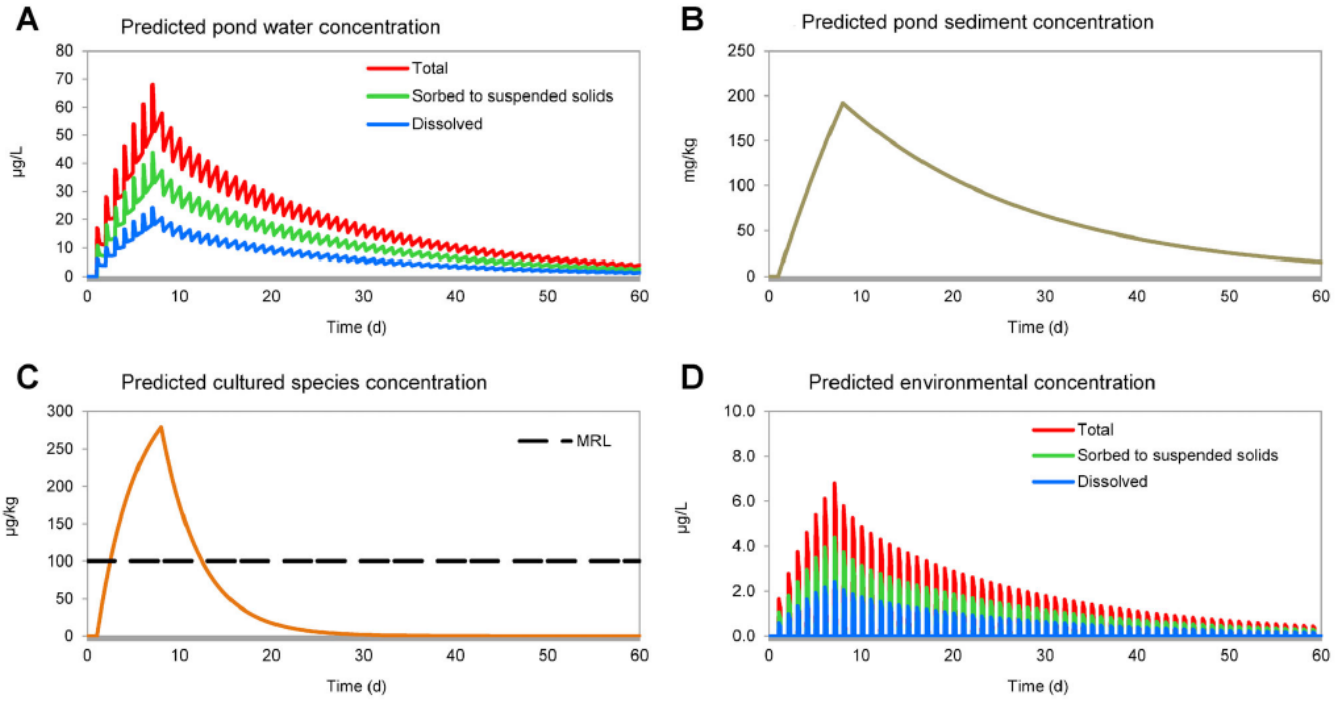


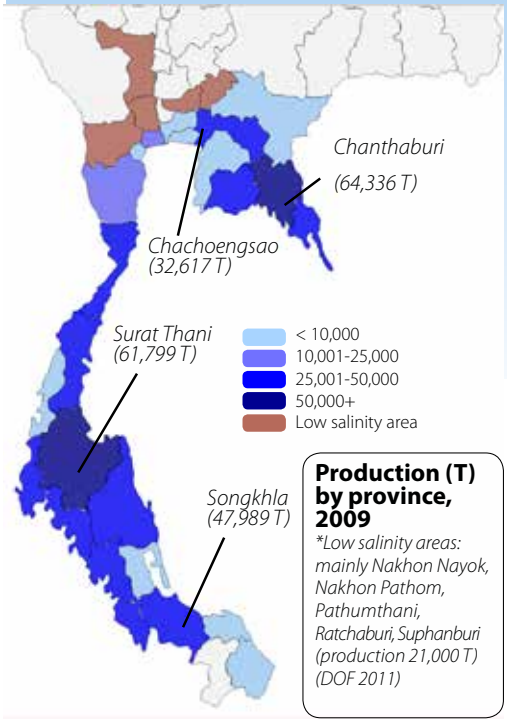
Figure 4: *Predicted concentration dynamics for oxytetracycline in (A) pond water, (B) pond sediment, (C) cultured species, and (D) environment, calculated with the ERA-AQUA model. MRL ¼ maximum residue limit.*
Source: Rico, A., Yue, G., Focks, A. and Van Den Brink, P.J. 2013. Modeling Environmental and Human Health Risks of Veterinary Medicinal Products Applied in Pond Aquaculture. Environmental Toxicology and Chemistry 32(5): 1196-1207.

Addressing Sustainability Issues

The Institute of Aquaculture (University of Stirling, UK) coordinates the project and specifically the work packages on production systems, sustainability issues, and action research on enhancing food values and dissemination. Work on sustainability can only be approached in an interdisciplinary manner, thus the project collaborates together with other disciplines, realized in various work packages such as the global value chain analysis with Stirling's Department of Marketing and the WorldFish in Malaysia, the ethical framework development with the Centre for the Study of the Sciences and the Humanities at University of Bergen, Norway, environmental modeling with Stirling's Sustainable Aquaculture Research group (Environmental Sustainability and Spatial Analysis and Applied Physiology), contamination risks with Wageningen University's Department of Environmental Sciences, Aquatic Ecology and Water Quality Management Group, food safety and public health with the Faculty of Life Sciences, University of Copenhagen, improving transparency for information access with FAO, and policy development with CEFAS, United Kingdom.

In Thailand, Ms. Arlene Nietes-Satapornvanit, a SEAT-Stirling doctoral researcher, is looking at sustainability issues faced by the shrimp and tilapia value chains, with a main focus on the production sector. The main issues affecting the sustainability of operations among shrimp and tilapia producers, especially related to ethical trading for exports, include disease, water quality, environmental and weather changes, markets and prices, product quality, availability of technology and skilled labor, as well as government regulations, socio-political issues, and standards and certifications. In addition, future involvement of farmers' children in shrimp and/or tilapia farming or business may be hindered by the discouraging and difficult experiences the farmers are currently facing, except for established medium scale shrimp farmers. Thus, labor, especially migrant labor because Thai workers are hard to find, has become important in the shrimp farms. However, with the introduction of advanced technologies such as more efficient aeration and autofeeders, as well as a slowdown in shrimp farming operations due to disease, many farms have reduced the number of their workers.

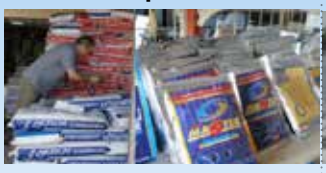
The Shrimp Value Chain



Production (T) by province, 2009

**Low salinity areas: mainly Nakhon Nayok, Nakhon Pathom, Pathumthani, Ratchaburi, Suphanburi (production 21,000 T) (DOF 2011)*

Inputs ▶



>240 suppliers of PLs, feed, health supplements & substances, probiotics, equipment, technical & professional services. Some have contract agreements with farmers.

Production ▶

>25,000 individual, family or corporate farms, mainly intensive monoculture systems from small to large scale operations.

Collection ▶

Producers and buyers agree on price before harvesting. Shrimp goes either directly to processing plants or sold in auction markets.

Processing ▶

>200 processing plants & cold storage for basic & value-added processing. Raw materials are obtained from farms (with local & global certifications) & auction markets.

Trading ▶

>150 processors exporting frozen shrimp to >50 countries. Companies have long-term contracts with buyers, while new markets are being explored.

Consumption

70% of production are exported as frozen fresh and value-added in various forms. Processed/value-added increased from 4,929 T in 2005 to 26,548 T in 2010.

SUPPLIERS → **PRODUCERS** → **COLLECTORS** → **PROCESSORS** → **BROKERS/SELLERS** → **DOMESTIC CONSUMERS**

PROCESSORS → **EXPORTERS** → **FOREIGN CONSUMERS**

REGULATORY/ INSTITUTIONAL ASPECTS

Farm Registration/ThaiGAP
Fisheries Movement Documents/Feed Analysis/Certification/Chemical Substances Registration/AQ Insurance
Club Membership

Contract Farming Agreements
Fisheries Movement Documents
Price Standards

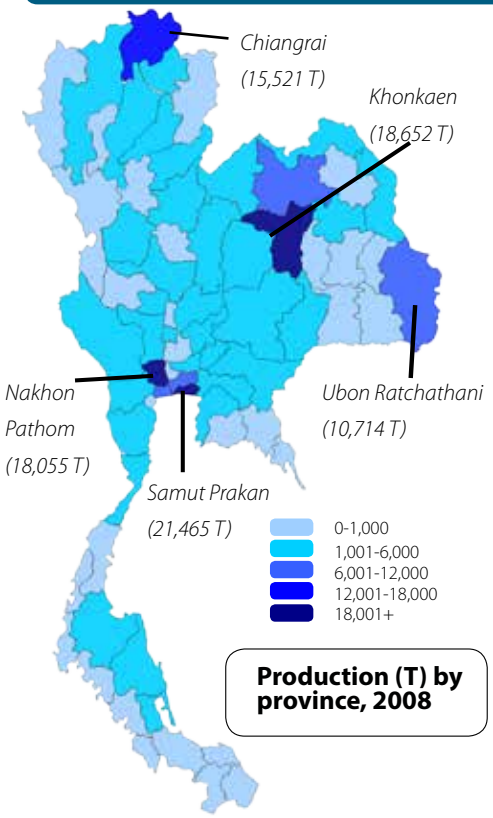
Registration/Certification/Standards/CODEX
Fisheries Movement Document
Health Sanitation Certification
Importing country/buyer requirements

Consumer Protection
Industry/Supermarket Standards
EU Hygienic Package

As the SEAT Project comes to a close, the team is now at the stage of putting together project results and experiences for dissemination. It is hoped that all the information and learnings will be shared back to participating stakeholders and partners, as well as the global audience. In this way, through dissemination, the value chain actors in each of the seafood producing and exporting project countries will be given a voice in the global trade arena, in the same way as the other end of the value chain (the importers, buyers, choice editors, consumers and others) have voiced out their requirements for product quality through standards compliance and media articles. Knowledge of the value chain actors' concerns, issues, situation, and needs could help in understanding what makes for sustainable production and trade leading to global food security in the near and distant future.

Note: *Most of the information from this article were compiled from SEAT Project Documents and website. (http://seatglobal.eu/)*

The Tilapia Value Chain



Inputs

> 70 suppliers: quality fry & fingerlings, feed, health supplements & substances, probiotics, equipment, technical & professional services. Some have contract agreements with farmers.

Production

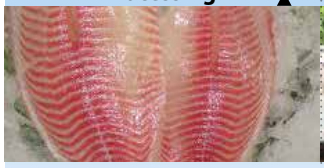
> 255,000 individual, family, or corporate farms. Production: >80% from ponds (polyculture), 15% from cages (monoculture), <5% from paddies & ditches.

Collection

More fish are transported live from farms by brokers/agents/traders to agents & wholesalers, then on to retailers; Processors also collect directly from farms.

Trading - Local

Processing



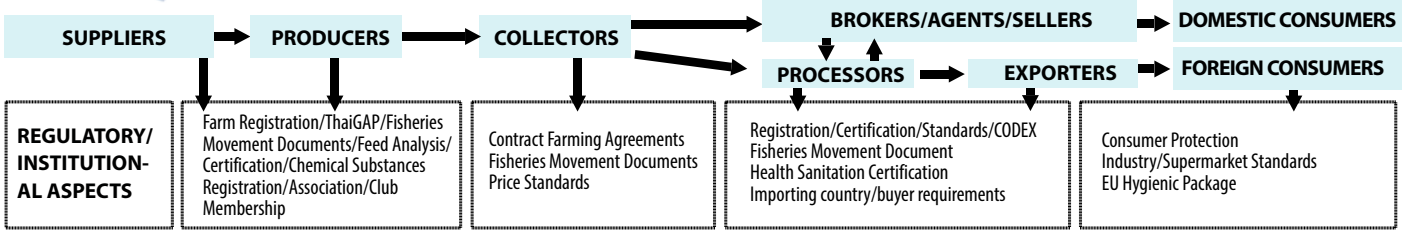
>50 processing plants/cold storage for fillet & value-added; raw materials from farms & auction markets; local processors produce other forms for local market.

Trading - Export

A lady keeping records in an auction market. Women sell & separate fish, men carry heavy baskets. Around 20 wholesale markets in the country, >50 exporters.

Consumption

Popular due to its delicious taste, varied ways to cook, & health benefits. Locally available in wet markets, supermarkets & restaurants. Exported to Asia, Canada, EU, United States, Middle East.



Source: SEAT Kasetsart-Stirling Value Chain Posters, 2012.

AIT and Sustainability

Sustainable development has been central to Asian Institute of Technology's (AIT) research and development efforts since its inception.

AIT's Centre of Excellence on Sustainable Development in the Context of Climate Change (CoE SDCC) was established on 24 September 2009 to support AIT's vision of responding to global climate change challenges and concerted trans-disciplinary efforts leading towards a more sustainable society.

The goal of CoE SDCC is to integrate the Institute's research efforts and broaden the networks and partnerships by providing a platform to discuss and launch shared initiatives and pool resources to effectively address issues and challenges in sustainable development and climate change in Asia and beyond.

Developing AIT's Research Roadmap

The research strategic plan for 2012-2016 emphasizes the consolidation of research efforts and strengthening AIT's niche technical areas to further harness the institute's range of network, experience, and expertise. CoE SDCC served a strategic function during the formulation of the AIT Research Strategy (AITRS) 2012-2016 by conducting a series of in-depth analysis and discussions with key experts within AIT and many of the institute's respected partners.

The formulated research strategy follows four strategic principles, the application of aims to consolidate AIT's leadership in generating solutions to address real-life challenges to support AIT's mission to the sustainable development in the Asian region and its integration into the global economy.

The following are the four strategic principles of the research strategy:

1. **Research Focus:** The AITRS (2012-2016) will focus on select thematic areas under the broad umbrella of Sustainable Development in the Context of Climate Change involving relevant stakeholders.

2. **Research Quality:** AIT will continue to focus on continuous quality assurance and systemic quality improvement of its research processes and research outputs.

3. **Quality Collaboration in Research:** AIT will continue to promote and sustain quality collaborations with relevant stakeholders, existing and new ones, for research, and implementation of research applications to address real-life challenges. While supporting research institutions in the region to build their capacity, AIT will also proactively seek engagements with leading research institutions to continue increasing the institute's capacity and assist creating and strengthening linkages between institutions.

4. **Research Resource Mobilization:** AIT will seek to diversify its resource portfolio through the implementation of this strategy. AIT will seek to increase its research resources by 10% every year and pursue active engagement of public-private partnerships for resource mobilization.

Thematic Areas

Disaster Risk Management

Lower Carbon, & Sustainable Production & Consumption Technologies & Management

Sustainable Land & Water Resources Management

Urban and Rural Quality of Life & Sustainabillity

Business and Innovation Models for a Green Economy

With contributions from Prof. Kanchana Kanchanasut, AIT's Vice-President for Research, and Amandeep Sangha of AIT's Center of Excellence in Sustainable Development in the context of Climate Change.

A Living Laboratory

The Need for Greening the Campus

The mission of the Asian Institute of Technology (AIT) is to promote technological changes and sustainable development in the Asia-Pacific region, and to develop highly qualified and committed professionals who play leading roles in the region's sustainable development and its integration into the global economy.

With an overall curriculum oriented towards preparing students on sustainability, development, and technological issues, AIT is an excellent training ground for the youth who will take up decision-making positions in their respective countries and the region. It is with this mandate that AIT would like to emphasize on setting a living example of a resource efficient and low-carbon campus, where learning about sustainable development is not only derived from theoretical teaching but is reinforced by experiential learning and life on a campus that exemplifies sustainability.

AIT faculty, staff, and students have long been and are addressing these issues in and outside the campus. Often times these projects are time-bound and targeted as capacity building or technology dissemination for external parties and countries. The Institute's commitment to partners has allowed experts to support sustainability initiatives that are focused on facilitating development in communities, countries, and the region.

Research performed at AIT on sustainability has included studies on the development of a low carbon campus through application of renewable energy, energy efficiency, and energy conservation measures focusing on the mitigation of greenhouse gas emissions, innovative demand side management strategies, and 3R (reduce, recycle and reuse) of wastes.

As AIT endeavors to fulfill its mission, it is increasingly important to adopt a holistic and visionary goal for the campus – a Living Laboratory. Experts at AIT believe that it is the right time to proceed as AIT rebuilds and upgrades its campus, activities, and curriculum after the flood devastated the campus at the end of 2011.

Vision: The Five Year Target

The Living Laboratory will be a change agent that integrates sustainability principles into everyday activities for achieving higher educational and research excellence and contribute to region's sustainability. By preparing highly capable and dedicated workforce that not only learns, but lives "the sustainability experience" in the AIT campus, AIT can thus serve as a showcase and role model for other educational institutions in the region.

To convert AIT into a sustainable living laboratory will initially start by following the low carbon pathways of living and learning, hence resulting in a self-sufficient eco-community. Sustainability at AIT needs to have its imprint in all spheres of its activities covering curriculum development, research, operation, outreach, among other priority areas.

The journey towards sustainability would take AIT through sustainable and low-carbon pathways highlighted by the wise consumption of goods, waste minimization and recycling, water conservation and reuse, energy efficiency, renewable energy use, agriculture and food, housing and transportation, construction, office automation, information technology, purchasing and procurement, sustainable business practices, and management.

Creating a Green AIT Campus means focusing at least on the following major sustainability themes, including sustainable, green procurement:

1. Energy, water, and waste management (3R - reduce, recycle and reuse),
2. Sustainable transportation,
3. Natural resources and wilderness preservation,
4. Application of information and communication technologies, and others.

AIT Campus Scenery

Demonstration Projects for Year 1 and 2

The following activities will be developed and implemented as demonstration projects:

Baseline Setting: Studies for gathering the overall ecological and/or carbon footprints from waste, wastewater, and energy usage in the Institute.

Waste Reduction, Reuse, Recycle: Mandatory waste segregation for student, staff, and faculty houses, food waste recycling bins, and composting or an anaerobic digestion. Policy to minimize the use of plastic while increasing the use of reusable bags when purchasing items inside the campus.

Water Management and Wastewater Treatment and Reuse: A pilot-scale wetlands system for wastewater treatment.

Energy Efficient Building and Operations: Adding onto the current energy efficient initiatives at the Energy Building and by installing solar lighting in the campus.

Sustainable and Green Purchasing: Preparation of sustainable purchasing code of conduct for office and others in campus.

Documentation and Dissemination of Sustainability Performance through Interactive "Eco-Campus Web Portal": Since sustainability is a continuous process, continuous monitoring and evaluation and the dissemination of sustainability performance is essential. The development of an interactive "Eco-Campus Web Portal" could be a part of the entire sustainability plan that can facilitate discussion of sustainability ideas by all stakeholders while serving as a platform for presenting sustainability indicators and the Institute's performance.

Daylight Availability and Light Pipe Application in an Academic Building

The evaluation of daylight availability in an academic building at AIT was conducted in this study by using a software simulation. This evaluation supported the installation of a light pipe in an area not reached by natural light.

Software validation was done by comparing the results of daylight illuminance from the simulation with measured data. Rooms with different window orientation in the reference building were chosen for measurement - facing north, south, east, and facing both south and west.

The estimation of daylight availability in the referred building was conducted through 11 representative rooms with various characteristics such as window orientation, number of shading devices, and window areas. The results of daylight availability showed that all rooms in the referred building do not meet the minimum standard of 300 lux as task of office and class room. The rooms need additional lighting from artificial lighting to satisfy the users. Performance lighting was compared between the contribution of daylighting and artificial lighting.

Results showed that the illuminations from artificial lighting in some rooms meet the minimum standard and some rooms do not, due to the position of lamps in the workplace, properties of lamp, and types of lamp fixture. When a room/space does not have any windows, it will require lighting from artificial sources throughout the day. Two 3.4-watt LED lamps and 1 36-watt T8 fluorescent lamp have been installed in a corridor (20 hours/day approximately).

A vertical light pipe was installed at the corridor to provide daylight. The design of light pipe is vertical cylindrical tube with 60-cm diameter, 3.8-m length and 90% reflectance of aluminum tube. It provides sufficient daylight illuminance during 8:00-16:00 hour and meets the minimum level of 100 lux for 5-8 hours/day in a year which can save electrical energy of 107.64 kWh/year.

Before installation of light pipe

After installation of light pipe

Energy Efficiency

Studies at AIT concentrated on the implementation of energy efficiency and energy conservation of lighting system at selected areas for greenhouse gas (GHG) emission reduction. It was determined that electricity consumption contributed to the highest share of GHG emissions (50%), followed by transportation (37%), waste generation (11%), and others (2%) giving a total of about 15 ktCO^{2}eq/year. The average GHG emission of AIT is 4.32 tCO2eq/capita. Policy recommendations for moving towards low carbon campus were also proposed for AIT.

Energy Building

Energy Building

In 2008, a research on the assessment and implementation of technical measures to reduce lighting load was performed at AIT's Energy Building. This was based on data showing that lighting accounts for an important portion of the Institute's electricity consumption - about 38% on weekdays and 27% on weekends.

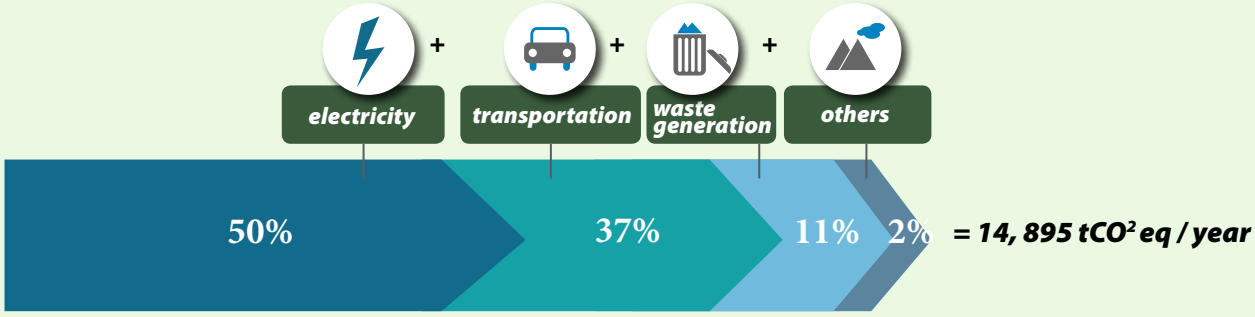
The study determined that the total saving was at least 6,570 THB per month (1,960 kWh) or 78,800 THB annually (23.5 MWh). This accounts for approximately 22% considering savings based on measurements and would also lead to carbon dioxide emissions reductions to 16.9 tons per year.

The electricity consumption was measured before and after the implementation of measures. It was found that electricity consumption was reduced to at least 22 MWh per year (74,000 THB per year) and CO2 emission reduced to 15.6 tons per year.

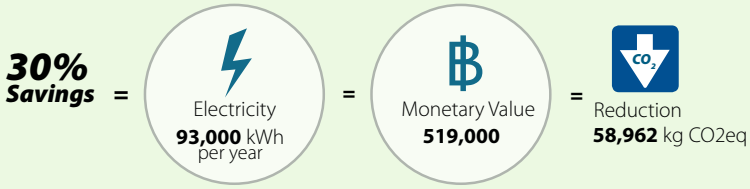
Environmental Engineering and Management (EEM) Building

Completed in May 2010, this study concentrated on implementation of energy efficiency and energy conservation of lighting system at selected areas in AIT for greenhouse gas (GHG) emission reduction. Policy recommendations for moving towards low carbon campus were also proposed for AIT.

The major activities of AIT considered included the analysis of AIT's carbon footprint. It was determined that electricity consumption contributed the highest share of GHG emissions (50%), followed by transportation (37%), waste generation (11%), refrigerant leakage (1%) and stationary combustions (1%) giving a total of 14,895 tCO2eq/year. The average GHG emission of AIT is 4.32 tCO2eq/capita.



The implementation of energy efficiency and energy conservation measures during a period of 16 weeks at the EEM laboratories resulted in the overall electricity saving of about 30%. Implementing energy efficient technologies contributed to 20% while energy saving promotion and awareness programs saved 10%. The results were evaluated through interviews and measurements after implementation of all activities. In terms of monetary value, the study determined that almost 17,000 THB per month can be saved with a one year payback period of energy efficiency measures.



In terms of monetary value, the study determined that an approximate 17,000 THB per month can be saved with the payback period of energy efficiency measures was about one year.

Green Day, November 2010.

Biogas and Anaerobic Digestion

Managing Organic Waste in AIT with Dry Anaerobic Digestion

According to the waste audit conducted in 2006, the Institute generated about 2 tons of waste each day, and 60% of which was organic waste. Paper and cardboard shared a larger proportion. Fifty percent of solid waste generated from AIT administrative offices were paper.

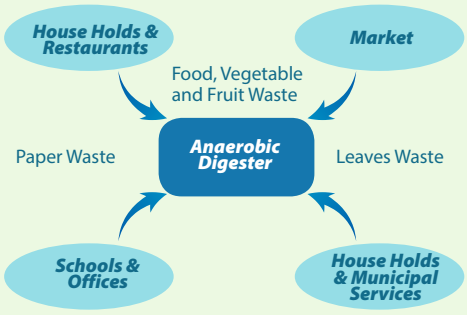
Material and energy recovery from these organic fractions of the waste is possible with technologies like Composting and Anaerobic Digestion (AD) respectively.

On-site decentralized AD system proves beneficial to a closed or small community living such as university campuses, considering it reduces the waste sorting, handling and transporting, as well as full utilization of the energy recovered back into the community.

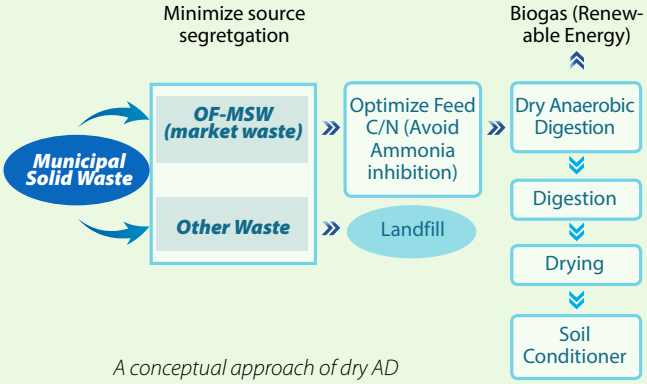
The AIT campus successfully demonstrated the production of biogas from organic fractions of waste such as paper waste, vegetables, and fruit waste using the dry AD. Dry AD with thermophilic condition facilitates higher organic loading rates and provides improved process performance and biogas yield than the wet process under hemophilic condition.

The most critical step is the feed preparation. Shredded paper (10-15 mm) was mixed with other putrescible municipal solid waste (MSW) to maintain the optimum C:N ration and high organic loading because paper waste usually have very high carbon content but less than 0.05 % nitrogen. During the startup period, an active and homogeneous inoculum consisting of cow dung, anaerobic sludge, and anaerobic reactor digestate can be used. In addition, pH was maintained at 7. The system produced a methane yield of 1630 L/kgVS/d in dry condition. Even in a semi-dry condition, the biogas yield was 1445 L/kgVS/d more than in wet condition. The digestate was further treated and used as a soil amendment product.

As AIT is envisioning to transform into a sustainable living laboratory, translating this successful demonstration of a pilot scale decentralized dry AD serves a perfect home-brew technology solution for the organic waste and energy management of the institute.

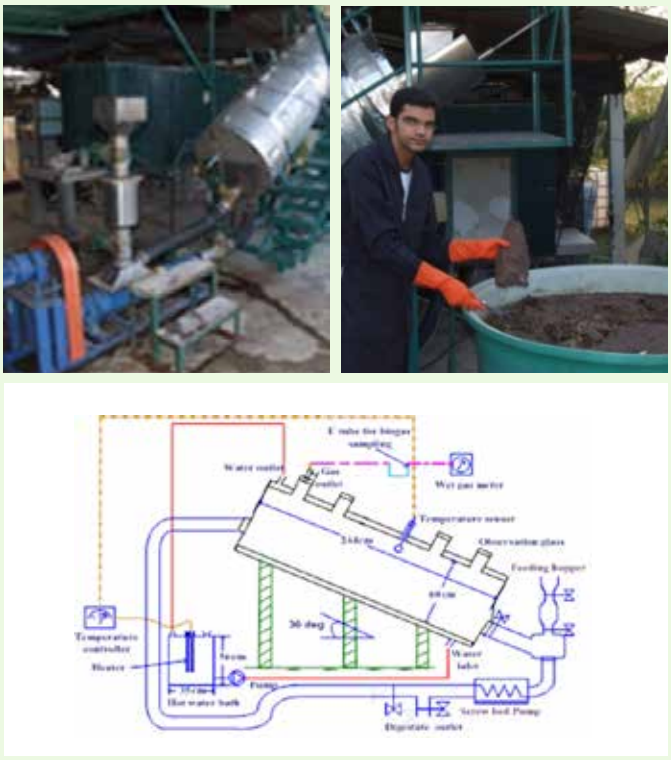


Decentralized AD in a small community



A conceptual approach of dry AD

Feed figure preparation and the pilot dry AD



Pilot-scale dry AD design details

Realising AIT's Living Laboratory

AIT's academic activities through applications oriented towards innovative curriculums and programs were a model for Asia in the last century. In the 21st century, when Asia is expected to lead the world, the need for sustainability concepts being imprinted on the decision makers is more relevant. Therefore, the concept of a Living laboratory is being initiated, and it is believed that this can have far reaching influence in the coming years, in the region and the world.

The potential impacts of AIT's Living Laboratory are long-term and transformative:

- Students, staff, faculty and residents witness and live in an environment where sustainability principles are adhered to on a daily basis
- Visitors and potential donors would be inspired by the way AIT demonstrates its vision
- Resource efficiency will be improved, leading to financial benefits, as co-benefits to the institute

Academic institutions have long been agents of change – catalysts for action and centers of learning. Realizing a Living Laboratory in AIT will advance the boundaries of knowledge; inspire leaders, decision-makers, and teachers; and play a significant role in promoting responsibility for generations to come.

Thanks to initial seed fund from the French Agency for Energy and Environmental Management (ADEME), the following activities were initiated in March 2014 as part of the Green Campus Initiative and the demonstration activities for the year 1 and 2.

- Wastes at AIT: Generation, Reduce, Reuse, Recycle, and Disposal
- Water consumption and waste water
- Collection, management, and disposal of hazardous and toxic waste
- Lighting electricity consumption reduction
- Green sustainability of cooking facilities
- Promoting participatory homestead sustainable vegetable production
- Healthy AIT Eco- Campus through Greener and Diverse Wetlands: Eco-city Approach
- Promoting bicycle-access to harmonize walking and cycling
- Web-based water level and water quality monitoring system using open-field server

The results of these initiatives are expected to lead to more activities for a greener AIT.

AIT Sustainability Club

AIT
Sustainability Club

The AIT Sustainability Club was initiated in February 2014 and currently boasts of over 100 members. As one of the first activities of the club, plastic bag use was reduced in the campus and replaced with cloth bags. With a donation of more than 50 cloth bags, the volunteers of the club provided these cloth bags to the grocery store, Lawson 108 shop, and other outlets in the campus. Customers of these shops can now use these bags as they purchase goods and return the empty bags to the shops or to predetermined spots in the residential areas. The initial response from the AIT community has been very positive; expansions of this activity are being planned.

The AIT Sustainability Club meets twice a month (2nd and 4th Thursday). For more information, visit: https://www.facebook.com/aitcampussc

News in Brief

AIT can be a regional hub for sanitation R&D: Bill and Melinda Gates Foundation

Dr. Doulaye Kone, Senior Program Officer, Bill and Melinda Gates Foundation (3rd from right) discusses about collaboration with AIT Interim President, Prof. Worsak Kanok-Nukulchai (2nd from right) and other AIT officials.

The US-based Bill and Melinda Gates Foundation (BMGF) has signified its vision for growing its partnership with the Asian Institute of Technology (AIT) in aim of improving human sanitation services in developing countries, one of the Foundation's prime sustainable development objectives.

On 15-16 May 2013, Dr. Doulaye Kone, Senior Program Officer, BMGF, visited AIT to disclose his idea titled "Sustainable Decentralized Wastewater Management in Developing Countries: Design, Operation and Monitoring" and to discuss about further collaboration with AIT. Dr. Kone visited to familiarize himself with the latest work of BMGF-funded Naturally Acceptable and Technologically Sustainable (NATS), a US$ 5-million AIT project spearheaded last year by Dr. Thammarat Koottatep of Environmental Engineering and Management at AIT's School of Environment, Resources and Development, which aims to "reinvent the toilet", starting in Thailand, Cambodia, and Vietnam.

NATS applies a market-driven research approach to catalyze commercialization of sustainable decentralized wastewater management systems to radically improve sanitation for the urban poor in Asia. The AIT-led effort is anchored in science and technology, and is strongly supported by market evidence for development of products that impact people's lives for the better.

According to Dr. Kone, BMGF's aim for this project is to challenge the Asian research community to come up with new ideas for tackling the poor sanitation situation in developing countries. BMGF is interested in linking up with other R&D organizations in the region, and is considering the idea of AIT as a regional hub for collaboration on sanitation technology research and development, policy development, and applications for sustainable development.

The meeting on May 15 was attended by Prof. Worsak Kanok-Nukulchai, Interim President of AIT; Prof. Kanchana Kanchanasut, Vice President for Research; Prof. Siddharth Jabade, Intellectual Property Specialist, AIT Consulting; and Dr. Thammarat Koottatep.

March 2013 | Bangkok, Thailand

Source: *Media and Communications Unit, AIT*

AIT to promote Habitech Building Technology in Africa

L-R: Prof. Stephen Olu Ogunlana, former faculty, Structural Engineering, SET, AIT; Dr. Elizabeth Bola Ogunlana, Director and CEO of EPSL Prof. Worsak Kanok-Nukulchai, Interim President, AIT and Mr. Gyanendra R. Sthapit, Interim Director, Habitech Center, SET.

Asian Institute of Technology (AIT) will promote Habitech Building Technology in Nigeria and other countries in Africa following the signing of a Memorandum of Understanding (MoU) with Elim Project Systems Limited (EPSL), Scotland, UK.

The MoU was signed on 17 June 2013 by Dr. Elizabeth Bola Ogunlana, Director and CEO of (EPSL), and Prof. Worsak Kanok-Nukulchai, Interim President of AIT.

Besides promoting Habitech building technology, both parties will also develop joint proposals for submission to prospective funding agencies to facilitate the provision of decent and affordable housing in Africa. The MoU also stipulates joint collaborative research projects and joint training courses in the field of building material production and construction, and community development activities in relation to affordable housing.

Prof. Stephen Olu Ogunlana, former faculty of Structural Engineering in AIT's School of Engineering and Technology (SET) and Mr. Gyanendra R. Sthapit, Interim Director, Habitech Center, SET attended the MoU signing ceremony.

Habitech Center specializes in creating cost-effective housing system called Self-Contained Housing Delivery System or Habitech Building System. Nearly 150 projects based on this system have already been implemented.

June 2013 | Bangkok, Thailand

(Details about EPLS are available at this link: http://www.elim-project.com/About.htm)

Source: Media and Communications Unit, AIT

Exploratory Meetings with Alumni

Myanmar

In mid-March, ten alumni representing the AIT Alumni Association (AITAA) – Myanmar Chapter joined the team from AIT Consulting (AITC), Dr. Naveed Anwar, Executive Director, and Engr. Thaung Htut Aung, Coordinator, Structural Engineering, for a dinner meeting at the Kone Myint Thar Restaurant, Yangon, Myanmar.

The meeting was organized by Mr. Saw Htwe Zaw, M.Eng. Structural Engineering '90, a key structural engineer from S&A Co. Ltd., who is also handling one of AITC's structural peer review projects, the Diamond Inya View Palace Building.

Potential collaboration between AITC and the AIT alumni based in Myanmar were discussed among the 10 alumni who attended including Mr. Toe Hlaing, Technical Director, MA GA Manufacturing Company Ltd. and Mr. Kyaw Thu Oung, Director of Business Development, Aung Pyitan Co., Ltd., Myanmar, who both expressed immediate interest in working with AITC in the area of structural engineering. Following the meeting, AITC submitted two proposals to MA GA Manufacturing Company Ltd. on Structural Design and Testing of Electricity Poles and for Slab Testing.

March 2013 | Yangon, Myanmar

Malaysia

The AITAA - Malaysia Chapter met with Dr. Naveed Anwar, Executive Director, AIT Consulting (AITC), together with Prof. Joydeep Dutta, Chair in Nanotechnology, Water Research Center, Sultan Qaboos University, Oman at the Renaissance Hotel, Kuala Lumpur, Malaysia.

Heeding the advice of AITC advisory board member and AIT alumnus, Mr. Tuck Oon Choong, M.Sc. Computer Science '84, AITC organized this get-together to deepen relationships with key AIT alumni. Eighteen alumni attended the event, many of whom are decision makers in their respective fields.

Following a short introduction of AITC by Dr. Anwar and updates on AIT by Prof. Dutta, discussions on possible collaboration proved fruitful with the group. Several leads for collaboration in various areas of expertise were identified. Possibilities for involvement included collaborating for future project review and independent engineering services and developing linkages with the Institution of Engineers Malaysia (IEM) for jointly conducting seminars, training and other professional activities. The possibility of conducting short course AIT programs and workshops for undergraduate and graduate students from various universities in Malaysia was also discussed.

April 2013 | Kuala Lumpur, Malaysia

Cambodia

Early April, the AITAA - Cambodia Chapter met with AIT Consulting (AITC) representatives Dr. Naveed Anwar, Executive Director, and Dr. Siddharth Jabade, Director, Innovation and IPR Unit for a dinner meeting at Phnom Penh, Cambodia.

The meeting was organized through AIT alumnus Dr. Mom Mony, M.Eng. Structural Engineering '99, President and CEO, Mony Engineering Consultants Ltd. Dr. Mony is also a current partner of the Asian Center for Engineering Computations and Software (ACECOMS) Associate Center in Cambodia. Since 2011, AITC and ACECOMS have been functioning symbiotically, synergizing on projects covering software development, seminars, and capacity building.

The Cambodian alumni showed great interest in the collaborating with AITC specifically as resource persons and experts for selected future projects undertaken by AITC in Cambodia and the region more broadly, and as associates to jointly undertake projects in their areas of expertise in the country.

April 2013 | Phnom Penh, Cambodia

Executive-style Course : Environmental Management and Climate Change

An Executive-style course on Environmental Management and Climate Change was conducted by the Asian Institute of Technology (AIT) in collaboration with CSR Asia delivered on 6-9 September 2013. Participants joined from Hong Kong, Myanmar, Malaysia, and China to discuss contemporary environmental challenges and business-related tools, management systems, and life-cycle based approaches for reducing operational impacts on the environment during four days of intensive training. The practical course focused on business contributions to mitigating and adapting to climate change as well as approaches to developing comprehensive climate change strategies.

Course leader Prof. Richard Welford, founder and Chairman of CSR Asia and adjunct faculty at AIT's School of Management, together with four distinguished AIT professors and four guest speakers from United Nations Environment Programme (UNEP), Regional Resource Center in Asia and the Pacific (RRC.AP), Women Organizing for Change in Agriculture & Natural Resource Management (WOCAN), and the World Wildlife Fund (WWF) facilitated the sessions and guided participants in planning environmental management strategies for their own organizations.

AIT and CSR Asia designed eight intensive four-day courses to meet the needs of professionals who seek high-level competencies to manage complex social, environmental, and governance challenges in a competitive business environment and make CSR more strategic. The courses aim to build capacity in the private sector to manage the sustainability challenges in Asia and the Pacific.

For more information on the courses and other topics covered in the courses, please visit: *www.csr-asia.com/4-Day-Courses.php.*

AIT's Prof. Kanchana inducted into global Internet Hall of Fame and 25th Anniversary of ".TH"

Prof. Kanchana Kanchanasut, affectionately referred to as the "Mother of the Internet in Thailand", was inducted into the global Internet Hall of Fame by the Internet Society based in Geneva, Switzerland on 26 June 2013. Prof. Kanchanasut brought the Internet to Thailand and was actively involved in many Internet connectivity initiatives in other Southeast Asian countries, championing the idea of email, and later the Internet, in that region in the 1980s. She directs the Internet Education and Research Laboratory at the Asian Institute of Technology (AIT) in Thailand, where she is also Interim Vice-President for Research and professor of Computer Science at its School of Engineering and Technology. She has also been Interim Vice President for Research at AIT since April 2013. She set up the first experimental domestic research and education network in her nation in 1988, connecting five universities in Thailand with dial-up connections to the Australian Academic and Research Network. She also registered the .TH domain name and has been its administrator since 1988. June 2013 also marked the 25th anniversary of ".TH" signaling the length of time Thailand has been connected to the Internet through AIT. In 1991, Dr. Kanchanasut's efforts led to the first leased line with TCP/IP connection to the global network. Her current research focuses on challenged and emergency networks, digital media communication and tele-education.

For the full citation: http://www.internethalloffame.org/inductees/kanchana-kanchanasut
Source: Internet Society Hall of Fame

ACECOMS promotes CSI Software at the 16th ASEP International Convention

Mr. Thaung Htut Aung, Project Coordinator, AIT Consulting (center) with representatives from ACECOMS Satellite Center, The Philippines, Mr. Harry Wong (right) and Ms. Vickie Tan Wong (left) at the CSI Software Exhibition Booth.

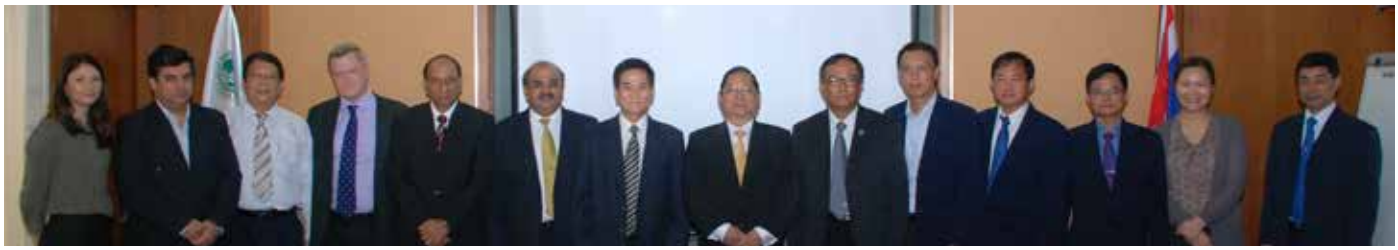
The Association of Structural Engineers of The Philippines (ASEP) held its 16th ASEP International Convention on 23-25 May 2013 at the Dusit Thani Hotel, Makati City, The Philippines. ASEP is a nationally recognized association established in 1961 to advance structural engineering practice; uphold high ethical values; and promote national and international professional collaborations with governments, industry, and academe. This year's convention featured the theme "Prolonging the Life of Structures" which consistently resonated during the various sessions and lectures covering topics such as extreme loads and environment, structural health monitoring and assessment, restoration and rehabilitation of structures, retrofitting and strengthening of structures, and performance-based design. The convention also featured a two-day exhibition highlighting structural engineering products and projects of the event sponsors.

The Asian Center for Engineering Computation and Software (ACECOMS) in coordination with its Satellite Center in Manila, Philippines participated in the event in order to promote the Computers & Structures, Inc. (CSI) software. CSI, one of the major event sponsors, is recognized globally as the pioneering leader in software tools for structural and earthquake engineering. ACECOMS is currently providing support to CSI for the development of design tools, particularly for the ETABS software package used by engineers in building and structure design of multi-story commercial and residential structures.

A short presentation on the newest version of the ETABS2013 software was performed by Mr. Thaung Htut Aung, Project Coordinator, AIT Consulting. An exhibition booth featuring CSI software was prepared with assistance of Mr. Harry Wong and his team from the ACECOMS Satellite Center in Philippines. Promotional efforts included a one page advertisement in the souvenir program and the visual references to the CSI logo during the event such as the center stage of the convention venue, the ASEP website, and the give-away materials such as the convention bags and kits.

May 2013 | Makati, Philippines

Myanmar's Deputy Minister of Construction Expresses Interest in Collaborating with AIT



H.E. Dr. Win Myint, Deputy Minister, MOC (7th from right); Mr. U Kyaw Linn, Managing Director, MOC (6th from right); and Prof. Worsak Kanok-Nukulchai, Interim President, AIT (8th from right) with other MOC and AIT Officials.

Myanmar's Deputy Minister of Construction (MOC), H.E. Dr. Win Myint, led a five-member delegation of senior ministry officials from MOC on a one-day visit to the Asian Institute of Technology (AIT) to explore collaboration between MOC and AIT. The meeting was also an opportunity to discuss the rules and regulations of the engineering council in the ASEAN region, of which AIT as a regional institute is highly familiar with. This meeting was in response to an invitation extended by Dr. Naveed Anwar, Executive Director, AIT Consulting and Mr. Thaung Htut Aung, Project Coordinator, AIT Consulting who both visited Myanmar in June 2013.

The high-level visitors were warmly welcomed to the campus by Interim President Prof. Worsak Kanok-Nukulchai, who reiterated AIT's strong desire to assist Myanmar's development through capacity building and technical training. The creation of an Engineering Council in Myanmar, similar to the one existing in Thailand, was high on the agenda during the meeting and Prof. Worsak Kanok-Nukulchai promised to assist the officials with contacts and any available expertise as much as possible for such purpose.

H.E. Dr. Win Myint remarked that he is eager to aid the development of his country by dramatically increasing the professional capacity and expertise of its engineers and thus expressed an interest in AIT playing an active role. His Excellency then expounded on the discussions with AIT Consulting for a 3-month Hybrid Professional Development Programs on bridges and tall buildings for MOC engineers.

Other members of the delegation from the Ministry of Construction, Myanmar included Mr. U Kyaw Linn, Managing Director; Mr. U Aung Myat Oo, Chief Engineer; Mr. Nay Aung Ye Myint, Deputy Chief Engineer; and Mr. Tin Oo, Deputy Superintendent Engineer, Bridge Construction Unit 9.

July 2013 | Bangkok, Thailand

Nepal President Assures AIT of Nepal's Full Support during AIT Delegation's Visit

Professor Emeritus Dr. Sahas Bunditkul, Chairman of the Executive Committee of the AIT Board of Trustees and former Deputy Prime Minister of Thailand, together with Professor Worsak Kanok-Nukulchai, Interim AIT President, led an AIT delegation on an official visit to Nepal during the third week of July 2013. The delegation was invited by the AIT Alumni Association-Nepal (AITAA-N) and the Nepal Education Foundation-Consortium of Colleges, Nepal (NEF-CCN) for a three-day visit, which was highlighted by meetings with the country's President, Chairperson of the Interim Election Government, and Foreign Minister.

On the first day in Kathmandu, the AIT delegation had the opportunity to visit the President of Nepal, Rt. Honorable Dr. Ram Baran Yadav, whose son is also an AIT alumnus. During the meeting, the President showed his appreciation for AIT's contribution to the human resource development of Nepal, assuring AIT of his country's full support, including the possibility of AIT setting up a satellite campus in Nepal.

The following day, the delegation paid a courtesy call on the Rt. Honorable Mr. Khil Raj Regmi, Chairperson of the Interim Election Government,

President of Nepal, Rt. Honorable Dr. Ram Baran Yadav (center) next to Professor Emeritus Dr. Sahas Bunditkul (left), and Interim AIT President Prof. Worsak Kanok-Nukulchai (right), with government officials and AIT delegates.

who also showed his appreciation to AIT for playing an important role in the country and region. The meeting discussed the possibility of AIT launching modular programs intended for Nepali government officials as well as the possibility of AIT setting up an undergraduate satellite campus in Nepal.

This was followed by a meeting with the Nepal Foreign Minister H.E. Mr. Madhav Prasad Ghimire, who is also an AIT alumnus. During the meeting, Foreign Minister Ghimire gave his assurances in expediting the launch of the inaugural two scholarships from the Government of Nepal for Nepalese nationals to pursue their higher studies at AIT, as well as for the replenishment of the AIT Nepalese Local Currency Fund. He also welcomed any proposal to set up an AIT satellite campus in Nepal, and assured AIT of the Government of Nepal's full blessing.

Dr. Naveed Anwar, Executive Director, AIT Consulting, who was in Nepal at the time conducting site visits for an ADB-funded program on School Disaster Risk Reduction, joined the AIT delegation which included Mr. Sanjeev Jayasinghe, Interim Head of Alumni Affairs and AIT Fundraising Director, and Mr. Karma Rana, Institute Secretary.

July 2013 | Kathmandu, Nepal

Over 35 participants attend the ACECOMS Workshop on Modeling, Analysis, and Design of Reinforced Concrete Buildings using ETABS in Lao PDR

Mr. Keerati Tunthasuwat, Senior Manager, ACECOMS (first row, third from right) with the workshop participants

On 17-19 July 2013, the Asian Center for Engineering Computation and Software (ACECOMS) in collaboration with the Vientiane Institute of Technology (VIOT), and Lovanh Consultants, organized a Workshop on Modeling, Analysis, and Design of Reinforced Concrete (RC) Buildings using the ETABS2013 software in Luang Prabang, Lao PDR.

The workshop welcomed over 35 structural engineers from private and government organizations located in the Northern region of Lao PDR. The main objective of the workshop was to train the engineers in using the newest version of the ETABS software package, which is developed by Computers & Structures, Inc. (CSI) with support of ACECOMS. The ETABS software is used by engineers in building and structure design of multi-story commercial and residential structures.

Mr. Keerati Tunthasuwat, Senior Manager, ACECOMS led the three-day workshop. The first day featured topics including building structural systems; overview of modeling, analysis and design of building structures; gravity load systems; and lateral load systems. The second and third day featured three hands-on training workshops covering the topics on modeling, analysis and design of RC buildings using templates; modeling, analysis and design of 10 story RC buildings; and the best practices from actual RC building projects.

July 2013 | Luang Prabang, Lao PDR

Over 60 Participants from 5 Countries Join International Seminar and Workshop on Performance Based Design of Reinforced Concrete Buildings

On 27-28 August 2013, the Asian Center for Engineering Computations and Software (ACECOMS) in collaboration with AIT Consulting, organized a seminar and workshop on the Performance Based Design of Reinforced Concrete Buildings at the AIT Hotel and Conference Center, Asian Institute of Technology, Bangkok, Thailand.

The seminar welcomed over sixty participants from the Philippines, Myanmar, Thailand, Brunei, and Hong Kong, ranging from practitioners with diverse backgrounds, and students from AIT.

The two-day seminar and workshop provided the necessary background and hands-on demonstration of performance based design of concrete buildings. Performance Based Approaches (PBA) have gained considerable acceptance in the recent years for determining and designing structures for specific hazards, especially earthquakes. PBA provides a rational and systematic way for determining the performance of structures using relatively rigorous techniques and tools, including the effects of non-linearity and dynamics to achieve specific response targets.

The seminar covered topics such as Performance Based Design Overview, Modeling for Pushover and Nonlinear Dynamic Analysis, Modeling for Performance Based Design in SAP2000, Modeling for Performance Based Design in PERFORM 3D, Capacity Based Design of Structural Components, Wind Effect on Buildings and Wind Tunnel Test Procedures, Site-specific Seismic Hazard Assessment, and Nonlinear Analysis of Ductile Core Wall Building in SAP2000.

Key instructors at the seminar included Dr. Pennung Warnitchai, Associate Professor, Structural Engineering, School of Engineering and Technology, AIT; Dr. Naveed Anwar, Executive Director, AIT Consulting; Dr. Teraphan Ornthammarath, Scientist, Seismic Risk Evaluation and Mitigation Regional Integrated Multi-Hazard Early Warning, System for Africa and Asia (RIMES); and Mr. Thaung Htut Aung, Coordinator, Structural Engineering Unit, AIT Consulting.

August 2013 | Bangkok, Thailand

Launch of New Hybrid Professional Development Program

A Hybrid Professional Development Program that has been under development for the past few months was launched early September 2013 by the Asian Institute of Technology (AIT) through AIT Consulting.

The Hybrid Program offers a value-added interactive learning facility and is based on AIT's rich academic legacy and expertise to serve the needs of community seeking educational inputs for skill enhancement and added qualification.

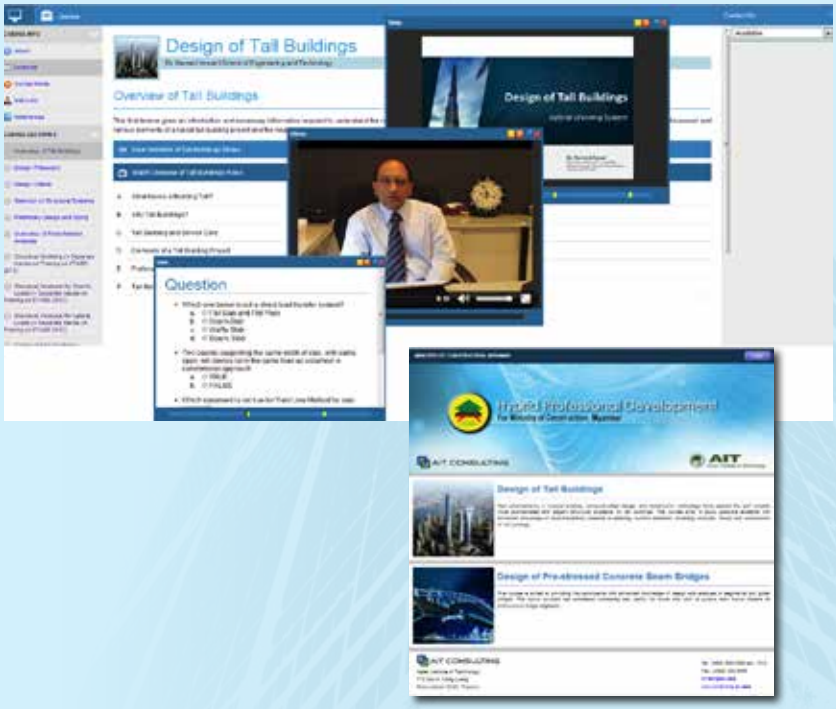
Aiming to be a tool to provide wider access to quality professional programs through a combination of distance and classroom approaches, the Hybrid Program is set to bridge the gap between teachers and students regardless of their geographical locations. Through its online component, courses are offered online while giving the participants the same learning experience with the courses delivered inside a classroom. The program is divided in six key phases, including: written pre-evaluation, registration for online course, delivery of the online course, hands on training, on-the-job training, and online evaluation.

The Ministry of Construction (MOC) based in Naypyidaw, Myanmar will be the first client to utilize and experience the Hybrid program for two professional development programs. MOC is responsible for the country's construction and maintenance of public infrastructure, including roads and bridges. The ministry also oversees the initiative to professionalize engineers and bring them at par with their international peers.

Following the visit of Dr. Naveed Anwar, Executive Director, AIT Consulting and Mr. Thaung Htut Aung, Project Coordinator, AIT Consulting to the MOC, Myanmar in June 2013, it was decided that AIT Consulting would provide two programs covering the topics on the structural design of tall buildings and bridges. The professional development programs for the officials from MOC were designed for 15-20 participants for each program. The onset of the first professional development program on the topic of Tall Buildings was on 9 September and is set to run until 15 November 2013. The second program on the topic of Bridges was conducted over a three-week period, from 16 September to 22 November 2013. All the key phases of the training are being conducted in Myanmar except for the on-the-job training which will be implemented in Bangkok, Thailand.

The participants will be able to access the online components through personal computers and mobile devices such as phones and tablets. Participants may create their own profile, use online functions such as a virtual desk, calendar, mail, and an online library.

September 2013



Quiz : TALL BUILDINGS

Part 1: True/False

1. In "limit state design", some part of "factor of safety" is applied to "strengths" and some part is applied to "actions". ***(True/False)***
2. Lack of explicit performance in design codes is primary motivation for performance-based design. ***(True/False)***
3. Performance-based design ensures that structure as a whole reaches a specified demand level (including both service and strength design levels). ***(True/False)***
4. The action-deformation curve at material level is moment-curvature curve. ***(True/False)***
5. Coupling of walls and columns solely by slabs is a relatively weak source of energy dissipation. ***(True/False)***

Part 2: Multiple Choices

1. Among all structural analysis methods, the most rigorous numerical analysis is:
   a. Non-linear time history analysis
   b. Response spectrum analysis
   c. Non-linear static pushover analysis
   d. Non-linear large displacement analysis
2. Idea of "Plastic Hinges" corresponds to concept of:
   a. Point non-linearity
   b. Lumped non-linearity
   c. Member non-linearity
   d. None of the above
3. Which is the incorrect statement regarding slab systems:
   a. Slab thickness depends on span lengths, aspect ratio, continuity conditions, and steel strength of reinforcement
   b. Main reinforcement is provided in two orthogonal direction in one way slab systems
   c. Slab can be modeled usingplate and shell elements
   d. Two way slab can be design by using either strip method or yield line method
4. Factors affecting slenderness effects in columns are:
   a. Effective length
   b. Effective stiffness
   c. Loads
   d. All of the above
5. The limitation of strip method of slab design:
   a. Based on assumed location of yield lines
   b. Can lead to over-conservative design and /or poor serviceability
   c. Both (a) and (b)
   d. None of the above

Answers on page 56

Upcoming Events

Green Technology Workshop at AIT

Following the success of AIT Technology Event in July 2013, the Asian Institute of Technology (AIT) will organize focused events this year, one on Green Technology.

The Green Technology Workshop 2014 to be held in June at the AIT Conference Center, Pathumthani, Thailand is a follow up on the two issues discussed during the AIT Technology Event: "What makes buildings green and sustainable?" and "Reducing the carbon footprint through sustainable production practices" in response to requests from the participants to further discuss and elaborate those impetus.

One of the speakers in the AIT Technology Event, Dr. Brahmanand Mohanty, Energy Expert and Visiting Faculty at AIT, will be the workshop's key presenter. The topics include "Industrial best practices of energy and environment management" and "Green building certification systems: advantages and drawbacks."

The workshop aims to provide a platform for both public and private sector in the field of buildings and the industry in discussing, interacting, and networking as well as discovering innovations in policy, technology, and best practices that will assist to achieve greater success in their sustainability efforts.

Nanotechnology Workshop at AIT

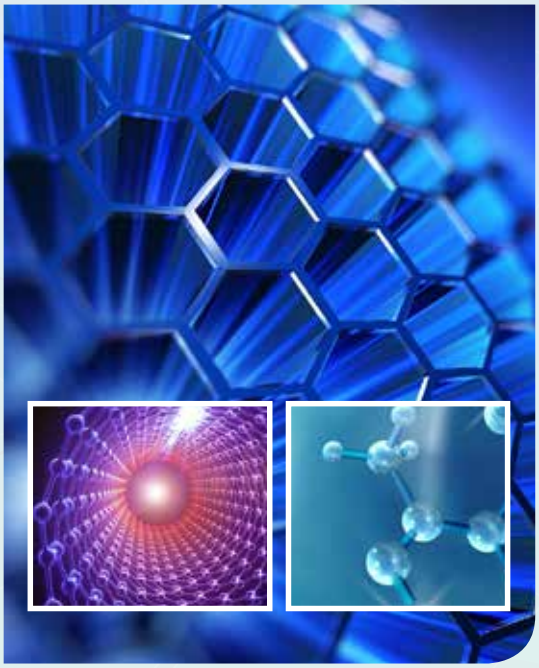
The Asian Institute of Technology (AIT) will organize the Nanotechnology Workshop 2014 to be held in July 2014 at the AIT Conference Center, Pathumthani, Thailand.

The Nanotechnology Workshop 2014 is a follow up on the topic ***"Practical Nanotechnology today - concepts to applications"*** presented during the highly-informative AIT Technology Event in 2013.

During the AIT Event, one of the speakers, Prof. Joydeep Dutta presented several nanotechnology applications that are already in the market from the information technology, energy, medicine, and consumer sectors. He mentioned that some of the nanotechnology applications that are available today were developed and refined in AIT.

In response to requests from the participants to further discuss and elaborate the applications of nanotechnology, this one-day focused event will be an opportunity to interact with researchers and scientists in discussing, interacting, and networking as well as discovering advancements in nanotechnology and nanomaterials in the fields of energy, and environmental technology that are available at the Institute.

Prof. Louis Gabor Hornyak, Interim Director, Center of Excellence Nanotechnology (CoEN) at AIT, will be the workshop's key presenter. He will focus on the promising approaches of Nanotechnology towards sustainable production and consumption that will reduce emission and waste.



Interested industry leaders and developers as well as development agencies are invited to participate in this event.

For more information, please contact:

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Asian Institute of Technology
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The AIT Technology Event

The AIT Technology Event explored the key benefits in adopting advanced technologies for the performance enhancement of organizations, businesses, and their specific projects. Over 200 delegates representing more than 130 organizations from more than 16 countries across Asia and the rest of the world attended the exclusive event.

The AIT Technology Event

The first AIT Technology Event was held at the InterContinental Hotel, Bangkok, Thailand from Wednesday, 10 July, to Thursday, 11 July. An Opening Ceremony Reception was held prior on 9 July, highlighted by the attendance of the Former Minister of Foreign Affairs of the Kingdom of Thailand and AIT alumnus, H.E. Dr. Subin Pinkayan.

The technology event explored the key benefits in adopting advanced technologies for the performance enhancement of organizations, businesses, and their specific projects. Over 200 delegates representing more than 130 organizations from more than 16 countries across Asia and the rest of the world attended the exclusive event. The primary focus of conversation was to convey how AIT can support research, development, and consulting services specific to real-estate and manufacturing industries. The event also drew on the Institute's offerings from relevant and multi-disciplinary fields such as sustainability, information technology, and food security. Bringing together major stakeholders, including industry representatives, expert consultants, and policy makers, the AIT Technology Event facilitated a nexus for discussions characterized by multiple viewpoints and an exceptional quality of debate.

The format of the event involved a mixture of keynote speeches, presentations on topical issues, and extensive panel discussions, a full exhibition of AIT offerings, and plenty of scheduled time for formal and informal networking.

The two-day event addressed two themes.

- Performance Enhancement of Tall Buildings, Real Estate, and Industrial Projects
- Performance Enhancement of Manufacturing, Retail, and Distribution Enterprises

The following presents the main elements of discussions by the experts during the event.

On Public-Private Partnerships

H.E. Subin Pinkayan

Stressing the importance of public-private partnerships (PPP), Chief Guest Speaker H.E. Dr. Subin Pinkayan (Water Resources Engineering '61) said he was pleased that the event focused on how AIT's technology could benefit the business sector.

The former Minister of Foreign Affairs, Thailand, Honorary Advisor of GMS Power Public Company Ltd., and AIT Hall of Fame inductee (2010) shared his successful experience of applying public-private partnerships (PPPs) to build a hydropower station in Lao PDR early is his career. He enjoined the engineers, academics, and senior business executives to select and implement projects that benefit the public.

Dawei Development: At the crossroads of Myanmar and Thailand

Somchet Thinaphong

Prominent AIT graduate Dr. Somchet Thinaphong, Chairman, Geo-Informatics and Space Technology Development Agency, and President, Dawei Development Co., explained aspects of the large Dawei greenfield project in Myanmar. He emphasized the impact of AIT in the planned mega-project, saying it could fundamentally change Thailand's neighbor. Many of the infrastructure elements of the project incorporate engineering expertise from AIT and are the result of 25 years of technology development, he said.

On the Fast Lane: Thailand's Subway System

Chih Huang

Mr. Chih Huang, another successful alumnus, explained how Mass Rapid Authority of Thailand (MRT)'s mega-project to extend the Thai capital's subway system also carries the imprint of AIT. According to Mr. Huang, the billion-Baht project expected to finish in March 2017 is providing many opportunities for AIT expertise to take the lead. "A large number of management consultants involved in project management are AIT alumni," he said.

ASEAN is Rising: Trends and Innovations in Building and Construction Industry in the ASEAN

Chaovalit Ekabut

Mr. Chaovalit Ekabut delivered the day's Keynote Address titled 'Trends and Innovations in Building Construction Industry in ASEAN.' As the Vice President-Finance and Investment & CFO, SCG and President of SCG Investment, he spoke of his firm's vision to be the region's market leader by 2015. He noted the importance of research and development by citing how the company's engagement with Ph.D. holders has grown over the years; from employing roughly six to seven employees with doctoral degrees ten years ago, to over 70 today. There are over 1,000 researchers and designers spread in all of SCG's business units.

The former AIT Alumni Association (AITAA) President illustrated how ASEAN is one of the world's fastest growing regions based on the increase in cement consumption in the region, with Singapore leading. The majority of the ASEAN nations have a GDP of over 6% with the exception of Brunei and Singapore signaling the tremendous large-scale construction opportunities across the region.

Mr. Ekabut poignantly mentioned how the Asian Financial Crisis has influenced Thai government spending - noting that government investment into infrastructure development, with the exception of the construction of the Suvarnabhumi Airport, has been minimal after 1997. Interestingly, the cases of Indonesia and the Philippines do not differ much. It is clear that at this time, the governments in this region realize that investment in key public infrastructure is a clear and present need.

He proceeded to provide an overview of Thailand's mega projects which includes two mega projects on water management and flood prevention and the upgrade and expansion of the high speed train system. Other large-scale projects include the construction of the third stage expressway, the second phase of the international airport, and expanding the trans-ASEAN road which will connect countries such as Myanmar, Thailand, Laos PDR, Cambodia, and Vietnam.

In closing, he reminded participants of the importance of environmental sustainability in any business plan, as today's sophisticated investors look at both a firm's profit and its attention to environmental concerns.

Designing and Constructing Buildings for Higher Performance, Cost Effectiveness and Sustainability: An Overview

Naveed Anwar

Dr. Naveed Anwar, Executive Director, AIT Consulting unveiled recent developments alongside an overview of issues in the development of tall buildings. He began by providing statistics on the rate of population growth and presented relevant opportunities that can be explored due to this gradual shift to accommodate increased urbanization as forecasted globally. He illustrated how an area being occupied by 10 families can be expanded to a 40-story building that could be divided into 200 residential units. One hot topic was on the fast-paced trends in Asia exemplified by the ongoing construction of 220-storey Sky City building in China set to be completed in 7 months juxtaposed with most of Europe's resistance to the development of high-rises. For example, a tall building in the United Kingdom's The Shard, which stands at 75-stories, took ten years to get approved and be built since first proposed, completing over 200 public hearings.

He then elaborated on AIT's expertise in modeling, analysis, performance-based review and design of tall buildings, bridges, and other special structures and subsequent adaptations in different seismic zones. An example given was the opportunity to work on buckling restraint brace system (BRB) of a high-rise building in Manila, a first for the Philippines. The relationship between cost and performance was also discussed together with solutions and customizations for optimization.

How Safe are our Buildings for Earthquakes and Winds?

Pennung Warnitchai

Dr. Pennung Watnitchai, leader of the Civil and Infrastructure Engineering Group of AIT's School of Engineering and Technology (SET), elaborated on seismic hazard assessment, earthquake resistance of various structures, and other potential hazards.

He mentioned that the growth in height of tall buildings has been exponential rather than linear, and that diagrid system of buildings, which is popular in Western Europe may not be suitable for seismic zones in Asia. After providing visuals showing the devastating effects of differing ground motions and strong winds all over the world, he discussed the case of Bangkok where many tall buildings are located. A natural flood basin, the soil in Bangkok and peripheral provinces is characterized by very soft soil that can amplify the ground motion from areas as far as Sumatra and China, over 2,000 km away as in indication of seismic risks.

At AIT, Dr. Warnitchai and his team is trying to understand this issue more by measuring the dynamic characteristics of tall buildings, having completed over 100 buildings to date. Another team is working on understanding the soil basin further using the array microtremor measurement developed in Japan and is notably the best technology available today. This technology allows scientists to identify soil properties up to 1km deep.

Currently, the AIT team is measuring soil properties in 50 different locations in Bangkok.

Innovative Solutions for Foundations and Deep Basements

Dr. Noppadol Phien-wej of AIT's Geotechnical and Earth Resources Engineering field stated that AIT performed pioneering work on land subsistence in Thailand.

Noppadol Phien-wej

He noted that the construction particularly for urban areas including excavation requires emphasis on public safety while considering cost effectiveness as the duty of geotechnical engineers to society.

He provided an overview of the foundation and excavation work in soft soil citing experiences in Bangkok and Singapore as examples. Topics covered issues on ground water pumping, settlement and land subsidence, soil strength, deep excavation specifically in the context of urban development. He also mentioned the likely impacts of creating a channel and continuous digging in Bangkok, and highlighted the rising water table in the subsoil found in Chatuchak Park.

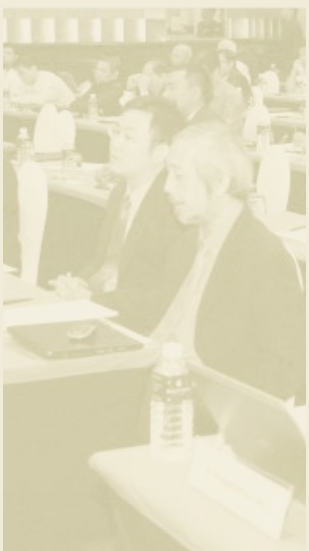
Dr. Phien-wej also gave specific techniques when performing deep excavation considering soil strength and water pressure by improving the soil on the base and applying a concrete crossbeam and dewatering to name a few.

What Makes Buildings Green and Sustainable?

Brahmanand Mohanty

Dr. Brahmanand Mohanty, visiting faculty at Energy in AIT's School of Environment, Resources and Development (SERD) revisited sustainable living approaches in the past and then showed how the human progresses since the advent of the industrial revolution have put humanity on an unsustainable path. He showed how homes built by ancestors ensured comfort of the occupants by exploiting locally available natural resources. It urged all to come full circle by blending the past wisdom with modern technology in achieving net-zero and energy-positive status for the buildings.

He noted that taller buildings are not only effective in fighting urban sprawl, but also required less materials per unit of useable floor space, and smaller surface area of envelope per floor area, thus minimizing the thermal exchanges with the surrounding. Taller buildings have the



potential to harvest solar and wind energy at height and they also provide opportunities to enjoy better air quality.

According to Dr. Mohanty, some disadvantages of high-rise residential buildings include less interaction with the occupants and the increased requirements of materials with high-embodied energy for the construction of safe and tall structures. The high-embodied energy can be justified if the buildings were designed to last longer, and consumed less energy by adopting passive design features, choosing energy efficient equipment and processes, and incorporating locally available renewable energies.

He recounted the three interesting human inventions over the past 100 to 150 years, notably elevators, electricity, and air conditioners, that were the key to the birth of high-rise buildings, symbolized by the famous Empire State Building in the United States.

He presented a sustainable energy strategy to achieve low-energy or net-zero energy buildings cost-effectively, especially in the context of developing Asia where the demand for increased floor space in residential, commercial and industrial buildings is huge. He then illustrated the virtue of retrofitting existing buildings by combining technology with building energy monitoring and control systems in order to keep both energy consumption and operating costs low. He finally concluded by emphasizing the role that national governments can play by creating public buildings that "lead by setting example".

Managing Facilities and Properties through GIS-based Integrated Systems

Hamid Mehmood

Dr. Hamid Mehmood, AIT alumnus and Assistant Professor at the Institute of Space Technology, Pakistan highlighted the importance of location data for evaluation systems for real-estate and properties applications.

Dr. Mehmood supplied information on the newly-developed FIMS – Facilities Integrated Management System, influenced by GIS-based monitoring and evaluation systems. Direct applications discussed were on site selection and strategic planning. For example, when markets change, FIMS can help determine existing locations and new markets to penetrate.

He also mentioned how maps generated from GIS can be used for diverse purposes from identifying marketing strategies to aide decision making for maintenance necessities in housing developments. The main advantage of utilizing FIMS is that it provides a visual output that can be manipulated to show data in a more useful manner.

Assessing and Managing Risk in Projects

Gregory L. F. Chiu

Dr. Gregory L. F. Chiu of AIT's Offshore Technology and Management field of study spoke about developing and implementing risk assessment.

Dr. Chiu directly addressed the ideas behind the profitable opportunities in risk management consultancy services.

He mentioned that nature of the consulting engineering is changing wherein experts are becoming technologists rather than professionals. He listed several new and improved engineering tools but was quick to remind the audience that the fundamentals in the disciplines have not changed. He puts forth the question on whether the educational process, apprenticeship process, and professional requirements as practicing engineers require better tools.

Additionally, he emphasized that having access to knowledge and tools is more lucrative in an environment where the clients demand lower cost for services.

Dr. Chiu then discussed the case of Yankee Stadium in New York City of how Building Information Modeling (BIM) aided timely completion and how a sophisticated database allows a superior system to manage the stadium particularly its maintenance.

He summarized risk management as the provision and quantification of a set of options based on probabilities as technical services. A complete statement of risk involves three components – dollars, probability, and time. Applications of risk management in the structural engineering practice equates to professional integrity assessments of structures that continually degrade such as those with high seismic risk, bridges, and waterfront structures. Arguably, he mentioned that structural engineers today define that the most difficult problem is converting engineering options into dollars.

Dr. Chiu believes that the ASEAN Economic Community (AEC) will not dramatically affect engineering practice but because of implementation, it will affect the industry somehow. It is increasingly important to have familiarity in risk management within the context of this region which requires consulting engineers to be aware of the various levels of hazards and vulnerabilities local to differing communities.

In closing, Dr. Chiu emphasized that AIT is distinctly international, relevant, and committed to developing solutions to problems using imaginative techniques and a strong vision. And that is the reason for holding a knowledge exchange of this kind - to convey the knowledge the Institute has harnessed over the years and build on the relevant to the engineering practice and technologies for the future.

Solutions and Systems for Social and Affordable Housing

Naveed Anwar

Gyanendra Sthapit

Following his presentation earlier, Dr. Naveed Anwar introduced this topic by addressing the gap between the average income of the major part of the population and cost to purchase residences. Three terms are being used interchangeably today: affordable housing, public housing, and social housing with the common denominator or requirements of affordability and the use of appropriate technology to achieve cost efficiency.

Mr. Gyanendra Sthapit of AIT's Habitech Center then presented the innovative concept of interlocking bricks, micro concrete roofing which are all part of the Institute's signature system for affordable housing. Known as Habitech Technology, this concept was developed at AIT and has been used in various places in Thailand and abroad. The materials are light, strong, and require relatively less time to produce. The technology has been applied in many circumstances as a solution for residential areas, educational and health facilities, renovation activities, self-help social housing projects, and to assist resettlement activities for disaster devastated communities.

Managing the Extended Enterprise: An Enterprise Architecture Approach

Prof. Thomas Gulledge, Professor Emeritus, George Mason University, United States and President, Enterprise Integration, Inc., United States presented on Managing the Extended Enterprise. The presentation focused on the design and implementation of solutions for supply chain integration & management. He discussed three main points: Enterprise Business Architecture, Extended Enterprise Integration, and Governance.

He argued that a company needs all three of these topics to come together in the right kind of way in order to plan for extended enterprise or the Enterprise Planning and Management. Prof. Gulledge described Extended Enterprise Integration as inter-enterprise integration extended to incorporate other entities into the integration domain. These other entities include customers, suppliers, partners, and other organizational claimants. For Prof. Gulledge, the

Thomas Gulledge

first stage of alignment is to try to understand how the plans inside of an organization relate to the processes. This has to do with the way managers organize their work to meet the requirements that are coming down from senior management. He elaborated on the importance of an organized database as it is an asset for an organization and a management responsibility to manage, own, and understand data. If the plans and the strategic directions of the organization align with the business processes, the data also align with the business processes only then can management control the organization and therefore align the systems as required.

Prof. Thomas emphasized that Enterprise Business Architecture is neither a compulsory nor a sufficient condition for success. Its success depends on how managers engage in and how they use it in order to solve particular problems. He further stressed that a plan does not guarantee success but a company is much more likely to succeed with a plan, than without a plan.

Practical Nanotechnology Today: Concepts to Applications

Joydeep Dutta

Prof. Joydeep Dutta centered his talk on why business entrepreneurs need nanotechnology to create new enterprises or improve their products that are in the market.

He started the session by sharing a brief background on how knowledge evolved throughout the years. He said that today knowledge levels double every 5 years, but tomorrow it is expected that knowledge will double within a few months. He talked about how in the past, businesses defined the products and presented them to the custom-

ers but today customers decide what kind of products they want next. Prof. Dutta emphasized the importance of innovation, globalization, and the instant adaptation of new techniques. Prof. Dutta then unveiled developments in nanotechnology and how businesses can take advantage of this technology.

Prof. Dutta said, "Nanotechnology is the 21st century manufacturing technology irrespective of what business you are in and who you are. You will use nanotechnology in the future. And this is one of the reasons why the Asian Institute of Technology (AIT) started training master's and doctoral students in nanotechnology since 2006. " Prof. Dutta predicted that more and more academic institutions will have to integrate nanotechnology programs in the future.

He presented several nanotechnology applications that are already in the market from the information technology, energy, medicine, and consumer sectors. Some of the nanotechnology applications that are available today, and were also developed and refined in AIT, can be found in the current generation of solar cells, hydrogen production, water purification, LPG gas sensor, among others.

To end his presentation, he shared a quote from W. Edwards Deming, "It is not necessary to change. Survival is not mandatory." He told the audience, "The choice is yours if you want to implement nanotechnology in your product or program because change is not mandatory if you don't want to survive."

Operation Model for Supply Chain Performance Transformation: What Does Good Look Like?

Phiraboon Phaiboontham

Mr. Phiraboon Phaiboontham explored the many facets of supply chain from a practitioner's point of view.

Starting with a brief overview of the concepts of supply chain and performance transformation, he emphasized on three key implications of a supply chain: it is the core competency of modern enterprises, it covers the end-to-end processes, and it implements strategies by making and turning them into process executions and routine works.

Delving on the characteristics of a good supply chain operation model and how it can help guide enterprises towards successful performance transformation, Mr. Phaiboontham introduced a world class supply chain reference model along with some selected samples on how to apply the operation model to improve supply chain performance. He highlighted that three key elements that a company needs to achieve performance transformation are: reorientation, revitalization, and recreation.

"Supply Chain Management is the core competency of modern enterprises," he emphasized, "It is how value-added activities are driven and created, how competitiveness is defined and executed and how capabilities are built and sustained."

He stressed that the supply chain performance transformation is a fundamental change to the way a business operates. It is an attempt to align organization activities with its business strategy and vision for a change aimed to meet long term objectives.

Process Driven Change: Supply and Demand Planning

Vatcharapol Sukhotu

Dr. Vatcharapol Sukhotu began by stating the importance of having a solid single plan and looking at the big picture.

Dr. Sukhotu introduced the concept of supply chain, supply chain management, and the importance of forecasting or predicting something that may become a trend in the future. He mentioned that a company must try to minimize the cost of each part of the business and look at the end-to-end to see the bigger picture. He also added that supply chain planning is needed to increase competition, introduce new products more often, manage resources better, and minimize supply chain constraints. He emphasized that to optimize the whole process, companies must have an integrated plan characterized by demand, production, supply, inventory, storage, and transportation. He further elaborated that by creating an advanced planning system, companies will likely to achieve optimized end-to-end supply chain process.

Dr. Sukhotu said that the keyword in the Supply Chain Management is coordination. The real challenge is how to properly coordinate people involved in the supply chain that will result in improved performance and increased revenue. He gave some guidelines on how a company can optimize the end-to-end supply chain process: collaboration must be built-in into the forecasting and demand planning process supported by the demand

planning system; data sources must interface through the demand planning system; planning of the demand, production, supply, inventory, storage, and transportation is integrated into a single plan; sales and operation planning (S&OP) process must be supported by scenario planning so changes made can be immediately simulated for better decision making and lead to a feasible plan; and replenishment decision from up-stream sources should be part of the supply chain planning with a level of automation.

Reducing the Carbon Footprint for Sustainable Production Practices

Brahmanand Mohanty

Dr. Brahmanand Mohanty introduced the concept of reducing the carbon footprint through sustainable production practices. He emphasized that by reducing the carbon footprint, we are also creating opportunities to innovate, reduce carbon emission, and generate financial returns.

Dr. Mohanty stated the need for an organization to analyze its carbon footprint in order to reap benefits that can then be translated into potential market advantages, better supply chain management, adherence to prevailing or future regulations, and GHG emissions reduction. He urged the audience to start taking the right steps in order to flourish in future by emphasizing that, "It's not only about money but about sustainability in all senses."

He recommended a three-step approach for an enterprise wishing to reduce its carbon footprint. He illustrated it by presenting case examples of the initiatives taken by two companies in this direction. Apple (manufacturer of IT products) and Mahindra Reva (manufacturer of electric cars) dramatically changed the configuration of their products and the whole supply chain in order to become energy-efficient while increasing their revenues at the same time.

Dr. Mohanty explained why it was important to evolve from traditional carbon management in which companies engage individually, to carbon management across the supply chain in which companies engage collaboratively up and down the supply chain and carbon savings come from both internal efficiencies and external process change and reorganization. He briefly presented the newly established ISO 14067 Standard aimed at supporting the assessment of life cycle GHG emissions of products, facilitating the reporting and communication with all stakeholders, and providing a common basis for the comparison of results arising from the use of this standard.

In summary, Dr. Mohanty advocated that carbon footprint reduction is a win-win solution wherein companies can reduce carbon emission and increase profits.

Seeing the Big Picture: Sensing, Linking, Analyzing, and Visualizing Big Data

Paul Janecek

Dr. Paul Janecek explained that Big Data refers to data that is too large, complex, and dynamic for any conventional data tools to capture, store, manage, and analyze.

He emphasized that the right use of Big Data allows analysts to spot trends and gives niche insights, creating value and innovation much faster than conventional methods. The challenge now lies in how to make data useable and actionable to make correct decisions.

Dr. Janecek presented an example of real-time monitoring conducted jointly by Think Blue Data and a U.S. company that focuses on detecting Hazardous Algal Blooms (HAB). The company uses Environmental Sample Processors (ESP), which are in-situ sensors that collect data in the open ocean, through underwater eco-genomic robots that detect DNA and toxins created by the algae. The ESP processes the data and continuously sends near real-time data back as images to the shore.

Dr. Janecek also mentioned that beyond sensing, there is also the linking, analyzing, and visualizing of the data before data can become actionable. Linking data refers to the process of taking one data point and assembling it with other relevant data points that are collected among many sensors. Analyzing data refers to the processing of data in the form of images into cell concentration. Visualizing data refers to the abstracting of the analyzed data in some kind of schematic form.

He explained how a data visualization portal works highlighting that this portal can detect any kind of immediate problem, for example the monitoring of Hazardous Algal Blooms is reduced from 3-5 days to 3.5 hours.

In conclusion, Dr. Janecek summarized the transformation of big data, from its collection from in-situ sensors to processing the data to make it actionable. He reiterated the current challenges faced by the 3Vs of Big Data: Variety, Volume, and Velocity; then highlighted some on research and technology wherein some applications such as data analysis, process analysis, business intelligence, decision support, and monitoring can be applied.

Cloud-enabled Collaboration for the Enterprise

Matthew Dailey

Dr. Matthew Dailey defined Enterprise Architecture (EA) as the systematic approach to transforming business strategies into a change management process. EA decomposes and optimizes the structure and purpose of an enterprise, beginning with a vision and strategy, identifying as-is architectures, analyzing gaps, and planning change. Some of the facets of an EA include business architecture, data architecture, application architecture, and technology architecture.

Dr. Dailey briefly discussed two complementary aspects of EA, business centric such as Business Process Management (BPM) and IT centric perspectives such as cloud computing and platform as a service. He highlighted that BPM uses technology to help humans focus on decision making by letting systems do the tedious work, achieve rapid change in the business process in response to customer needs, regulatory constraints, business opportunities, as well as to enable monitoring for bottlenecks and compliance.

Dr. Dailey differentiated cloud computing the benefits of its adoption such as being able to "pay as you go" and access to high quality of IT services without the creation of a full IT department. He emphasized that this is a good way to try out solutions without committing to IT support resources that apply to all major cloud service models, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

Dr. Dailey concluded by highlighting the main prospects for cloud-enabled collaboration for the enterprise adding that very little may needed to get started and that the potential benefits are great.

Robots and Machines Development: from Imagination to Implementation

"AIT is the pioneering institution that launched a Mechatronics program in the region more than 10 years ago," began Dr. Manukid Parnichkun.

He described the architecture of robots or machines in comparison to humans and/or living animals, as both consisting

Manukid Parnichkun

of three main elements - sensors, processors, and actuators.

He explained that robots and machine study and development is known as Mechatronics Engineering, which is the synergic integration of 3 elements: mechanism, electronics, and computer engineering.

Dr. Parnichkun then highlighted seven Mechatronics projects at AIT, accompanied by short video clips. These seven projects include a flying robot that can be used for agricultural purposes such as pesticide or fertilization spraying, an underwater robot that can collect various types of information in deep waters, medical tele-analyzer that can diagnose abdominal mass remotely, and an intelligent vehicle project/smart car that can move autonomously from one place to another without a driver by using information from GPS, digital map, camera, and sonar. Another example of the work Dr. Parnichkun is the development of a gyroscopic unmanned bicycle that can balance itself automatically by using flywheel or centrifugal forces, and has the ability to balance people riding it, within a certain weight range. His team has also been working on exoskeletons that can be used to aid handicapped, paraplegic, or hemiplegic persons. The last research presented was the inverted pendulum which aims to evaluate the control performance of various control algorithms in balancing an inverted pendulum. An application is that the robot that can easily balance on a ball without falling over, and has the ability to send various types of useful information to the user.

Dr. Parnichkun projected that at least three robotics companies will be established in Thailand in the next three years to serve the needs of the country.

Innovations in Cleaner Production and Waste Management

Prof. Chettiyappan Visvanathan's topic on the innovations in waste management offered the participants valuable information about the current trends and technological advancements in solid waste management and wastewater.

According to Prof. Visvanathan, the difference between the 20th and 21st century in terms of waste management is the change in human perspective. Ten years ago, waste management was perceived as a problem worldwide because

Chettiyappan Visvanathan

the methods of solid waste disposal had serious consequences for health and the environment.

With the advent of technological advancements, waste management is now being considered as a resource and an opportunity to earn revenue. The global trend is now moving towards Waste-to-Energy (WTE) for sustainable development.

In China, the government is taking major steps to increase its WTE capacity. In Singapore, the government has set up an integrated solid waste management system in the last three decades that incorporates recycling, collection, and disposal. In Thailand, technological research and development done at the Asian Institute of Technology (AIT) is currently being used and ventured into for industrial purposes.

Prof. Visvanathan emphasized AIT's mission to work hand in hand with different industries to solve practical problems in solid waste and wastewater management for sustainable development.

Life Cycle Assessment of Products and Services to Assess Sustainability

Erik Bohez

Ir. Erik Bohez's presentation centered on answering three specific questions: What is Life Cycle Analysis (LCA)? What is Life Cycle of Product or Service? and What is Sustainability?

He defined LCA as the report on the total effect of emissions to the soil, water, and air during the life cycle of the product, including interpretation of data and subsequent recommendations. LCA requires data collection, surveys, defining scenarios or structuring data, defining the functional unit, and end reference flows.

By providing several examples on how LCA is conducted, Ir. Bohez then defined life cycle impact assessment by explaining its various methods based on classification, characterization, normalization, and weighting.

Associate Professor Bohez concluded by providing a clear example of how LCA can be conducted for different kinds of spoons made with aluminum, stainless steel, ceramic, wooden, and melamine materials. In this example, the functional unit and reference flows were based on using spoons of each type for a period of ten years, from the time the spoon was manufactured to the end of life of the spoon. The end of life scenario considered were land filling or recycling. The example was explained with screenshots from the Simapro software, several graphs, and process tree flowcharts for each spoon type as well as a comparative analysis of the spoons.

Sustainable and Safer Processing in Food Industries

Anil Kumar Anal

Dr. Anil Kumar Anal began his presentation by posing two main questions about food: Why do we eat when we eat? Why do we eat what we eat? He then talked about the changing trends in the food industry especially in terms of increasing obesity, increasing prevalence of diseases and the subsequent development of functional disabilities, increased health concerns of consumers, and the willingness to spend more for healthier foods.

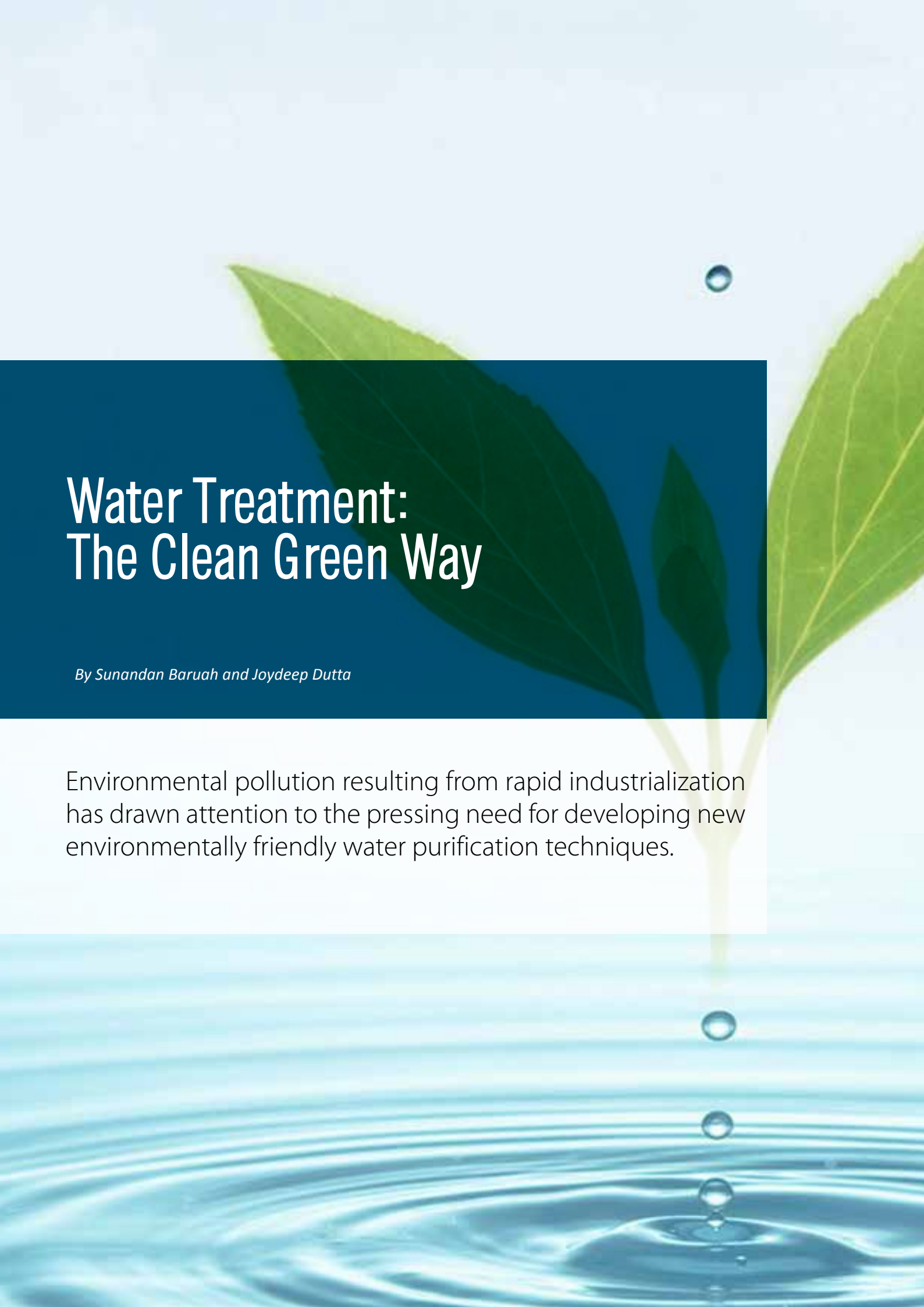
He elaborated on how food can become functional by mentioning three factors including; changing food habits to natural types of food products, enriching formulated food with functional ingredients, and altering the composition of whole foods to enhance beneficial components such as breeding techniques, animal diet, and genetic engineering.

Dr. Anil presented several technologies used to enhance food processing as well as several future processing trends. He focused on the use of probiotics as a functional component in foods. Probiotics are live microbial feed supplements that have beneficial effects on the host by improving its intestinal microbial balance.

He provided several examples of the types of foods using probiotics such as certain yoghurts, cereals, and drink products.

He deliberated on the implications of research in food and pharmaceuticals, including industrial applications and health applications, and discussed other technologies such as microwave heating and pulsed electric field technology. He also offered varying opinions on antimicrobial use in livestock and poultry production, in particular on the co-relation, major issues, and concerns related to animals, individuals, and the general population.

Dr. Anil also discussed an approach that reduces the use of synthetic antibiotics by using Lactobacillus Plantarum and/or other probiotics such as antibacterials. He also emphasized that nutrigenomics is an emerging tool in nutritional research as it increases growth, breeding, economic, food quality, and safety for livestock which in turn is converted to improvement in human health.



Water Treatment: The Clean Green Way

By Sunandan Baruah and Joydeep Dutta

Environmental pollution resulting from rapid industrialization has drawn attention to the pressing need for developing new environmentally friendly water purification techniques.

Environmental pollution resulting from rapid industrialization has drawn attention to the pressing need for developing new environmentally friendly water purification techniques. Present water treatment techniques demand high capital investment; operation & maintenance costs together with large spaces for installation. Treatment of pollutants in a cost effective manner requires the transformation of toxic substances into benign forms supported by effective risk management strategies. Application of nanotechnology for water treatment can include options for removal of the smallest particulate contaminants (~100 nm) from water through the use of nanoporous membranes and "smart materials" that can specifically target pollutants and obliterate, transform, or immobilize them. Nanomaterials have been receiving a lot of interest of late for possible applications in the area of environmental remediation. Nanomaterials are attractive for properties like high surface area compared to volume and high surface reactivity. Heterogeneous photocatalytic systems via metal oxide semiconductors like TiO_2 and ZnO, are capable of operating effectively and efficiently for waste water treatment. Improved photo fenton techniques can also be a green way of water purification.

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Water Scarcity In Orissa, India / Balaram Ranasingh

Introduction

Most of the pollution problems faced by the world like high chemical contamination in air, water, and soil including compounds with high carbon content, are related to the rapid growth pace of global population. Current world population is about 6.5 billion and increasing at an alarming rate with a projected population of 9 billion by 2050. Extensive use of persistent chemical pesticides to boost agriculture production has contaminated ground water and also adversely affected our eco-system. Water pollution is probably the most challenging problem being faced by humanity in the twenty-first century. Fresh water is a necessity for life sustaining activities like drinking, cooking, cleaning, and agricultural activities. Human activities have disrupted the equilibrium between the consumption and natural purification processes leading to a shortage of fresh water. Out of 1,386 million cubic kilometers of water on Earth, only 3% is fresh water. Only about 0.1 million km^3 of water is above ground primarily in lakes, swamps, and rivers, while about 13,000 km^3 is in the atmosphere. Surface water has not increased for the past 2 decades, and groundwater

Children fish in a polluted river covered with algae in Hefei, China / Jianan Yu, REUTERS

tables are also dropping. Seven hundred million people across the globe face water scarcity, and it is estimated that this problem will touch 1.8 billion people by 2025.

Waterborne epidemics have almost been eradicated in the developed countries with the extensive use of chemical disinfection methods like chlorination and ozonation. However, water borne diseases are still alarmingly high in developing countries. Even in developed countries like USA, there were at least 1870 water borne epidemic outbreaks during the period from 1920 to 2002, an average of 22.5 per year. In the period from 1991–2002, 207 water borne disease outbreaks and 433947 illnesses were reported. According to the 2004 WHO report, at least one-sixth of the world population (1.1 billion people) lack access to safe water. Inferior quality drinking water continues to pose a major threat to human health. Diarrheal disease alone amounts to an estimated 4.1% of the total global burden of diseases and is responsible for the deaths of 1.8 million people every year. It was estimated that 88% of that burden is attributed to unsafe water supply, sanitation and hygiene and is mostly concentrated on children in developing countries. Water disinfection and microbial inactivation are therefore of prime importance.

The criteria for a water treatment scheme to be considered green are that nothing should be added to the water and no additional water should be used in the process. Further, the treatment process itself should not add or generate any harmful chemicals.

The criteria for a water treatment scheme to be considered green are that nothing should be added to the water and no additional water should be used in the process. Further, the treatment process itself should not add or generate any harmful chemicals. The currently employed chemical disinfection methods can effectively control microbial pathogens but results in the formation of harmful disinfection byproducts (DBPs). Chemical disinfectants commonly used for water purification like free chlorine, chloramines, and ozone can react with different chemical species present in natural water to form DBPs. Many of the reported DBPs (more than 600) are carcinogenic in nature. The more resistant the microbes, the higher the dose of chemical disinfectants is required and the formation of DBPs is higher. It is therefore of utmost importance to develop innovative methods that improves the disinfection process without forming DBPs. Nanotechnology is a disruptive technology that can possibly address these issues.

Nanotechnology is an interdisciplinary science encompassing areas like physics, chemistry, biology, material science, and engineering. Nanotechnologists are capable of self-assembling atoms into structures with highly controlled properties. These nanostructures may be zero dimensional (nanoparticles), one dimensional (nanowires), two-dimensional (thin films) or three dimensional (arrays, hierarchical structures). Nanostructures can be obtained through two different approaches that have been termed as top down process and bottom up process. The top down approach usually involves breaking down of big chunks of material (physically or chemically) into smaller objects of desired shapes and sizes using techniques like mechanical milling and ion implantation. The bottom up approach uses self-assembly to build up the nanostructures by bringing in individual atoms and molecules together.

Nanomaterials offer large surface to volume ratios and are exceptional adsorbents. Nanostructures of wide band gap semiconductors like zinc oxide (ZnO), titanium dioxide (TiO_2), and tungsten oxide (WO_3) are good photocatalysts and are capable of degrading harmful contaminants in water into benign forms in presence of ultraviolet light. The advantage of ZnO as a nanostructured photocatalyst material is that it can be engineered to absorb visible light thereby enhancing solar photocatalysis. ZnO is also reported to be strongly antibacterial on a variety of bacterial targets like Escherichia coli, Staphyloccocus aureus, Bacillus subtilis, to name a few. ZnO nanoparticles showed maximum antibacterial activity on Staphyloccocus aureus compared to other semiconductor nanoparticles like MgO, TiO_2, Al_2O_3, CuO, and CeO_2. The antibacterial activity of ZnO can be attributed to the binding of Zn^{2+} ions, released through dissolution, to the membranes of microorganisms thereby prolonging the lag phase of the microbial growth cycle and photocatalytic activity upon light illumination.

Semiconductor nanostructures are being effectively utilized in photocatalytic applications. The electron-hole pairs generated by solar radiation in semiconducting materials can catalyze oxidation-reduction reactions that destroy organic chemicals, a process with apparent environmental remediation potential. A significant amount of research on wide band semiconductor catalyzed photo-oxidation of organic chemicals has consequently been done during the past two decades. The ability to catalyze the obliteration of a wide variety of toxic long chained organic chemicals and their complete oxidation to CO_2 and dilute mineral acids, lack of inherent toxicity, photo-stability and low costs render this process attractive for environmental remediation. Two major disadvantages of TiO_2-based photo-oxidation technology are the lack of adequate fixed bed reactor designs and the large band gap of TiO_2 (~3.2 eV). For bulk TiO_2, this wavelength is in the near UV region, which means that only a small fraction (~3%) of the solar spectrum can be harvested.

Increased concern for environmental remediation has generated interest in the development of highly efficient photocatalysts that can participate in detoxification reactions. Removal of contaminants from water by photocatalysis has several advantages over conventional processes: direct conversion of pollutants to nontoxic byproducts without the necessity of any other associated disposal steps; use of oxygen as oxidant and elimination of expensive oxidizing chemicals; potential of using free and abundant solar energy; self-regeneration and recycling of the photocatalyst and so forth. It is, therefore, of no surprise that the research and development activities in this field have been very forceful in last decade.

Standard Green Water Purification Techniques

Carbon Filters

The most efficient method of removing dissolved chlorine is by using carbon filters. Even though some carbon filters are primarily made from coal, the very best carbon filtration media is however granulated activated carbon, more popularly know as GAC. The best part of GAC is that it is made from coconut shells, which is a renewable resource. Activated carbon offers tremendous surface area (500 to 1,400 square meters per gram), which is a boon for surface reactions involved in water purification. Even though GAC is an effective material for removing chlorine, the disadvantage in its use is the growth of bacteria on it with time resulting in lower efficiency. Carbon filters therefore need to be replaced quite frequently.

Ozonation

Ozone becomes a powerful oxidizing agent after losing an atom of oxygen. This radical can adversely affect waterborne organisms. Ozone reduces by transferring the extra oxygen atom to any chemical that can be oxidized. The only by-product of ozonation is pure oxygen and the high oxygen content of ozonated water adds to the purification. Ozonation is capable of disinfecting water from viruses, algae, mold, fungus, and yeast spores. Ozone also oxidizes metal chemical contaminants like iron, sulfur and manganese, and the oxide precipitates can be filtered out. An ozone generating unit is normally installed in a water tank for the purpose of ozonation.

Dissolved Oxygen Generators

Dissolved oxygen can effectively oxidize iron and manganese and allow their easy removal through filtration. Dissolved oxygen generators can create high levels of dissolved oxygen in water. Unpleasant iron, manganese, and hydrogen sulfide odors can also be removed using dissolved oxygen. An electrical current is allowed to pass through water, which splits water into hydrogen and oxygen. This process produces extremely small oxygen micro-bubbles, which are unable to break the surface tension of water. So the released oxygen remains dissolved in solution and is available for oxidizing chemical contaminants. Scientists are of the opinion that this process can also be used to remove Arsenic (III) from water.

Ultraviolet Treatment

Ultraviolet (UV) light, with wavelengths below 400nm purifies water by affecting the DNA of microbial contaminants like bacteria and viruses, severely damaging their reproductive system. The process is simple yet effective and eliminates more than 99 % of harmful microorganisms within a few tens of microseconds. UV treatment is an attractive purification technique, as no chemicals need to be added and the taste of the water is not affected. In certain cases, UV proved to be more effective in removing organic contaminants than chlorine. UV purification however is not used in centralized water treatment systems, as the effect is short lived. It can be considered an ideal disinfection process for residential applications. An UV water treatment system does have its own share of problems. In the presence of suspended solids or particulate matter, microbes may actually pass through the UV filter without being affected by the UV light. Staining on the quartz sleeve resulting from untreated metals can adversely affect its disinfection capabilities.

A typical wastewater treatment plant.

The effects of nanoparticles on human health and the eco-system are not yet properly understood. This has necessitated the use of photocatalyst supports, which can be regenerated and can be conveniently removed.

Novel Green Water Purification Techniques

Photocatalysis

Photocatalysis is the acceleration of a chemical reaction in the presence of a light activated catalyst. The photocatalyst accelerates a reaction by interacting with the target either in its ground state or in its excited state and/or with the primary product, depending on the mechanism of the photoreaction. Heterogeneous photocatalytic systems based on solid metal oxide semiconductor photocatalysts has been an area of active research since the report of successful splitting of water into oxygen and hydrogen molecules through photo illumination of TiO_2 electrode. Photocatalysis is comparable to the natural photosynthesis process, as both require energy in the form of light radiation and a catalyst to accelerate the chemical reaction. Proper adsorption of the reactants to the photocatalyst surface is essential for efficient mineralization in both the cases. The illustration below shows a schematic comparison of photocatalysis and photosynthesis processes.

Electrons are exited from the valence band to the conduction band upon irradiation of a photocatalyst semiconductor surface with energy greater than its band gap. The electron hole pair (exciton) thus formed has a very short life span (typically a few picoseconds) and loses energy either through surface trapping, volume and surface recombination or reactions through interfacial charge transfer. Photo-exited electrons at the conduction band reduce adsorbed oxygen (O_2) or organic compound/dye, producing super oxide anion (O_2^-). The super oxide then reacts with hydrogen ion (H^+) producing hydroperoxyl radical (HO_2^-) that later changes into water. Photo generated holes at the valence band can directly react with organic molecules and oxidize it to CO_2, H_2O and mineral salts. A free hole can oxidize hydroxyl ion to highly reactive hydroxyl radical.

A variety of photocatalyst nanomaterials have been reported in the literature. Oxides like titanium dioxide (TiO_2), zinc oxide (ZnO), iron oxide (Fe_2O_3), tungsten oxide (WO_3), tin dioxide (SnO_2), silver oxide (Ag_2O), vanadium oxide (V_2O_5), strontium titanate ($SrTiO_3$) or sulphides like zinc sulphide (ZnS), cadmium sulphide (CdS), molybdenum disulphide (MoS_2), copper sulphide (Cu_2S), silver sulphide (Ag_2S), lead sulphide (PbS) or selenides like cadmium selenide (CdSe), lead selenide (PbSe), mercury selenide (HgSe) or iodides like silver iodide (AgI) and also modified systems such as coupled semiconductor systems (CdS/TiO_2, $CdSe/TiO_2$, SnO_2/TiO_2, ZnO/TiO_2, ZnO/CdS), etc. Titanium dioxide (TiO_2), zinc oxide (ZnO), tungsten oxide (WO_3) and strontium titanate ($SrTiO_3$) are popular for the degradation of toxic contaminants from water mainly under ultraviolet (UV) light illumination. Of late, researchers are concentrating on visible light photocatalysis to exploit solar energy, as visible radiation

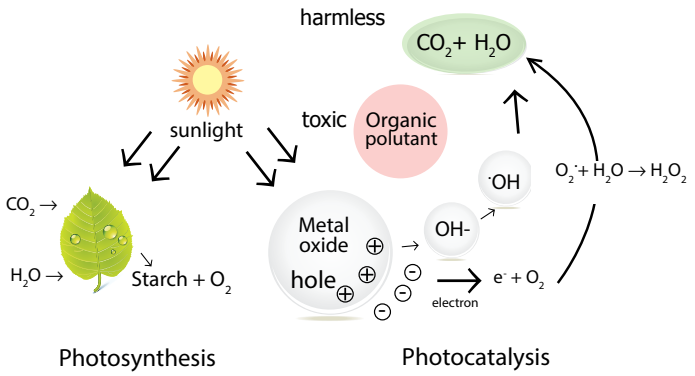


Figure 1: *Comparison of photosynthesis process in leaves and photocatalysis using metal oxide nanoparticles. In the photocatalytic process, energy greater than the optical band gap of the semiconductors are generally required (compared to 2.5 eV for photosynthesis process).*

constitutes a major portion (~ 46%) of the solar spectrum compared to UV light (~7 %). Photocatalysis using visible light has been reported to be possible through doping of semiconductors with transition metals to reduce the effective band gap and also through the incorporation of intentional defects into the semiconductor crystals during synthesis. The crystal defect initiated quasi-stable energy states within the band gap allow visible light absorption enhancing the generation of electron-hole pairs leading to higher photocatalytic activities.

Nanoparticles of metal oxides are efficient photocatalysts and can degrade both chemical and biological contaminants. The biggest limitation in the use of nanoparticles for practical applications is the difficulty of removing the particles after the treatment. The removal of these particles requires expensive post purification through nanofiltration usually together with flocculation and there is serious concern that these particles may ultimately affect the ecosystem. The effects of nanoparticles on human health and the eco-system is not yet been properly understood. This has necessitated the use of photocatalyst supports, which can be regenerated and can be conveniently removed.

An antibacterial water purifier was designed at the Center of Excellence in Nanotechnology, Asian Institute of technology using ZnO nanorods grown on polyethylene fibers. The water purifier was shown to successfully immobilize two model bacteria *Escherichia coli* and *Staphylococcus aureus*. The antibacterial activity of the ZnO nanorods was attributed to arise due to the combined effects of two mechanisms, release of zinc ions through slow dissolution of ZnO and the formation of reactive oxygen species through photocatalysis. Upto 99% ($0.99x10^{10}$ colony forming units per liter (CFU/L)) of the *Escherichia coli* and *Staphylococcus aureus* cells could be immobilized upon exposure to sunlight, while under room lighting conditions, 80% ($0.8x10^{10}$ CFU/L) of *E. coli* and 59% ($0.59x1^{10}$ CFU/L) of Staphylococcus aureus could be inactivated. Apart from fit to tap applications, the water purifier can be used in disaster areas to alleviate the scarcity of pure drinking water. A schematic

Quiz : Bridges
(Answers from page15)

Part 1: True/False

1. True
2. False
3. True
4. False
5. False

Part 2: Multiple Choices

1. d 2. d 3. b 4.b 5.a

Quiz : Tall Buildings
(Answers from page 40)

Part 1: True/False

1. True
2. True
3. True
4. False
5. True

Part 2: Multiple Choices

1. a 2. b 3. b 4.d 5.c

Polluted water in Songhua River reaches Harbin, China / CDIC, REUTERS

figure explaining the concept of operation of the water purifier is shown in Figure 1. The inactivation efficiencies under illuminated conditions were observed to be almost double than those under dark conditions. Anomalies in supernatant Zn^{2+} concentration were observed under both conditions as compared to control treatments, while cell membrane damage and DNA degradation were observed only under illumination. Inactivation in the dark was attributed to the bactericidal effect of Zn^{2+} ions, while inactivation under illuminated conditions the inactivation is alleviated due to photocatalytic electron injection process. The Zn^{2+} ions, released through dissolution, bind to the tip of pili of bacteria and prolong the lag phase of the bacterial growth cycle thereby checking reproduction. Strong radicals generated through photocatalysis can disrupt bacterial cell walls creating permanent damage. The inactivation of pathogenic bacterial densities by the ZnO nanorods in the presence of visible light implies potential ex situ application under sunlight for water decontamination at ambient conditions. The levels of dissolved ZnO post-catalysis were determined to be non-lethal. The degree of cell membrane damage among the test organisms was measured using a novel technique based on endonuclease pre-treatment, where evidence of possible DNA damage was also found[18].

Conclusion

Environmental protection and pollution issues are frequently debated as topics that need to be addressed with urgency. Nanotechnology can endeavour to provide and fundamentally streamline the technologies currently used in environmental detection, sensing and remediation. Some nanotechnology applications are near commercialization: nanosensors and nanoscale coatings to replace thicker, more wasteful polymer coatings that prevent corrosion, nanosensors for detection of aquatic toxins, nanoscale biopolymers for improved decontamination and recycling of heavy metals, nanostructured metals that break down hazardous organics at room temperature, smart particles for environmental monitoring and purification, nanoparticles as a novel photocatalyst for environmental catalysis and so forth.

Richard Feynman, an eminent physicist and a Nobel Laureate said in his famous lecture in 1959 :

> *" The biological example of writing information on a small scale has inspired me to think of something that should be possible. Biology is not simply writing information; it is doing something about it. A biological system can be exceedingly small. Many of the cells are very tiny, but they are very active; they manufacture various substances; they walk around; they wiggle; and they do all kinds of marvelous things – all on a very small scale. Also, they store information. Consider the possibility that we too can make a thing very small which does what we want – that we can manufacture an object that maneuvers at that level!"*

And that was more than five decades back! Of course, it has not been possible till date to realize all that Feynman predicted, but the future will definitely show new applications of nanotechnology in the field of water purification and environmental remediation.

References

J. Sawai (2003) Journal of Microbiological Methods, 54, 177-182.

M. F. Craun, G. F. Craun, R. L. Calderon and M. J. Beach (2006) Journal of Water and Health 4, 19-30.

M. Marcucci, I. Ciabatti, A. Matteucci and G. Vernaglione (2003) Annals of the New York Academy of Sciences, Editon edn., vol. 984, pp. 53-64.

M. R. Wiesner, G. V. Lowry, P. Alvarez, D. Dionysiou and P. Biswas (2006) Environmental Science and Technology, 40, 4336-4345.

N. Jones, B. Ray, K. T. Ranjit and A. C. Manna (2008) FEMS Microbiology Letters, 279, 71-76.

Q. Li, S. Mahendra, D. Y. Lyon, L. Brunet, M. V. Liga, D. Li and P. J. J. Alvarez (2008) Water Research, 42, 4591-4602.

S. Atmaca, K. Gul and R. Clcek (1998) Turkish Journal of Medical Sciences, 28, 595-597.

S. Baruah and J. Dutta (2009) Environmental Chemistry Letters 1-14.

S. Baruah, C. Thanachayanont and J. Dutta, Science and Technology of Advanced Materials, 2008, 9.

S. Baruah, R. F. Rafique and J. Dutta (2008) Nano, 3, 399-407.

S. Baruah, S. S. Sinha, B. Ghosh, S. K. Pal, A. K. Raychaudhuri and J. Dutta (2009) Journal of Applied Physics, 105, 074308.

S. Hirano (2009) Environmental Health and Preventive Medicine, 14, 223-225.

S. R. Lewis, S. Datta, M. Guia, E. L. Cokera, F. E. Huggins, S. Daunert, L. Bachas and D. Bhattacharyya (2011) PNAS, 108, 8577-8582.

S. W. Krasner, H. S. Weinberg, S. D. Richardson, S. J. Pastor, R. Chinn, M. J. Sclimenti, G. D. Onstad and A. D. Thruston Jr (2006) Environmental Science and Technology, 40, 7175-7185.

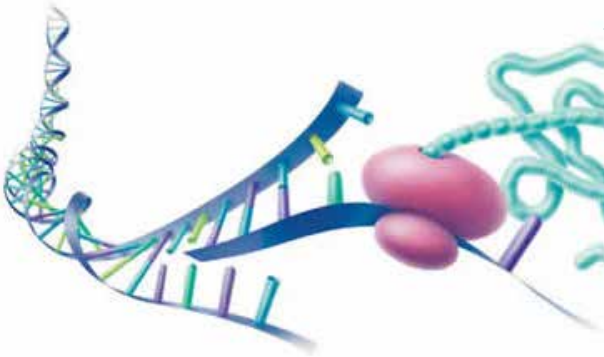
World Health Organization http://www.who.int/water_sanitation_health/en/factsfigures04.pdf

World Health Organization Burden of disease and cost-effectiveness estimates, http://www.who.int/water_sanitation_health/diseases/burden/en/index.html

Z. Huang, X. Zheng, D. Yan, G. Yin, X. Liao, Y. Kang, Y. Yao, D. Huang and B. Hao (2008) Langmuir, 24, 4140-4144.

BIOTECHNOLOGY

For Sustainable and Healthy Food Production



A whole range of technologies has been developed or adapted, including renewable energies new materials, eco-friendly chemicals, transport and processing systems, and adequate monitoring and control methods.

Since 1970s various technologies in biotechnological have continually emerged, recently these advancements have attracted increased attention from the general public.

Biotechnology has proved capable of preventing and better cure of diseases, generating enormous profitability, and influencing every sector of the economy. Biotechnology has substantially made an impact in healthcare, sustainable production and processing of food and pharmaceutics, agriculture and forestry, environmental protection, and the production of biomaterials and biochemical towards green and sustainable development. The policy makers of all nations whether developed or developing, are now formulating and implementing integrated plans for using biotechnology for industrial regeneration, job creation, and social progress. Biotechnology provides entirely novel opportunities for sustainable production of existing and new products and services. Biological production systems are inherently attractive because they use the basic renewable resources of sunlight, water, and carbon dioxide to produce a wide range of molecules using low-energy processes.

Biotechnology comprises three distinct fields of activity: genetic engineering, protein engineering, and metabolic engineering. A fourth discipline, known as bioprocess engineering, has been identified as a must for commercial production of biotechnology products and delivery of its services. Biological production systems are inherently attractive because they use the basic renewable resources of sunlight, water, and carbon dioxide to produce a wide range of molecules using low energy processes.

There is an urgent need to develop a sustainable form of food production, considering the rapidly growing world population and the detrimental impact of agricultural systems on the environment. Approximately 42% of crop productivity is lost to competition with weeds and to pests and to pathogens. There are also the limitations with the biological and physical limits of the crops' productivity. There are several potential key contributions of biotechnology to remedy such situation.

In regions lacking water, plant biotechnology could help to develop crop plants with intrinsic resistance to drought and salt, modern plant-breeding and engineering techniques could help in selecting and developing plant varieties better adapted to a whole range of stress factors, including heat and cold as well as drought and salt.

There are now alternatives to agrochemicals (synthetic fertilizers, herbicides, and pesticides), generally now referred as biopesticides and biofertilizers such as fermented sludge, biological materials such as chitosan and cyanobacteria. Biofertilizers and biopesticides are considered as eco-friendly and safe. The first generation of biological fertilizers was based on nitrogen fixing rhizobial bacteria found naturally in the root nodules of legumes. These bacteria fix nitrogen from the air to provide the plant with assimilable nitrogen. Enhanced use of such biofertilizers will significantly reduce pollution, energy, and resource consumption associated with the use of conventional fertilizers. In a similar way, herbicide-tolerant plants manipulated at the genetic levels have been developed to reduce herbicide use.

Compared to their conventional counterparts, transgenic plants and animals offer many advantages, including superior yields, lower demand for fertilizers and pesticides, better tolerance to adverse environments and pests, improved nutrition and other functional qualities, ability to generate products that a crop does not produce naturally, and reduced cost of production. With the advancement of genetic engineering, the transgenic animals and plants are now considered as versatile living reactors in which the desired metabolites are synthesized for industrial production of various food compounds such as proteins, peptides, hormones, growth factors, biopharmaceutics, vitamins, minerals, and enzymes.

Many renewable bioresources are now waiting to be exploited to obtain the new compounds of potential values. For example, microalagae contributes substantially to primary photosynthetic productivity, but are barely used commercially. Microalgae are a source of high-value products such as polyunsaturated fatty acid, natural colorants, biopolymers, single cell proteins, and therapeutics other than using for biotreatment of wastewaters, and as aquaculture feeds, biofertilizers, soil inoculants, and biofuels.

The microbial worlds can now be exploited as potential sources of value addition products with the help of biotechnology. Innovative bioprocess intensification strategies are being put to use to substantially enhance producing the metabolite products from the microorganisms. The genetic manipulations and cloning of certain microogranisms help to produce abundant amounts of vitamins, proteins, peptides, hormones, and other biopharmaceutics. The fermentation processes help to produce industrial enzymes for application in various food and pharmaceutical industries. A new class of sugars, known as isomalto-oligosaccharides has potential commercial applications in the food industry as non-digestible carbohydrates bulking agent. Cellulase is a subject of intense research because of their potential for providing fuels, food, and other chemicals from widely available celluloses. Enzymes such as amylases and proteases are being added to animal feed to improve digestibility by supplementing the animals' own enzymes. Adding enzymes such as beta-glucanases and arabionoxylanase to feed cereals break down non-starch polysaccha ride anti-nutritional factors, aiding digestion and the absorption of nutrients, and thus improving the bioavailability. Extremophilic enzymes, or exterozymes, are now getting increasing industrial values because of their ability to withstand extremes

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of temperatures and other conditions. Enzyme catalysis in non-aquesous media has created new possibilities for producing useful chemicals such as modified fats and oils, structured lipids, and flavor esters.

The use of plant and animals based organic waste is being tackled by a number of approaches. The main products obtained are heat and alcohol, both implying problems of sustainability. A bioconversion of animal manure using thermophilic bacteria has been developed that produces biogas for heating and cooking purposes in rural, peri-urban, and even in urban areas. Bioplastics are other resources from animal and plant waste, which can also be obtained from microogranisms. Manufacturing these bioplastics would give a huge relief from the use of polyethylene bags and alleviate some environmental concerns. These bioplastics produced especially from microorganisms get much attention from food and pharmaceutical industries.

A necessary precondition for environment-friendly processing is the development of highly specific and efficient monitoring devices. A range of biosensors and bioassays has been developed and applied to bioprocess systems. These devices can be based on catalytic elements such as enzymes, microorganisms by using bioluminescence, and tissues, or on non-catalytic elements, such as receptors, nucleic acids, and antibodies. Multipurpose bioassays are quite promising, for instance, in the development of multi-enzyme systems for the detection of toxic compounds in complex food systems as well as in complex industrial effluents.

Outlook and Future Perspectives

The main sector for biotechnologically supported sustainable development is almost certainly in food production. Important advances have been made in developing herbicide and pest-resistant transgenic plants but other developments are also important for future world food supply, such as nitrogen fixation and resistance to environmental stress. The application of biotechnological methods to ex situ conservation of genetic resources for both plants and animals, however, is of major importance for future breeding efforts to sustain and enhance the productivity. The algal mass culture is expected to be the better means to reduce CO2 levels in the atmosphere, and thus contributing towards counteract of threat to climate change. The possibility of adapting crop plants and animals to the changes in climate can be quicker by using supporting biotechnological methods. The exploration of natural resources and biodiversity including the forestry products, herbs, microorganisms, and marine resources through bioprocessing methods is needed to sustain food and biomedical products for the green economy.

What is Biotechnology

Biotechnology is based on biology, especially when used in agriculture, food science, and medicine. The UN Convention on Biological Diversity defines this field as

> *"Biotechnology means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use."*

Modern biotechnology provides breakthrough products and technologies to fight against debilitating and rare diseases, reduce environmental footprint, feed the less-fortunate, use less and cleaner energy, and have safer and more efficient industrial manufacturing processes.

There are over 250 biotechnology health care products and vaccines available today, many for previously untreatable diseases. More than 13.3 million farmers around the world use agricultural biotechnology to increase yields, prevent damage from insects and pests, and reduce farming activities' impact on the environment. Numerous biorefineries are being built across the globe to test and refine technologies to produce biofuels and chemicals from renewable biomass, which can help reduce greenhouse gas emissions.

Recent advances in biotechnology are helping society prepare for and meet today's most pressing challenges.

Heal the World

- Reducing rates of infectious disease
- Saving millions of children's lives
- Changing the odds of serious, life-threatening conditions affecting millions around the world
- Tailoring treatments to individuals to minimize health risks and side effects
- Creating more precise tools for disease detection
- Combating serious illnesses and everyday threats confronting the developing world

Fuel the World

- Streamlining the steps in chemical manufacturing processes by 80% or more
- Lowering the temperature for cleaning clothes and potentially saving $4.1 billion annually
- Improving manufacturing process efficiency to save 50% or more on operating costs
- Reducing use of and reliance on petrochemicals
- Using biofuels to cut greenhouse gas emissions by 52% or more
- Decreasing water usage and waste generation
- Tapping into the full potential of traditional biomass waste products

Feed the World

- Generating higher crop yields with fewer inputs
- Lowering volumes of agricultural chemicals required by crops-limiting the run-off of these products into the environment
- Using biotech crops that need fewer applications of pesticides and that allow farmers to reduce tilling farmland
- Developing crops with enhanced nutrition profiles that solve vitamin and nutrient deficiencies
- Producing foods free of allergens and toxins such as mycotoxin
- Improving food and crop oil content to help improve cardiovascular health

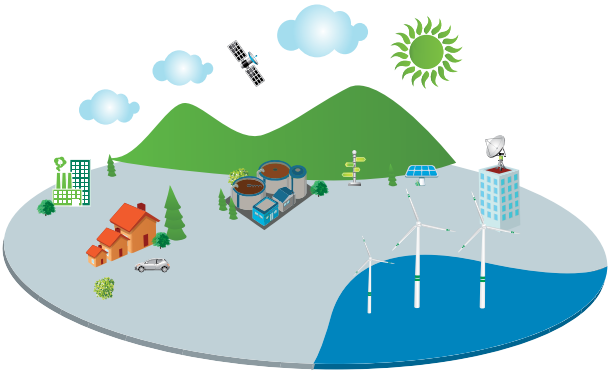
Source: United Nations and Biotechnology Industry Organization

Smart Grid: A Vision of Future Energy

By Jai Govind Singh and Weerakorn Ongsakul

Many grids are old and inefficient, leaving consumers with little choice despite the grid's importance in every person's daily life. With the increasing energy demands, the need to address this global issue is ever so evident. It is crucial to achieve this in an environmentally sensitive way.

A Vision of Future Energy



The current electrical grid structure and how it transmits and distributes power is central to how energy is used. With the changing times, it is important to address the challenges and at times difficulty in meeting the electricity demand through an energy efficient way. Many grids are old and inefficient, leaving consumers with little choice despite the grid's importance in every person's daily life. With the increasing energy demands, the need to address this global issue is ever so evident. It is crucial to achieve this in an environmentally sensitive way.

The projected energy demand from the year 2000 to the end of this century along with the projected contribution from various primary energy sources is illustrated in the figure on the left. It is clear that conventional sources fail to meet even half of the energy demand emphasizing the inevitability of alternate energy sources and their utilization.

Three main levers to meet tomorrow's challenges:

- Reduction of energy demand
- Increase of energy efficiency at all levels from generation to consumption
- Increase usage of renewable energy sources

A sustainable solution could only be attained by addressing these three. This inevitably means reducing the total energy demand, increasing the energy conservation, and the general adoption of energy from renewable sources which again points to the extensive use of distributed generation and their unification – through Smart Grid.

ODYSSEE MURE is a project coordinated by ADEME (French Environment & Energy Management Agency) and supported under the Intelligent Energy Europe Programme of the European Commission. This project gathers representatives such as energy Agencies from the 27 EU Member States plus Norway and Croatia and it aims at monitoring energy efficiency trends and policy measures in Europe.

Smart Grid and Buildings

The first key message delivered by the Energy Efficient Trends in Buildings in the European Union, a report that studies the ODYSEE MURE project, is that buildings consume around 41% of total energy and stays on top of transport (32%) and industry (25%). The reason is that residents do not usually actively participate in the energy conservation initiatives. However, increased awareness on timely electrical consumption feedback through smart metering is believed to significantly reduce consumer's indirect wasting of energy. Recent studies also show that timely electrical consumption feedback through smart metering can reduce electrical consumption by 5 - 15%. However, many inhibitors (residents) do not possess the ability to automate their personal space and fully configure it to their own needs in order to save energy. Also, consumers differ in behavior, preferences, and habits which directly affect energy consumption.

Smart Buildings

The utility remote control service in smart buildings makes remote monitoring/control about power utilities of building/company, emergency mobilization, and consulting service. They are also provided with Peak Power Alarming and Load Balancing Service providing better energy usage conditions. The energy management systems of smart buildings with their own renewable power sources and CHP is likely the trend of future. They facilitate improved grid operations with higher reliability, lesser outage time / shorter outages / smarter decisions and provide more options to meet future needs. With new costs lowering technologies and increased efficiency in operating existing systems, smart buildings provide cleaner, lower costs, and more efficient operations that meets the need with more environmentally preferred options and higher utilization rates of installed systems. This provides consumers with more choices on how to meet individual consumer needs, dynamic rates to better integrated needs of grid and consumer and new technologies to provide new demand side options along with lower overall energy costs.

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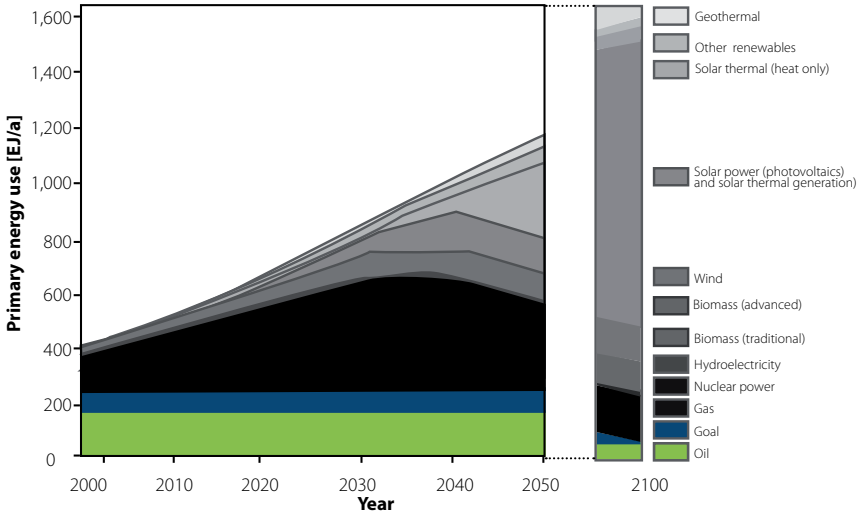

Figure 1: *Projected Energy Demand*
Source: German Advisory Council on Global Change (WBGU, 2003)

Smart Homes

The energy usage alarm services used in smart homes provide total and/or individual household electricity usage in real-time, forecasts monthly/yearly electricity usage and alarming accumulated electricity usage fee and also provide carbon emissions converted from electricity usage. This system also has a Standby Power on/off Service that functions using the Smart Box/Tag and IT system, a remote/automatic control service of home utility functioning using mobile terminals including iPhone, an energy saving helper service that provides consulting information for energy saving in home, telematics services and integrated e-billing service, marketing operations service based on the information of the smart green customer and also green mileage service giving mileage/points to smart green service subscriber who makes energy saving.

There have been astounding and path breaking technological achievements in energy management during past few years which have proved that energy efficiency is not only implemented and practiced by using efficient electronic devices or efficient heating/cooling systems with efficient building design but also by creation of energy at households level, in effect creative a negative supply requirement. This excess energy after meeting the household demands cannot only be transmitted to the central electricity grid but also a source of income for the inhabitants.

One example of energy efficiency measures is using smart controls that enable the automated operation of electronic devices, heating/cooling systems, and other energy consuming devices switching on supply for the ones that are currently in use. An important aspect of implementing energy efficiency successfully is the ingression of human psychology towards understanding of energy as a limited resource and the necessity of it consuming with care since research indicates irresponsible behavior is the biggest cause of unproductive energy consumption. The figure below illustrates such a scenario, where at least 37% of the energy can be saved by employing energy efficient and smart systems.

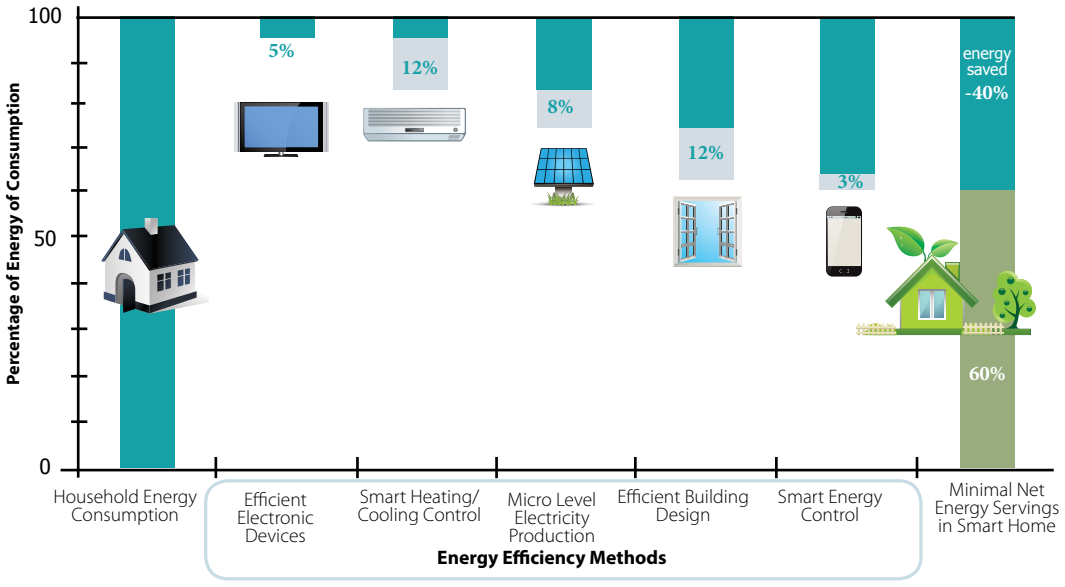

Figure 2: *Energy Savings in a Smart Home*

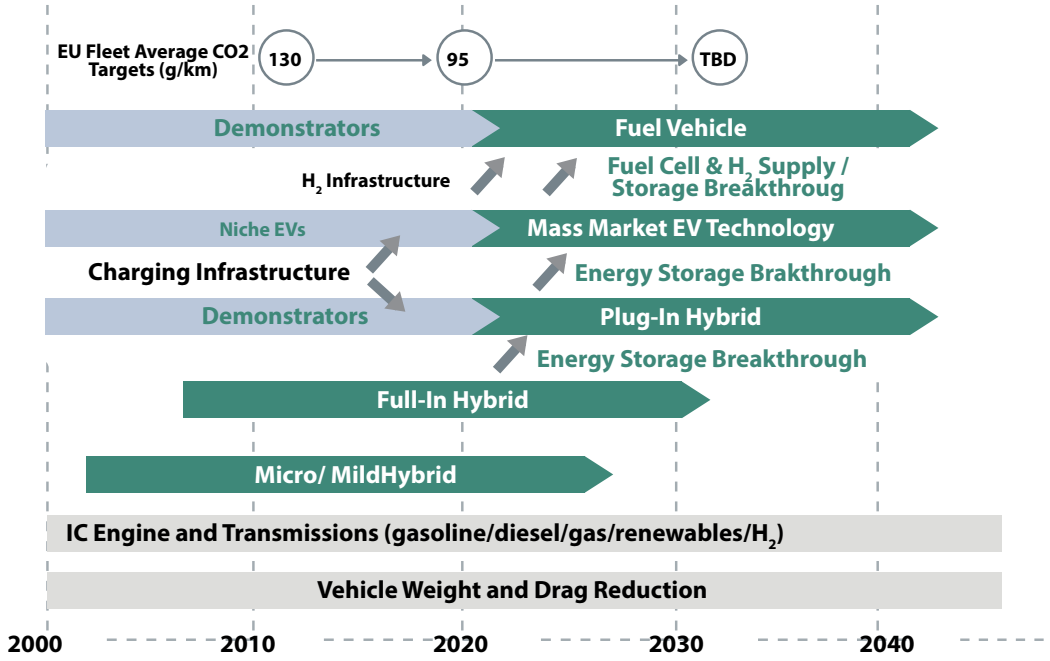

Figure 3: *Technology Roadmap on the Future of the Automotive Industry by New Automotive Innovation and Growth Team (NAIGT)*
Source: An independent report on the future of the automotive industry, NAIGT (2009)

Smart Grid and Transportation

The transport sector is currently responsible for 13% of GHG emissions (Intergovernmental Panel on Climate Change (IPCC), 2007) and 23% of CO2 emissions from global energy consumption (International Energy Agency (IEA), 2009). Transport energy use and CO2 emissions are projected to increase by about 80% by 2050, provided current trends are preserved. Although GHG emissions per capita are much higher today based on data from the Organization of Economic Cooperation and Development (OECD) countries, nearly 90% of future growth in emissions is expected to come from non-OECD countries (IEA, 2009). The projected growth of emissions in non-OECD countries results from an increase in both passenger and freight transport activity. The amount of GHG emissions from the transportation industry is directly related to the distances travelled, vehicle occupancy load, and carbon efficiency of the vehicle.

Exploring this area translates to evaluating alternative fuels that have lower carbon content and therefore generate lesser transportation GHG emissions. Eligible alternative fuels include ethanol, biodiesel, natural gas, liquefied petroleum gas, low carbon synthetic fuels (such as biomass-to-liquids), hydrogen, and electricity. Special interests are beginning to move toward the wider use of electrification in the transportation sector. This effort should start with on-road vehicles, such as plug-in hybrid vehicles, and truck stop electrification for heavy duty vehicles, as well as ancillary equipment in other modes such as ground support equipment at airports, hybrid switcher locomotives at rail yards and cold ironing at ports. State governments should work together with regional and national groups to encourage establishing the electrification of the transportation system at the national level; the regional and national aspects of the transportation system make this an imperative.

Tighter vehicle emission and fuel quality standards as well as fuel economy standards have already been implemented in many developing and developed countries. Regardless, there should be measures to ensure a more efficient pricing of parking, fuel, insurance, and vehicle registration fees. The establishment of dedicated funding mechanisms in countries to provide funding for sustainable low-carbon transport should be encouraged. Public transport should be promoted through mass transport systems and networks connecting different modes. BRT (bus rapid transport) is an affordable option for the developing world with more than a hundred schemes in operation under construction or planning in Europe, Africa, Asia, and Latin America. Public bicycles and car sharing schemes are now in operation worldwide. Other options encouraging commuters to avoid using individual vehicles should be promoted to reduce fuel consumption and GHG emissions. To reduce the threat on the environment, wide-scale use of alternative fuels, which reduce both air pollution and GHG emissions, should be encouraged. Ecological metro trains consume less energy by feeding braking energy back into power grid and by using mostly aluminum for the lightweight body design. An example is the new trains developed by Siemens for Oslo, Norway. These trains use 30% less energy than Oslo's current trains, emitting just 2.6g of CO2 per km and ton of weight.

E-mobility: Future of Transportation

The core grid will not have a problem in supplying electricity over the next few decades. The problem may show up around the substations because the periphery of the grid has not been designed to handle large increases in local demand at peak times, for example at the suburbs in the evening. Some companies offer charging management and demand response solutions to deal precisely with these localized demand issues. There are many potentially charging models, which range from normal billing according to kWhs usage to loyalty schemes where consumers can earn '"kWhs"' like air miles and use them at home, to free charging tokens such as those that can be purchased from local shops. It is likely that telecoms operators will offer electric vehicles (EVs) charging options through mobile devices for their customers.

To enable this multi-purpose option, Smart Grids need a lot of infrastructure development such as new charging stations similar or near to petrol pumps and vehicle parking could be facilitated with charging/discharging options.

It is also likely that schemes whereby consumers and utilities can trade the charging capacity of a Lithium battery to use as temporary energy storage. In Japan it will soon become mandatory to be able to use EVs to power your house. In the event of a power outage, for example, during a tsunami threat, citizens will have a 24-48 hour buffer available since they have alerted almost instantaneously – they would have only seen the tip of the iceberg. Countries such as Japan and countries in northwestern Europe, where gas prices and/or oil imports are high, the population is dense. An example is when commute distances are limited to an average of 100-200 km. Another consideration is that the political and economic climate is stable and is, in theory, best suited to install fast charging stations quickly. It is presumed that the United States will follow a bit later; the rest of Asia is a bit of a wild card at the moment.

According to the International Energy Agency, 80% of electricity generated by 2035 will still come from fossil fuels. But EVs can run on electricity generated from renewable energy sources like solar and wind, which is impossible for combustion engines to use. The younger generation is shifting their transportation habits from long haul combustion cars to city car-sharing and long-haul public transport. This is a global phenomenon and could significantly increase the use of electric transportation, including trains. EVs will naturally support this movement, which will in turn help to reduce smog levels in large cities such as Mexico City, Los Angeles, Beijing, and Tokyo.

A lot of research has been taking place on using EVs as back-up energy storage units during peak periods or in the absence of sources. A likely scenario is the use of second hand EV batteries which should be replaced when the battery still has at least 80 % of the original capacity after 7-10 years, serving as low-cost buffer batteries for homes and offices which will be a major asset within local power management and grid-demand management.

Smart Grid and Renewable Energy

Satisfying future energy needs is crucially linked to the security of energy supply and environmental issues. To pave the way to a sustainable energy future based on a large share of distributed power generation (DG), there is a clear need to prepare the electricity system for the large scale integration of both renewable and other distributed energy sources. The development of distributed power generation and renewable energy sources (RES) is essential to obtaining these goals. However, the integration of RES and DG into existing and future unified electricity systems represents an enormous technological challenge. For example, existing power grid design has not considered the impact of intermittency in renewable energy, especially solar and wind sources. Energy research is the mainstay of any long-term energy policy, providing scientific knowledge and technical options to make energy systems more efficient, affordable, accessible and environmentally friendly. The development of DG is a necessary prerequisite for the large scale deployment of many clean technologies, the most important of which are:

- Renewable energy sources
- Combined heat and power units
- Stationary fuel cells and hydrogen
- Energy storage
- Energy efficient technologies requiring an effective demand side management

Energy Storage is another major component to support and manage greater utilization of renewable energy which is quite difficult due to intermittency in it, e.g., solar and wind. The intermittent renewable sources are more prone to curtail or shut down during lower demand than availability because base load is mostly supported by traditional generation sources, e.g., thermal and hydro due to their reliability, start-up and shutting down issues. Therefore, energy storage can be stored when energy availability is higher than demand and later use to generate and connect to grid when demand is higher than availability. There are many options to store energy, e.g., battery, pumped-hydro storage, flywheel, superconducting magnetic energy storage (SMES), electric vehicle battery, compressed air storage etc. Among various storage schemes, the electric vehicle battery could be a multi-purpose and cost effective option. Electric vehicle can be getting charged during low energy demand and price and get discharged to grid at higher energy demand and price besides use for green transportation. To enable this multi-purpose option, it needs a lot of infrastructure development like, new charging station similar/near to petrol pump and also vehicle parking could be facilitated with charging/discharging options.

Demand Response (DR) is another alternative and also cheaper option to energy storage and it can be identified as the changes in the electricity usage by the end users/customers from their normal consumption patterns in response to the changes in price of electricity over time due to change in system dynamics and conditions. The benefits of DR are highly under-utilized energy markets (EMs). Due to advances in metering and information and communication technology (ICT), DR can now participate in the load frequency control, reserves and EMs by increasing or decreasing the load/demand. DR has massive potential but complex to manage in Electricity Markets. For example, DR provides an opportunity to lower electricity bills by making a commitment to reduce load in response to market prices or the need to maintain system reliability. Participation may help to ensure reliability and avoid disruption of electricity service for many customers. Additionally, DR participation may help to delay or avoid the building power system infrastructure that would only be utilized during the highest demand periods, for example a period of 10-25% of time in a day. Load reductions during peak demand conditions also may help to reduce emissions and the associated environmental impact on the planet. DR programs can be classified into two categories:

- Incentive Based Programs (IBPs) (direct load control, interruptible/curtailable load, demand side bidding capacity, ancillary service market)
- Priced Based Programs (PBPs) (time-of-use, real time pricing)
- Electric Vehicle (EV) and Flexible Demand, (electric heating, cooling/freezing, dryers, washer)

The Role of Smart Grids in Climate Change: An EU Example

> *"Smart grids are about building, expanding, operating, and maintaining the electricity networks of the future in a way which will also help meet the European Union's (EU) 20/20/20 climate change objectives."*

These ambitious targets for the year 2020 include 20% reduction in greenhouse gas emissions, 20% EU renewables share, and 20% savings in consumption by improving energy efficiency. Smart grids are key to reducing carbon emissions and improving energy efficiency by reducing network losses, facilitating higher penetration of renewable (wind), and distributed generation (small windmill or micro-CHP plant) in compliance with operational security, power system, and electricity market efficiency, helping consumers participate better in the market not only by using their energy more efficiently (through smart metering) but also by allowing consumers to act also as producers selling back their excess electricity (CHP or plug-in electrical vehicles).

Distributed Generations (DGs) are another major source of energy also helpful to alleviate GHG emissions. For example, highly efficient combined heat and power (CHP) plants, back-up and peak load systems are providing increasing capacity. In addition, together with renewable energy, these technologies offer new market opportunities and enhanced industrial competitiveness. Moreover, the greatest potential market for DG is displacing power supplied through the grid. In other words, on-site production minimizes transmission and distribution losses as well as transmission and distribution costs, a significant part (above 30%) of the total electricity cost. Further, as the demand for more and better quality electric power increases, DG can offer alternatives for reliable, cost-effective, premium power for homes and business. DG can provide customers with continuity and reliability of supply, when a power outage occurs at home or in the neighborhood, restoring power in a short time. In other words, convenience, security, and peace of mind are potential major drivers following several blackouts which have been experienced lately. DG also provides advantages to those customers with sizeable heat loads, through the operation of CHP units, to those with access to low-cost fuels, for example landfill gas or local biofuel, and to those with favorable climatic conditions who can exploit renewable-based units.

Overall Impacts of Smart Grid: A Study

A study conducted from 2008 by EPRI found areas in which Smart Grid–enabled technologies can create significant incremental savings. For each of these areas, EPRI created three penetrating scenarios for 2030. The first area identified by EPRI is continuous commissioning of buildings and other information-enabled technologies. In commissioning of commercial buildings, between 5 to 20% penetration was assumed to occur by this date. The other area of saving identified is improved operational efficiency of the distribution system by reducing line and substation losses. Enhanced demand response and load control also contributes to a Small amount of savings. Customer use is also reduced by monitoring real time prices. Also, customer feedback system were implemented in 25-75% of all American homes.

From that study, the significance of a smart grid in the future can be justified from the EPRI statistical study that, 56-203 billion kWh could be saved by 2030. Since investment costs and risks, do not coincide with the benefits of smart grids, the responsibility should be distributed to several stakeholders who are ready to invest at the initial stage.

Another study signified that **Energy Conservation** can have substantial environmental and social benefits. For example, each 100 MW of reduced electricity usage could lower carbon emissions by over 500,000 tons per year in New York State, a reduction equivalent to planting 68 million trees or taking fossil fuel based 71, 000 cars off the road.

References

Antesberger, Georg (November 2007) Energy Efficiency in South Eastern Europe. Siemens AG Österreich, http://www.docstoc.com/docs/10480460/Energy-Efficiency-in-South-Eastern-Europe

Electric Power Research Institute (EPRI), http://www.epri.com/

GEF-STAP (2010) Advancing Sustainable Low-Carbon Transport Through the GEF, A STAP advisory document by Holger Dalkmann and Cornie Huizenga. Global Environment Facility. Washington, D.C., http://www.thegef.org/gef/pubs/STAP_transpotation

Intergovernmental Panel on Climate Change (IPCC) http://www.ipcc.ch/

International Energy Agency (IEA) http://www.iea.org/

NAIGT report – "An Independent Report on the Future of the Automotive Industry in the UK" (April 2009). New Automotive Innovation and Growth Team (NAIGT). Department for Business, Enterprise and Regulatory Reform (BERR) now Department for Business, Innovation and Skills. United Kingdom, http://www.berr.gov.uk/files/file51139.pdf

The Royal Swedish Academy of War Sciences (KKRVA - Kungl Krigsvetenskapsakademien), http://kkrva.se/

Thailand Smart Grid 2013, http://www.thailandsmartgrid.com/

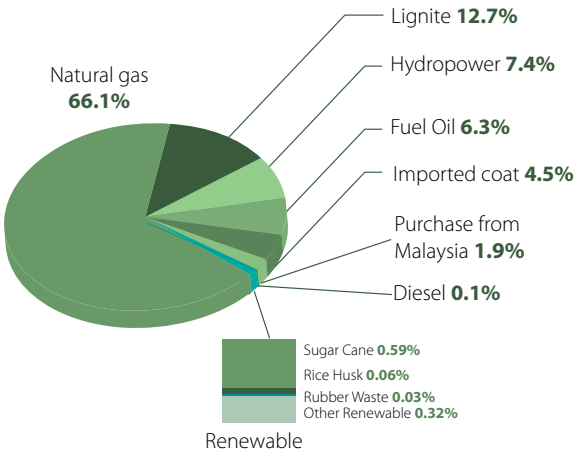

Figure 4: *Role of renewable energy in Thai electricity (MWh)*

Smart Grid and Thailand

" Thailand aims to raise the share of alternative energy to 20% of demand by 2022."

This is taken to be a key drive towards Smart Grid which is one of the best options in hand. The Provincial Electricity Authority (PEA) will invest 400 billion THB (13 billion USD) to create its smart-grid system for a nationwide intelligent power network over the next 15 years. The smart grid project is aimed at modernizing its power-transmission system by deploying information and communications technology to support the distribution of electricity to households. Thailand Smart Grid 2013, held in March 2013 at Bangkok, organized by IEEE PES and IEEE Thailand section was the third annual event for the Thai utility industry to discuss and devise new strategies towards the implementation of Smart Grid. Attended and supported by the key decision makers from the local utilities like Provincial Electricity Authority, Metropolitan Electricity Authority, Electricity Generating Authority of Thailand and Energy Regulatory Commission of Thailand the industry gathering focused on key issues shaping the Thai smart grid landscape and opportunities for further growth and expansion.

Smart Grid and ASEAN Region

ASEAN countries would be further benefited by having Smart Grid infrastructure connecting them to integrate all available but diverse energy resources in terms of renewable, including, fossil fuel. Through interconnection, ASEAN would be able to harness more renewable energy by minimizing intermittency in sources, especially in solar and wind. By using Smart Grid mechanism, uncertainty could be reduced by extending the geographical diversity, load control, and use of other energy sources, such as biomass, hydro, fuel cell, ocean, and fossil. Moreover, the ASEAN Power Grid is already taking in shape which needs to include these factors as well.

Recall that energy conserved is equivalent to energy produced. Conserve energy.

With contributions from Nikhil Sasidharan, Nimal Madhu M, Vivek Mohan, and Srujana Goteti.

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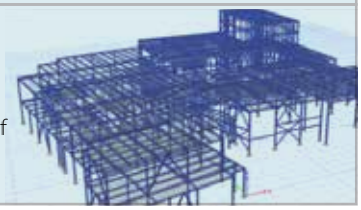

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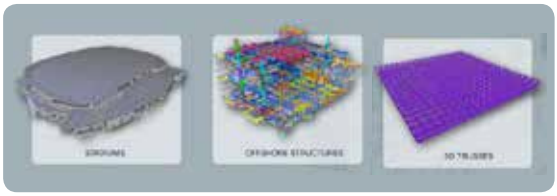

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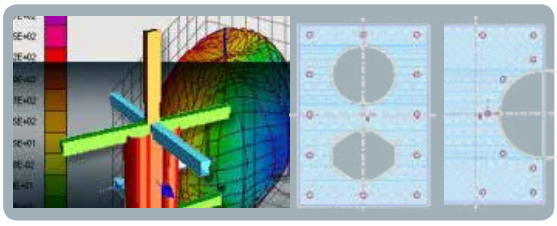

ACECOMS and AIT Consulting are providing support to CSI for development of design tools, particularly for the ETABS software package. These modules include section designer, wall designer, column designer, footings and steel connection. The developed ETABS modules will be used by engineers in building and structure design of multi-story commercial and residential structures.

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