

ADVANCING SUSTAINABILITY AT NTU



WATER & ENERGY NEXUS

NEWRI and ERI@N
Directors on sustainability

YOUNG & PASSIONATE

NTU alumni on sustainability

ENVIRONMENTAL ENDEAVOURS

Lien AID and sustainable
development

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ADVANCING SUSTAINABILITY AT NTU

Two years ago, NTU unveiled its five-year strategic blueprint, NTU 2015. Five Peaks of Excellence, on which the University would make its mark globally, were mapped out under this blueprint. Of these five strategic thrusts, Sustainable Earth has been identified as the Peak of Peaks.

With more than S\$830 million of research funding awarded to the University for sustainability research, a testimony to its excellence and leadership in this area, NTU is well-placed to scale this peak and bring it to excellence.

This supplementary special brings you some of the significant and exciting developments in sustainability research at NTU. Its pages illustrate NTU's active involvement in, and dedication to achieving *Excellence in Sustainable Earth*.

We speak to the Directors of two major research centres dealing with the most pressing environmental issues facing the world today – Water and Energy. The Nanyang Environment and Water Research Institute (NEWRI), launched in 2008, is NTU's and Singapore's answer to the global quest for sustainable supplies of water. NEWRI steers the development of the clean water sector in Singapore and brings together NTU's efforts for the past two decades as committed participant in Singapore's Environmental and Water Technology R&D landscape.

The research institute provides a coherent platform for the multi- and trans-disciplinary interactions of different groups across the University. It offers a contiguous value chain incorporating research, translation, development and applications for the development of innovative and practical environmental and water solutions beneficial to society and planet earth.

Launched in 2010, the Energy Research Institute at NTU (ERI@N) is a global centre of excellence for the advanced research, development, and demonstration of innovative energy solutions. ERI@N looks into the areas of sustainable energy, energy efficiency, energy infrastructure and the socio-economic aspects of energy research. It provides a unique platform for the different research centres and Schools in NTU to come together to explore new solutions to issues including energy generation, harnessing, storage, distribution, efficiency and impact on climate change and global warming. It seeks to develop a world-class research programme that will foster a multi-disciplinary environment for scientists, engineers and social scientists to interact and promote relevant energy solutions and policies towards a more *Sustainable Earth*.

We feature Lien AID, a Singapore based non-governmental organisation that was established in 2006 through the Lien Foundation - Nanyang Technological University Environmental Endeavour. Established within NEWRI, the Environmental Endeavour (EE) is a partnership between the Lien Foundation and NTU to advance the provision of clean water and sanitation for the benefit of communities in Asia not yet adequately empowered with sustainable solutions that improve health, alleviate economic stagnation, and mitigate environmental degradation. Read on to find out how Lien AID improves water and sanitation issues in these communities through sustainable development projects.

Our alumni too have made significant contributions towards the *Sustainable Earth Peak of Excellence*. In the following pages, find out what inspired Dr Teh Yong Liang and Dr Sally Shen in their research work towards a more sustainable earth. Dr Teh and Dr Shen embody excellence in environmental and sustainability research. Winners of the prestigious World Future Foundation (WFF) PhD Prize, Dr Teh and Dr Shen were commended for their groundbreaking research work on energy-efficient compressors and treating antibiotics in wastewater.

In the months and years ahead, NTU's journey towards achieving excellence in *Sustainable Earth* can only be accomplished with the efforts of the entire University community. From students to staff, faculty to Schools and research institutes, everyone will be engaged in initiatives and efforts towards scaling this *Peak of Peaks*.

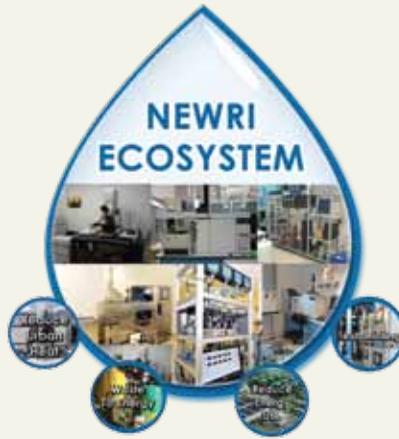
As further affirmation of NTU's commitment towards advancing sustainability, we have printed this supplementary special on paper certified by the Forest Stewardship Council (FSC). Moving forward, the magazine will be printed fully on FSC paper. FSC certification ensures our compliance with the highest social and environmental standards on the market where we source for, and use paper.

We hope that you will enjoy this special supplementary. On the last page, you will find tips from the World Wide Fund for Nature (WWF) on the little things you can do to contribute to a more *Sustainable Earth*. Take these steps with us today!



01

01 Er Prof Ng Wun Jern, Executive Director of NEWRI.



02

02 The NEWRI Ecosystem.

AN INTEGRATIVE ECOSYSTEM

Established in March 2008, the Nanyang Environment and Water Research Institute (NEWRI) comprises an ecosystem of research groups and centres providing a contiguous value chain integrating education, research, translation, development and applications in environmental science and engineering at NTU. Er Professor Ng Wun Jern, an environmental engineer who has dedicated some 30 years of his professional life to engineering, heads the institute. *NTULink* speaks to him to find out more about how the work done at NEWRI plays a significant role in steering NTU towards excellence in *Sustainable Earth*.

efficiencies in biotreatment processes, and membrane desalination and water reclamation processes.

Q: NEWRI is responsible for the development of Singapore's clean water sector, which has gained international recognition as a leading adopter of new water technologies. What are some of the new water technologies NEWRI has developed and fronted?

A: NEWRI's research, translation, and development activities are embedded in its Centres of Excellence (DHI-NTU Centre, Singapore Membrane Technology Centre (SMTC), Residues & Resource Reclamation Centre, Advanced Environmental Biotechnology Centre) and groups (Environmental Chemistry & Materials Group and Lien Foundation-NTU Environmental Endeavour). Activities include new generation membranes and membrane processes such as biomimetic* membranes, forward osmosis, and membrane distillation; and novel bioprocesses such as short-cut nitrogen removal to protect waterbodies from eutrophication*, recovery of carbon from carbon dioxide to reduce emission of greenhouse gases, and biosorption* for enhanced energy recovery from wastewaters. NEWRI has already moved some of its know-how from laboratory to full-scale plant applications. Examples of these full-scale systems include an anaerobic digestion* system for energy recovery, and combination of membranes and the bioprocess in one of the largest membrane bioreactor systems in ASEAN.

Q: Can you share with us more about membrane applications that NEWRI is renowned for?

A: NEWRI's SMTC has achieved international reputation in membrane material formulation and novel membrane processes. Examples of novel membrane material formulations include membranes with aquaporin, where membranes are allowed to "mimic" the kidney, and membranes with functionalised surfaces which allow membranes to self-clean and hence reduce fouling and operating downtime. An example of a novel membrane process is membrane distillation – success with this

Q: The term 'sustainability' holds varying connotations for different people. How would you define it?

A: Sustainability equals the long term pursuit of action which has sound environmental, economic, and social dimensions and consequences. Such action includes the responsible stewardship of resources and balanced ecosystems.

Q: What are some of the more pressing environmental issues facing Singapore today, and what are some of the ongoing projects that NEWRI is engaged in to address these issues?

A: NEWRI has interest in environmental issues concerning water and effluent streams in the urban setting, and how best resources may be recovered from such streams whilst maintaining a benign living environment. A recent and growing focus is the water-energy nexus. NEWRI carries numerous projects on improving energy

development has resulted in membranes which are less likely to foul when applied in bioreactors since these membranes would be presented with water vapour instead of the reactor's liquor.

Q: Your research interest lies in water and wastewater management. We understand that you are an advocate of wastewater treatment through energy recovery. Please share with our readers what this essentially involves.

A: The argument centres around challenging the wisdom of current state-of-the-art wastewater treatment which frequently applies the aerobic process. This process requires supply of oxygen and is hence, energy intensive. The process converts organic pollutants into microbial mass which requires further treatment. These two activities often account for 60-70% of total energy requirements at a treatment facility. Used water contains enough carbon which, if converted to energy, is more than sufficient for treatment of the wastewater.

Presently this carbon source is not recovered but instead the aerobic process attempts to oxidise and to convert it to microbial mass. The counter argument to this approach is to not treat the wastewater in the traditional manner but to attempt to recover as much carbon as is possible from the wastewater. The more carbon recovered, the better the quality of the wastewater which has been so "treated". This approach requires carbon capture as early as is possible at the treatment facility, and thereafter, the subjection of the captured carbon to bioprocessing to generate either methane or hydrogen which can be used to generate electricity.

Q: How can the work that is being carried out at NEWRI help NTU achieve its *Peak of Excellence* objective in *Sustainable Earth* under the University's 2015 blueprint?

A: NEWRI on its own cannot ensure sustainability because sustainability encompasses more than water and technology development which is NEWRI's primary domain. But water and NEWRI are part of the larger picture. The *Sustainable Earth Peak of Excellence* comprises many units and

NEWRI is one of these. NEWRI contributes to NTU's excellence in *Sustainable Earth* by working conscientiously towards achieving excellence in its focus domain – water and technology development.

Q: How does NEWRI ensure active participation of sustainable practices on a local level and how does it then make sure these practices are aligned to strategic national and global initiatives on sustainability?

A: NEWRI's focus on water and the water-energy nexus is consistent with national interests, and going forward, water and energy are more than likely to be also of global interest. NEWRI is not only active in pursuing research, translation, and development in the water-energy domain but also seeks to lend more obvious purpose to laboratory activities, and involve its academic, research, and postgraduate members in development work for deserving communities. Such work through NEWRI's Environmental Endeavour Programme (Lien Foundation-NTU Environmental Endeavour – read more about their initiatives on pages 08 to 10) give members the opportunity to interact with less privileged communities outside of Singapore, to share their know-how, and to see the implementation of their ideas. Such opportunities of visualisation and actualisation build a level of personal interest which is difficult to achieve if final outcomes remain vague and intangible.

Q: In your view, how can NTU promote sustainable practices in people who do not care about sustainability? What more do you think could be done to inform and engage people to develop more eco-friendly mindsets and habits?

A: Converting disbelievers requires patience and time. Information and education are important tools. The sustainability message can permeate curricula at NTU and over time this should help garner more support. NTU is amongst the very few institutions with a teachers college where this message can then be channelled to a larger and younger audience.

Q: Where do you see NTU ten years from now in sustainability research?

A: I see NTU acknowledged globally as a leader in sustainability research and particularly so in a number of specialised areas. NTU shall not only be recognised for the quality of its research output, but also for the impact of such output on industry and communities. The campus itself shall become a living laboratory and an example of what sustainability can look like.

Q: You have spent 30 years in the engineering profession and are a Professor at the School of Civil and Environmental Engineering. What do you love about what you do, and environmental engineering?

A: Environmental engineering allows the possibility of putting right inappropriate actions which have adverse impact on the environment. Environmental engineering has also afforded me opportunity to interact and share with students my interest, to bring research to application through partnerships with the industry, and to give a little back to society via work with communities in need of clean water and better sanitation.

Biomimetic: the study of the structure and function of biological systems as models for the design and engineering of materials and machines.

Eutrophication: The ecosystem response to the addition of artificial or natural substances, such as nitrates and phosphates, through fertilisers or sewage, to an aquatic system.

Biosorption: A physiochemical process that occurs naturally in certain biomass which allows it to passively concentrate and bind contaminants onto its cellular structure.

Anaerobic Digestion: A series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is used for industrial or domestic purposes to manage waste and/or to release energy.

SECURING EARTH'S POWER

With *Sustainable Earth* identified as one of the University's key thrusts, the Energy Research Institute at NTU (ERI@N)'s integrative role in synergising cross campus and key industry energy research collaborations is further foregrounded. Its Executive Director Professor Subodh Mhaisalkar, and Co-Director Professor Chan Siew Hwa, talk to *NTU Link* about the electric journey that lies ahead for ERI@N.



01

Q: The term 'sustainability' holds varying connotations for different people. How would you define it?

A: Sustainability is often confused with being 'green' or being minimalistic in nature. Actually, sustainability is a confluence of social, economic, and environmental responsibility. One cannot compromise safety, comfort, and productivity at the expense of reducing one's energy consumption, and in the same way, one cannot expect a company to compromise its products, profits and viability purely based on being 'green.' The onus is upon us to tackle the challenges of climate change, energy security, and environmental vulnerability in a way that is sustainable; minimising impact on planet earth. Sustainability may thus be summarised as 'meeting the needs of the current generation, without compromising the ability of future generations to meet their needs'.

Q: What are some of the more pressing energy-related issues facing Singapore today, and what are some of the ongoing projects ERI@N is engaged in to address these issues?

A: All our electricity generation is dependent on fossil fuels, primarily natural gas which we import from neighbouring countries. Singapore may be described as 'renewables disadvantaged' – even though we are in the solar belt, due to cloud cover and rain, we get only 30% more usable solar irradiance than southern Germany. The common perception is that Singapore does not have any significant wind and marine energy potential, however, anyone who has gone sailing knows that there is enough wind just a few hundred metres from our shores. ERI@N is thus leading a detailed study on our wind as well as marine (tidal, current, wave) energy potential.

We are also working on the electrical grid integration of solar energy so that we can efficiently utilise solar cells that are being deployed across Singapore.

A penny saved is a penny earned and in the energy domain, that translates to energy efficiency. In a typical building in Singapore, 60% of electricity is used for air-conditioning and a further 20% is used for lighting. ERI@N is focusing on new technologies for energy efficient air-conditioning that includes combining solar thermal to drive absorption chillers and LED lights managed by wireless sensor networks for efficient lighting management. Sustainable building design and the use of information technology in smart grids are also key initiatives championed by ERI@N.



02



The onus is upon us to tackle the challenges of climate change, energy security, and environmental vulnerability in a way that is sustainable; minimising impact on planet earth.

01 ERI@N's research staff collecting data on the micro wind turbine mounted on top of S2 building / School of EEE/NTU.

02 ERI@N's researchers using the Field Emission Scanning Electron Microscopy (FESEM) to view samples at Nano magnification.

Q: ERI@N is the principal facilitator of cross-campus energy research collaborations in the areas of sustainable energy, energy efficiency and socio-economic aspects of energy research. What are some of the challenges and rewards of: i) working across various disciplines; ii) translating education and research to relevant industry applications aimed at impacting climate change and global warming?

A: An example of a multi-disciplinary effort is the project on Electromobility in Megacities which is being executed in collaboration with the Technical University of Munich (TU Munich). The project involves participation from the School of Materials Sciences (for battery materials), the School of Electrical and Mechanical Engineering (for mechatronics), Computer Engineering (for simulation & modelling), Civil Engineering (for transportation engineering) and the School of Arts Design and Media (for design of the Electric Vehicle itself). The realisation that only with the contributions of all parties can the Electric Vehicle be completed is most satisfying.

There was however, the need to understand the challenges faced by the various Schools and the challenges of accommodating the priorities of an engineer and those of an industrial designer. Not only is the complexity different, the challenges faced on integrating technologies and elevating them to a total system solution again meant that patience and collaboration across a wide group of people were required. These challenges could be overcome by teamwork and the alignment and focus on one common goal; only then can the whole become much bigger than the sum of its individual parts.

Q: How can the work that is being carried out at ERI@N help NTU achieve its *Peak of Excellence* objective in *Sustainable Earth* under the University's 2015 blueprint?

A: Energy is just one part of Sustainability. For a *Sustainable Earth* effort, besides the energy-water nexus, we need to bring in our partners from social sciences, economics, business, and also other technologies such as earth sciences and biosciences. ERI@N is partnering the Office of Development and Facilities Management and other departments to reduce energy bills across NTU. This is done by implementing solutions in energy efficiency and integrating renewable energy, and in the building of new energy efficient buildings to contribute to a sustainable campus that would truly be a demonstration of our commitment to the *Sustainable Earth Peak of Excellence*.

ERI@N also engages the graduates of the Nanyang Business School with lectures on the latest technology trends in sustainable energy and supervises projects on business case problems related to clean technology ventures. ERI@N has also set up 33 Industry collaborations (e.g. Rolls-Royce, IBM, Bosch) and seven partnerships with foreign universities such as Berkeley, Cambridge, and TU Munich to launch projects of both scientific and technological relevance.

To reduce Singapore's carbon footprint and also to promote energy security and resilience, ERI@N works very closely with agencies like the Economic Development Board (EDB), the Building Construction Authority (BCA), the Energy Market Authority (EMA), and the National Environmental Agency (NEA) to ensure that we contribute to the national agenda which includes alternative sources of energy, decarbonising our electricity sources, and energy efficiency.



One of the key aims of ERI@N is translational research that will provide opportunities for solutions that would have industry and economic relevance to the clean industry development for Singapore.

Q: The Clean Energy industry is one that will provide strategic growth for Singapore's economy. How can ERI@N ensure its competitive research advantage and lead the further development of this industry?

A: One of the key aims of ERI@N is translational research that will provide opportunities for solutions that would have industry and economic relevance to the clean industry development for Singapore. In working closely with agencies such as EDB and by setting up joint laboratories and joint projects with companies such as Rolls-Royce, Bosch, Vestas, Gamesa, and IBM, ERI@N will continue to work on use-inspired research. With more than 150 full time staff and 100 PhD students, we also ensure that there will be an innovation pipeline that will also provide us the much needed breakthroughs to maintain our competitive research advantage.

Q: How does ERI@N ensure active participation of sustainable practices on a local level, and how does it then make sure these practices are aligned to strategic national and global initiatives on sustainability?

A: In partnering with the National Climate Change Secretariat (NCCS) and the National Research Foundation (NRF), ERI@N has been the lead organisation in helping to draft technology primers and support the development of R&D Roadmaps in the areas of energy efficiency, smart grids, and electromobility. In developing these primers and roadmaps, ERI@N also collaborates with leading organisations worldwide such as the US National Renewable Energy Laboratory (NREL), the Lawrence Berkeley National Labs (LBNL), the Energy Futures Laboratory (Imperial College London), and the Centre for Atomic & Alternative Energies (CEA) France. These partnerships and collaborations enable ERI@N to tap into global networks and identify opportunities and actions that are aligned with our national agenda.



Prof Subodh Mhaisalkar (right), Executive Director of ERI@N and Prof Chan Siew Hwa, Co-Director of ERIAN.

Q: In your view, how can NTU promote sustainable practices in people who do not care about sustainability? What more do you think could be done to inform and engage people to develop more eco-friendly mindsets and habits?

A: In partnership with the *Sustainable Earth* peak @ NTU (SE@N), we will be launching a *Sustainable Earth* initiative across NTU campus around April or May this year. This initiative will coordinate actions, to reduce our electricity consumption by at least 10% and also to introduce sustainability solutions across campus. Efforts such as increasing the air-conditioning set-point from 24 to 25 degrees across offices, laboratories, and lecture theatres are in progress. Actions to reduce unnecessary lighting and to assess the possibility of introducing cost effective renewable energy solutions across campus have commenced. The next steps would be to look at energy efficient retrofits for existing buildings and integration of renewable energy such as solar PV/thermal on the campus. These efforts will also extend to making sure that the new buildings to be designed and built on NTU campus, as part of our new Campus Master Plan, would be leading examples of energy efficiency and sustainability.

Q: Where do you see NTU 10 years from now in energy sustainability research?

A: We at ERI@N have a vision to be ranked amongst the top-five energy research institutes in Asia and to develop a reputation worldwide for industry-relevant solutions that make a difference. Our PhD students and professors will also generate top quality publications and opportunities for start-ups and spin-offs. I would also like to see that in ten years, we use 40-50% less energy than we use today on campus, with our campus representing sustainability in “walking the talk”.

Q: When will ERI@N move into CleanTech Park and how will the relocation help ERI@N to work better with its partners?

A: With the move to CleanTech Park, in the beginning of the 2nd half of this year, ERI@N and NEWRI would be in the same space and this proximity will truly lead to the creating of an energy-water nexus. We're also looking forward to setting up joint laboratories with our partners in wind energy, fuel cells, batteries, as well as sustainable building technologies and this will create further synergies in our research and innovation focus.

Q: Prof Subodh, you are also a Professor in the School of Materials Science and Engineering besides being the Executive Director of ERI@N. What do you love about working in NTU and what is it about research and teaching that drives you?

A: The focus on *Sustainable Earth* is exciting. It is satisfying to know that we at NTU are committed to working closely with industry in addition to pursuing basic scientific research. It is very fulfilling to see that I can use my domain knowledge in Materials Science in all fields of energy, be it nanomaterials coatings for wind turbines, photothermal materials for sustainable buildings or mesoporous materials for solar cells, to name a few. It is exciting to collaborate with professors and researchers across NTU who work in economics and supply chain management as well as to analyse customer behaviour. My industry experience in Microelectronics was certainly a highlight of my career, but the opportunity to learn such diverse disciplines is only possible in the vibrant research environment of NTU.

Q: Prof Chan, you have been with NTU since 1991 and now hold concurrent positions as Co-Director of ERI@N and Deputy Director of the Maritime Institute at NTU. You have won international recognition in research, as well as recognition in teaching. How does the synergy between research and teaching help you achieve your objectives?

A: As my basic PhD training was in internal combustion engines, I always find Carnot Principle-based machines fascinating, though my research now is inclined to alternative energy (fuel cells and fuel reforming). With a good understanding of conventional energy system and knowledge in Thermodynamics, I make fair comparison amongst different types of energy conversion systems without bias. This is important when imparting knowledge to students as it is not uncommon for a professor working on a particular research area to oversell his belief to his students. My strong interest in research also permits me to connect textbook materials to emerging technology, making the course more interesting to students.



I would also like to see that in ten years, we use 40-50% less energy than we use today on campus, with our campus representing sustainability in “walking the talk”.

- Prof Subodh Mhaisalkar



01

ENVIRONMENTAL ENDEAVOURS THAT GO A LONG WAY

Lien AID tackles Asia's water and sanitation issues via sustainable development.



02



03

- 01 With Lien AID's River of Life project on the Ton Le Sap in Cambodia, eight-year-old Non Siew May now gets to drink safe drinking water.
- 02 A villager in Amengkong Village, Yunnan Province, China, listens attentively to understand ways to mitigate drought and protect the environment.
- 03 Lien AID's part-time consultant, Dr Diarra Boubacar, educates villagers in Amengkong Village, Yunnan Province, China, in a hygiene workshop.

Man can live 40 days without food but just five days without water. Access to clean water and proper sanitation is critical to ensuring a healthy life and eradicating poverty.



“Healthy life is an outcome of sustainable development, as well as a powerful and undervalued means of achieving it. We need to see health both as a precious asset in itself, and as a means of stimulating economic growth and reducing poverty.”

Director-General Gro Harlem Brundtland,
World Health Organization

Lien AID is a Singapore-based NGO that seeks to alleviate poverty through tackling water and sanitation issues faced by poorer communities in Asia. These communities account for more than half of the 884 million people worldwide who currently have no access to safe drinking water.

A partnership between the Lien Foundation and NTU under the Environmental Endeavour (established within the Nanyang Environmental and Water Research Institute), Lien AID has been actively engaged in water and sanitation developmental work across Asia since 2006 – specifically in Cambodia, Vietnam and China. Today, Lien AID has impacted 250,900 beneficiaries through projects that strongly focus on sustainable solutions that yield long-term benefits.

Building Capacity of Beneficiaries

With the durability of any intervention highly dependent on the ongoing efforts of beneficiaries, the organisation's projects place emphasis on building the capacity of the community involved, equipping them with necessary knowledge and skills. Its drought mitigation project, for example, works on directly building the capacity of beneficiaries as part of a holistic approach to mitigate annual drought conditions faced by affected villages in the Yunnan Province.

With the first phase completed in July last year, the drought mitigation project saw the piloting of the organisation's 4-D methodology approach – **D**iscover, **D**evelopment, **D**efend and **D**isseminate, in five locations in the province. Sustainable water sources are first discovered through joint exploration with locals and relevant agencies. Managed implementation such as building water storage facilities and laying pipes then ensues. The defense of the water source is addressed through environmental protection measures and waste management. Finally the capacities of beneficiaries are built, in an effort to affect behavioural change.

Under this approach, the organisation equips the community with the proper knowledge needed to operate and maintain the water storage facilities built and the pipes installed. The villagers are also educated on water management practices to mitigate drought, public health as well as made aware of the importance of environmental protection, aimed at ensuring the sustainability of the intervention implemented.

“As the Chinese proverb goes: ‘Give the man a fish and you feed him for a day, teach the man to fish and you can feed him for a lifetime’, we believe in making our projects sustainable – and this comes in both hardware and software,” says Ms Ding Yan, Lien AID's Deputy Country Manager for China who is based in Beijing.

Identifying a Local Champion: Creating Local Ownership

Strong community involvement in the full cycle of a project is also a key factor in guaranteeing the sustainability of an intervention in the long run. Lien AID's emphasis on creating local ownership or identifying local champions in its projects helps to ensure that the water and sanitation interventions it puts in place continue to endure and impact beneficiaries long after they are completed.

It works in close partnership with the local community involved and achieves this on many levels. For example, beneficiaries are involved during the scoping of a project with their needs identified through close consultation. With the needs assessed, Lien AID also provides any initial training that is needed by beneficiaries and management involved. More importantly, it also ensures that the local community or government is invested in the project through a co-funding arrangement, thereby creating local ownership of the water and sanitation initiative proposed and ensuring its sustainability in the long run.

At the end of the day though, the true testament of the sustainability of an initiative put in place can only be measured long after the project has been completed. This is why Lien AID continues to monitor and evaluate completed project sites years after it has handed over the hardware to the local community to be maintained under their ownership.

A SUCCESS STORY: RIVER OF LIFE PROJECT

Location:

Chnok Trou Village, Chnok Trou Commune, Kampong Chhnang Province, Cambodia

Number of Beneficiaries:

1,000



Cambodia's Chnok Trou Commune's water treatment plant operator Ms Meas Mom (left), who was appointed by Lien AID for running the plant and selling 20-litre bottled Lotus water to families of the floating community.

The Context

An estimated one million people live in floating villages on the Ton Le Sap. The largest freshwater lake in Southeast Asia which was designated as a UNESCO biosphere in 1997, many depend on it as a source of water and livelihood.

Yet, the water remains heavily contaminated with waste and direct defecation. This same contaminated water is used by the community for drinking, cooking, bathing and other household purposes, perpetuating the cycle of disease and poverty.

The Intervention

The project saw the construction of a floating water treatment and bottling plant within the floating village. A local entrepreneur was selected and trained in business, management, sales and marketing to run the water treatment plant, with 20-litre bottled water to be sold at cost-plus, and at a price that is affordable to the families.

The water treatment enterprise is managed by a commune-led management mechanism, ensuring its sustainability. Besides that, operation and maintenance guidelines with a focus on product quality, health and safety were also developed.

Coined Lotus Water, the 20-litre bottled water is sold at 'cost-plus' (US \$0.20) – 'cost' being the cost of treating the water and 'plus' being the cost required to maintain the water treatment system – to the floating community on the Ton Le Sap.

Sustainability of the Project

Since the water treatment and bottling plant was commissioned in February 2010, Lien AID continues to monitor and evaluate the project to analyse its sustainability.

The results have been encouraging. Since its commissioning, the plant is still working at full capacity, treating raw river water into safe drinking water that is affordable for beneficiaries. Since January 2011, an average of 700 000 litres of water is sold annually, and the reach of the initiative continues to expand to neighboring villages, with beneficiaries reportedly travelling to the Chnok Trou Village specifically to purchase Lotus Water. And anecdotally, cases of water-related illnesses have reduced.

"At Lien AID, achieving sustainability is our topmost priority. Our River of Life project is an excellent example that demonstrates our commitment to sustainable development, towards poverty alleviation," explains Lien AID's Chief Executive Officer Koh Lian Hock.

Give The Currency Of Hope

Whilst efforts continue, access to safe water and proper sanitation still remain painfully elusive to many poor rural villagers in Cambodia, China and Vietnam. With the state of health and livelihood intrinsically entangled with the availability of safe water and proper sanitation, the perpetuation of this elusiveness for these villagers means a perpetuation of their poverty cycle.

Water is the currency of hope; hope for a better life, hope for a brighter future.

Would you like to extend this hope to others?

Answer our call to action and make a difference. For more information, please visit www.lienaid.org or email us at admin@lienaid.org



Dr Teh Yong Liang, MAE alumnus and advocate of sustainable living.

AN EDUCATOR'S PURSUIT OF SUSTAINABLE LIVING

For Dr Teh Yong Liang, being energy-efficient is a logical way of life. This rationality was the basis for a research thesis that garnered him the notable World Future Foundation PhD Prize in 2010, an award to recognise his outstanding research work in the development of energy-efficient compressors. Today, this talented alumnus continues his quest for more sustainable ways of living.

"Why should we use more than what is needed?" This deceptively simple question is one of the key mottos by which Yong Liang lives his life. In fact, his conviction led him to work on the development of a new compressor for refrigeration and air-conditioning purposes, winning him the World Future Foundation PhD Prize for excellence in environmental and sustainability research in July 2010.

Energy Efficiency As a Way of Life

"Air-conditioning and refrigeration consume an enormous portion of the world's energy usage, so I thought that a little improvement in this area might point to substantial savings in global energy consumption," Yong Liang shares, of his motivation for the choice of his thesis. "Being energy-efficient seems like a logical way of life for me," he adds. He believes that technological innovations that increase energy efficiency would make rational sense to users since the innovations would help them to cut cost on top of save energy.

But the work is not without its challenges. "In the development of any new product, the biggest challenges are probably those of the unknown. Until the technology has been rigorously proven to work, we are unsure of its functionality, effectiveness,

usefulness, economic viability and reliability. And when the technological difficulties have been somewhat overcome, the business-associated obstacles arise." Fear and greed are two emotions that are very difficult to deal with," he explains.

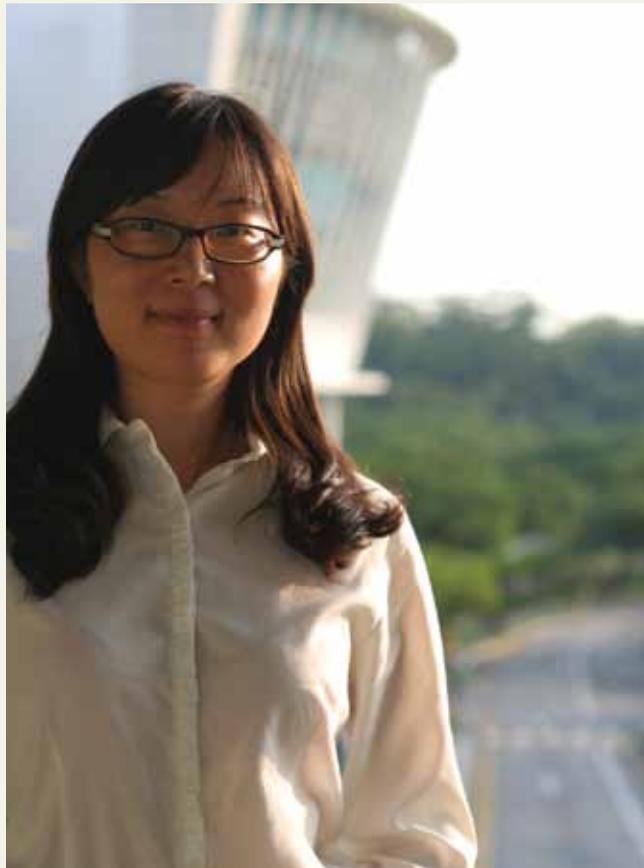
Yong Liang's passion for energy-efficiency began as early as 2003, when he was still a third-year undergraduate at the School of Mechanical and Aerospace Engineering (MAE), where he conceived the idea of an energy-efficient compressor that went on to win him and his NTU team the silver prize at the World's Best Technologies Showcase.

Towards Sustainable Living

Today, Yong Liang is a lecturer in green building and sustainability at Temasek Polytechnic. On his choice of career, he says: "I love to teach and I want to learn more about green and sustainable technologies and not to limit myself to compressors." In his day-to-day activities, this vegetarian tries to practise sustainable habits, like using only what is necessary.

He urges alumni to take their first step towards sustainable living in realistic measures. "Try to start with something small, such as driving only when necessary, taking public transport during peak hours, changing your water faucets to water-saving types, avoiding heated baths, and cutting down on unnecessary shopping etc. When you see the savings accumulate, you will naturally be motivated to do even more," he explains.

For Yong Liang, sustainability means the ability to co-exist with the environment for an indefinite length of time. But he is fully aware that there are no easy solutions to mankind's issue of sustainability. "We will eventually be sustainable, but only when we are forced by higher prices to lower our consumption rate to the point that it balances with the replenishment rate of resources. Prices will sky-rocket when supply dwindles. To better cope with this predicament, I would advocate that we live more prudently, consume only what is needed and save the excess," he advises.



Dr Sally Shen, star researcher and devotee of environmental sustainability.

RIDDING WASTEWATER OF ANTIBIOTICS

Her groundbreaking research on the discovery of a potential way to sieve out and treat antibiotics present in wastewater won her the prestigious World Future Foundation PhD Prize in Environmental and Sustainability Research in 2011. Dr Sally Shen shares with NTULink some of her motivations and challenges in treating a mounting global issue.

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I will share what I have gained from my education at NTU with the younger generation, in my current position as university professor.

Growing up during the reformation years in China, Dr Sally Shen has a very pragmatic sense of the relationship between a country's development and the price this translates to on its environment. Walking home from school each day, she had to take in the stench from rivers that were dumping grounds for factory discharges, and was sometimes caught in acid rains. Motivated by Laozi's belief that a *Dao*, which could bring about harmony for people and things, governs all creatures in nature, young Sally's cause for environmental sustainability was born.

Sally's interest in water and wastewater treatment was further intensified at NTU where she did her PhD, under Associate Professor Liu Yu's research group in the School of Civil and Environmental Engineering (CEE). "My supervisor and his partners have made a series of significant achievements, especially on granulation biotechnology in this field. I was spurred on by their passion and by the end of my first PhD year, I had developed a specific research interest on antibiotic pollutant," Sally shares.

Antibiotics in Wastewaters – A Potential Health Hazard

Sally's primary motivation for her choice of research thesis stems from the concern for the rapid and widespread increase of antibiotics on earth and its potential risks to human health, including the pathogen's growing resistance to antibiotics. Antibiotics can easily find their way into rivers and lakes as they are usually not removed through the normal sewage process. Their presence could wreak havoc on the aquatic ecosystem and human health.

The Solution

Sally's research team decided to come up with a sustainable technology combining the advantages of adsorption* and biodegradation. However, because of the fact that adsorption units would expire once adsorbents like activated carbon become saturated with the target pollutant, and that the conventional biological process in the wastewater industry is not tailored for antibiotics due to their antimicrobial property, the new technology has to be one that would overcome these limitations to deal with antibiotic-bearing wastewater.

"Specifically, we developed biofilms on activated carbon in a continuous bioreactor with antibiotic feeding, and found that all input antibiotic could be effectively removed along with the reactor operation. We then studied the removal mechanisms of antibiotic by the integration of adsorption and biodegradation through the biofilm-covered granular activated carbon (BGAC), and correlated them to the system performance," Sally explains of the research and development process.

A Challenge-Turned-Motivation

The greatest challenge facing Sally at the time of her research was the fact that the application of biofilm-covered activated carbon in antibiotics had not yet been reported. "Although antibiotic has emerged as an aquatic pollutant recently, relevant information to solve this problem is still scarce," shares Sally. Hence there was not

much Sally could leverage on from previous studies on the subject. This proved to be more of an obstacle for her at the initial stages of her work, than the study of the mechanism for eliminating antibiotics from wastewater.

However, the same challenge turned into a motivation for Sally to see through the research process. The result was the invention of a novel BGAC system with the combined function of adsorption-biodegradation for the possible high-efficiency removal of antibiotics from wastewater. The activated carbon granules that are specially covered with a biofilm of microbes would be able to break down harmful antibiotic chemicals into harmless products. Once optimised, the new technology could be installed in treatment plants around the world.

Sally's research work won her the prestigious World Future Foundation (WFF) PhD Prize in 2011. Awarded by the WFF, these PhD Prizes are Singapore's first-of-its-kind award to recognise excellence in PhD environmental and sustainability research.

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Active measures, like moving towards a more comprehensive understanding of sustainability, are urgent necessities to help us and our generations continue to live well on planet Earth.

Committing to Environmental Sustainability

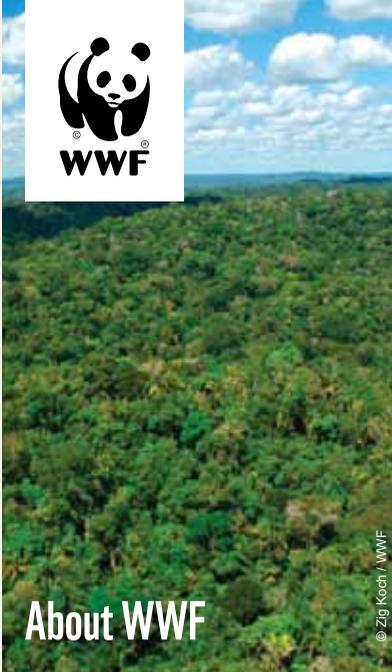
Today, Sally is Assistant Professor in the Department of Chemical and Biochemical Engineering at Xiamen University, where she continues her research work on environmental sustainability. She attributes her devotion to a career in environmental sustainability to the unwavering support provided by her supervisor, research group, and the School of CEE, as well as the opportunity that NTU has provided her to approach the academic and professional frontiers. She says, "I will share what I have gained from my education at NTU with the younger generation, in my current position as university professor."

For Sally, sustainability denotes the ability of a living thing to constantly maintain a dynamic balance with various corresponding environments. "Modern human activity has greatly altered the environment in both scale and degree. Consequentially, relationships within the whole ecosystem have become very intense and fragile. Therefore, active measures, like moving towards a more comprehensive understanding of sustainability, are urgent necessities to help us and our generations continue to live well on planet Earth," Sally explains. She urges all NTU alumni to continue with environmental efforts for our planet, and hopes to see NTU strengthen its leading role in sustainability research and become a hub of new environmental technology in Asia, in the next ten years.

Adsorption: The process by which molecules of a substance (gaseous or liquid) collect on the surface of another substance (solid). The molecules are attracted to the surface but do not enter the solid's minute spaces as absorption.



WWF



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About WWF

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable and promoting the reduction of pollution and wasteful consumption.

Tips for a more sustainable earth from the World Wide Fund for Nature (WWF)

Protecting the planet does not mean giving up the things you love. WWF brings you a list of simple things you can embark on, to make a difference to the planet you live on.

- Set air-conditioning temperatures to 24 degrees Celsius or higher. For every degree raised, you save about S\$20 a year*. The lower the air-conditioning temperature, the more energy is used and the higher your electricity bill.
- Switch your lights to LED or compact fluorescent lamps. The latter uses only about 25% of electricity compared to traditional light bulbs. That can mean saving up to 80% on your next electric bill.
- One million tonnes of paper is used daily. A lot of this paper usage is unnecessary. The next time you are about to press that print icon, ask

yourself if you really need to print the document. If so, print on both sides. Avoid printing out single line e-mails or unnecessary copies of documents.

- Product packaging and disposable bags are just a waste – what you really want is the thing inside. Less packaging means less waste in landfills, which release large amounts of methane, a powerful greenhouse gas that contributes to global warming.
- Wherever possible, buy local, seasonal produce that has not crossed the globe to get to you. If you have to buy produce from far away, make sure the produce was shipped, and not flown to your country.
- Only buy what you will eat. In the US, 14% of food purchased at the grocery store is thrown away. This is an incredible waste of resources – not just to produce the food but also to ship, process and store it.

*Source: <http://www.e2singapore.gov.sg/energy-saving-tips.html>

Organised by WWF, Earth Hour is a global campaign encouraging individuals, businesses and governments to switch off their lights for one hour and commit to positive actions for the environment.

WWF Singapore is urging individuals, businesses and government agencies to sign up and be a part of the Earth Hour celebration. On that day, participants can count down to the 'lights-off' hour with live performances, an eco-carnival and the first-ever Earth Hour human formation in the shape of "60+ Singapore".

Sign up at <http://earthhour.wwf.sg> and be our Earth Hour Ambassador. Help us spread the word of going beyond the act of switching off lights for an hour. To empower you and the people around you to take action for our planet, you will receive an Earth Hour Ambassador Kit that includes a useful and informative guide on eco-friendly living, a limited edition of Earth Hour 2012 t-shirt and cap made from post-consumer recycled plastic bottles and eco-friendly products and merchandise.

There is a participation fee of \$35.00 per person. For group registration of 20 or more people, the fee is \$30.00 per person.

For more information, visit <http://earthhour.wwf.sg> or call 6730 8100.



Celebrate Earth Hour 2012 @ Orchard

Date: 31 March 2012, Saturday

Time: 6.30pm to 10pm

Place: Ngee Ann City, Civic Plaza along Orchard Road