

# Full Support for Sustainability at PolyU

Sustainable development has never been as important as in today's world. As concern for the pressing issue of global warming mounts worldwide, various countries are paying increased attention to reducing carbon emissions while exploring alternative sources of energy. In fact, it is every person's responsibility to contribute to the environmental cause. Being in the forefront of discovering and applying knowledge, universities have a pivotal role to play in helping ensure a clean and efficient use of resources.

At PolyU, substantial research relating to environmental protection has been undertaken, covering areas from the

creation of electric cars, eco-friendly building blocks, renewable energies, to waste water treatment. The research outcomes generated thus far have proven valuable to both the public and private sectors, and at international, regional and local levels. PolyU scientists, for example, provided real-time data on the air quality in Beijing during the 2008 Olympic Games, in line with their goal to conduct world-class research on changes to air quality. Research collaborations with private companies and even schools have led to projects with far-reaching practical values.

On the PolyU campus, a string of energy-saving measures has been adopted in

support of its sustainability drive. They include the installation of state-of-the-art technologies to monitor and control CO<sub>2</sub> emission in classrooms and meeting rooms. As explained below, particular policies have also been put in place, in addition to campaigns aimed at enhancing students' and staff's awareness for energy-saving. The University backed Earth Hour 09, the global campaign that called on all companies, governments and individuals to switch off lights for one hour on 28 March 2009 as a show of support for action against climate change. In the days ahead, the University will continue to demonstrate unwavering commitment to making sustainability a fact of life.

## On-going Advanced Research

Researchers at the University are engaged in numerous projects related to sustainability. They cover latest technologies in wide-ranging areas including energy saving, renewable energy, GIS and remote sensing for air pollution monitoring, water treatment, land contamination, landscape deformations, noise pollution, heat island, waste management and recycling, infrastructure condition monitoring, and so forth. This feature story highlights five research projects which have made an impact on society, and showcases the University's commitment in fighting against air, water and land pollution, as well as developing renewable energy technologies. More projects are listed on P.14.

### Electric Vehicle

A team of experts led by Prof. Eric Ka-wai Cheng from the Department of Electrical Engineering (EE) has for many years worked on environmental applications for automobiles. The new findings have opened up new possibilities in battling against the problem of air pollution.

The quadcycle, electric vehicle mycar, is a project originated from PolyU. The Giorgetto Giugiaro designed vehicle is the first Hong Kong-developed vehicle to obtain the World Manufacturer Identification (WMI) Code. This is also the first home-grown vehicle from Hong Kong to hit the international market. Ideal for

short rides or rides in enclosed estates such as clubs, or airport, it typically moves at a speed of 65 kilometres (40 miles) per hour and has a range of about 70 miles. A full recharge of the battery takes six to eight hours, but a short charge, which can be done by plugging into a normal household electricity socket, can be done in two hours.

PolyU's Industrial Centre did the initial body frame and auto parts, the Rapid Product Development Syndicate did the detailed engineering design while Prof. Tak-chi Lee of the School of Design coordinated the design. Mr Andrew Young, Director of Partnership Development, handled the investors and



took on the project management role. The engineering team of the EuAuto Technology Ltd contributed extensive efforts to it. The final design and engineering thus had input from Hong Kong, Italy, France and Australia. The electric vehicle, mycar, is already available for sale in the UK and French markets.

PolyU will be collaborating with Pok Oi Hospital to develop new electrical vehicles to be used as mobile Chinese medicine clinics.

### Electric Vehicle-related Research

The team at EE has also come up with other innovations applicable to electric vehicles:

1. *Electrical High Power Universal Vehicle Charger*— It is a high efficiency and low temperature rise design. The converter can be operated with a main voltage of only single phase 13A power system, i.e. same as the domestic power supply. It can charge different types of battery cells with all battery protections. In addition, its high current charging capability can shorten the charging time significantly, thus improving its efficiency. It can also extend the battery life time with the special charging profile.



2. *HID Lighting System* – This newly developed technology employs the compensation techniques and the voltage feedback from the lamp voltage so that a good correlation is able to be obtained for the temperature compensation of the lamp. The lamp lighting output is thus regulated to provide dimming control and instant startup. In comparison to current practice, this method is much easier to implement. The HID system uses the freeforming techniques developed by PolyU's Department of Industrial and Systems Engineering for the optical design.



3. *LED Matrix Lighting* – High power LEDs are now widely used and recognized as an efficient source of light. Classical DC-DC converters are ideal drivers for LEDs. To improve the performance of LEDs, the team has modified the classical DC-DC converters such that the number of components (including capacitor and diode) used to drive the LED light can be reduced. This new technology not only lowers the manufacturing cost of LEDs, but also simplifies the circuit design as well as reduces the size of converters. It has been proven to be compatible with current LED lighting applications in automobiles.



4. *Polymer-bonded Magnetic Device* – Winner of the Gold Medal with Mention at Brussels Eureka 2007, and the Silver Award at the 16th China Invention Exhibition in 2006, this patented technology emulates the magnetic functions provided by traditional metal and copper transformers. Such "magnetic" devices can now be produced in any different shapes as its application sees fit. It is also low cost, non-brittle and lightweight. It will have many applications, especially for the making of transformers and inductor components, direct-current-to-direct-current power converters, high frequency power supplies, and screening of electromagnetic wave.





5. *High Efficiency Motor Drive System*

– The innovative design of the highly efficient Motor Drive optimizes the braking system and increases the efficiency of power regeneration. This regeneration process converts kinetic energy produced during braking into electrical energy that would be stored back in energy supply. This system has higher regeneration efficiency than that of the conventional ones, without the need of using expensive components. Its specially-designed driver enables the use of common and lower-cost components, thereby reducing half of the conventional production cost.

6. *In-wheel motor* – This technology, based on a fault-tolerance, switched-reluctance motor design, is to integrate the motor into a wheel. The new development allows steering by wire and simplifying the overall propulsion system of a vehicle. All the mechanical subsystems including gear box, shaft, transmission and clutch can be eliminated. The design can realize a true four-wheel vehicle by direct wheel propulsion control.



## Study on Regional Air Pollution

Rapid industrialization in the Pearl River Delta (PRD) has led to rising pollution problems such as haze, acid rain and ozone – an ingredient of photochemical smog and a greenhouse gas which contributes to global warming. PolyU has played a pertinent role in analysing air pollution in the PRD region, providing valuable insights for policymakers.

Prof. Wang Tao from the Department of Civil and Structural Engineering is Chief Scientist for China’s 5-year research project on controlling acid-rain pollution, formed under its National Basic Research Programme (also called the 973 programme). He also heads the project entitled *An Integrated Study of Photochemical Ozone, Haze, and Acid Rain Pollution in the Pearl River Delta and Other Fast Developing Regions of China*, launched by PolyU in support of the 973 project, under its Niche Area Development Scheme for 2006-2011.

Prof. Wang’s team has conducted atmospheric measurements and analysed data obtained from multiple platforms including surface, mountain-top, aircraft, and satellites in Hong Kong, southern and eastern China, using state-of-the-art computer models to understand the various complex chemical and physical processes involved. It has also analysed the long-term trends of ozone concentration in northern and southern

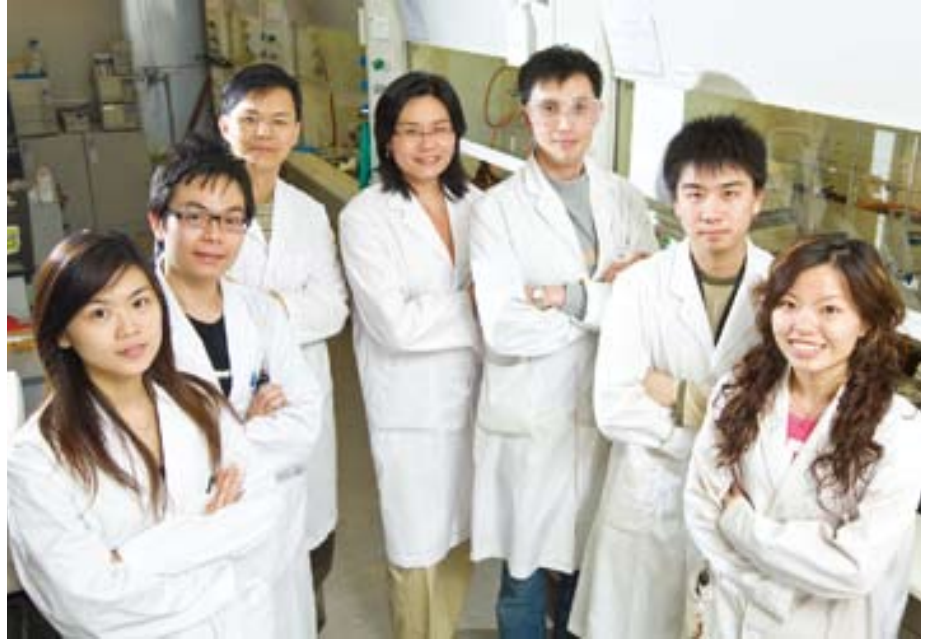
China, the result of which will contribute to air quality management measures.

The work focuses on the Pearl River Delta, Yangtze River Delta and Beijing-Tianjin cluster, three of the most important economically developed areas in China. The research has been carried out in collaboration with a number of renowned universities and institutions in the mainland and abroad.

The study has identified some formation processes of atmospheric particulates that are unique to China’s environment, including the strong formation and growth of particles under polluted conditions and the formation of very high nitrate in ammonia-poor environments. Some of its findings have been published in leading international environment journals, such as *Atmospheric Chemistry and Physics*, *Journal of Geophysical Research*, *Atmospheric Environment*.

The finding on the super-regional transport of ozone and particulate pollution in Hong Kong was considered by the Environmental Protection Department (EPD) when it revised its Air Quality Objectives. Prof. Wang also serves as a science advisor/independent specialist for two large PRD air quality studies commissioned by the EPD. During the 2008 Beijing Olympics, his team also collected and provided near real-time data to China’s Ministry of Environmental Protection for conducting quick assessment of the effectiveness of the air quality control measures introduced then.





## Nano-Particles That Clean Water

A research team led by Dr Pauline Pei Li of the Department of Applied Biology and Chemical Technology has brought waste treatment technology to a new era. Their invention of tiny polymer particles with sizes in the range of nano- to submicro-scale can effectively purify waste water at low concentration level. The particles are composed of well-defined hydrophobic cores and functional hydrophilic shells. The unique core-shell design of the particles enables the shell to adsorb most of the unwanted organic and inorganic contaminants found in industrial wastewater, while the core provides structural support of the particle for subsequent separation from water.

This outstanding nanotechnology-based materials give a simple and efficient treatment process that takes little time, is easy to operate and at least three times more effective than low-cost adsorbents in removing both organic and inorganic pollutants.

The absorbed particles containing contaminants can be separated by using an ultra-filtration system, then easily regenerated for repeated uses without affecting their adsorption capacity and removal performance for the targeted compounds.

The cutting-edge technology won the University and one of its top business partners on the project, Dunwell Environ-Tech, the Technology Achievement Grand Award of 2008, Hong Kong





Awards of Industries. In June 2007, the University signed a license agreement with Dunwell, which specialises in providing technological environmental solutions, on the nanosorbents technology system.

The research and development of the products, which received a Gold Medal in the 35th International Exhibition of Inventions, New Techniques and Products, Geneva, and the Best Invention award from International Jury and Islamic Azad University in April 2007, were also supported by the US chemical giant Rohm and Hass.

The latest technology can also be applied in the separation of toxic organic waste from special wastewater; isolation of pharmaceutical active ingredients from reacted or extracted solution in the pharmaceutical production industries.

## Eco-blocks

The Eco-blocks developed at PolyU since 2002 are an environmentally-friendly alternative to conventional building blocks. Widely used in various local sites including government buildings, universities, private and public housing estates, recreational playgrounds and eco-parks, they are made from recycled waste glass derived from beverage containers, construction and demolition waste, instead of sand and stone.

Apart from alleviating the pressure on waste disposal facilities, Eco-blocks have proved to be effective in converting air pollutants into non-hazardous materials. Laboratory tests showed that at least 20 per cent of nitrogen oxides can be effectively removed with the use of the product invented by Prof. Poon Chi-sun, Director of PolyU's Research Centre for Environmental Technology and Management.

The product has undergone three generations of development and the latest generation has successfully combined



the use of recycled materials with a small quantity of photo-catalyst. It is via a photo-catalytic reaction that the Eco-blocks can remove air pollutants such as nitrogen oxides. The technology utilizes sunlight as the energy source and can function through the year requiring little maintenance.

## Durable Materials

With the same life span as conventional materials, the Eco-blocks are superior in terms of water absorption capability, hardness and aesthetic value. It has won a string of awards in recent years, including the Green Building Award (Merit) given by the Professional Green Building Council in 2006 and the Eco-product Award (Notable Mention) the same year. In 2008, it won the Gold Award in the 6th China International Invention Exhibition Awards.

Recently PolyU has received a \$2 million donation from HSBC Insurance in support of its two-year "Let's Travel Green" programme aimed at promoting environmental education and improvement at schools.

Under the programme, 10 schools will be selected to have their outdoor landscaping areas paved with Eco-blocks. Half of the schools will be from urban areas. Students and teachers in all selected schools, apart from enjoying an improved environment, will be able to learn more about environmental protection and conservation. The first three beneficiaries of the programme are the child care units of the Hong Kong Society for the Protection of Children in Mong Kok and Ma Tau Chung, and King Lam Catholic Primary School at Tseung Kwan O.



## Renewable Energy Projects

The Renewable Energy Research Group (RERG) at the Department of Building Services Engineering has developed seven alternative energy systems at the Ma Wan Theme Park. With the support of the developer, Sun Hung Kai Properties, the team headed by Prof. Yang Hongxing established various demonstration installations that derive electrical energy from different renewable sources at the Windmill of the 18-hectare park.

Energy is provided by the sun via Photovoltaic panels on a roof and by a wind powered installation, which feeds into the grid, and by a heat pump system which rejects heat into or sucks heat out of the ground to drive air conditioning. There is also a biogas generation system and a hybrid lighting system powered by solar and wind energies.

For research purpose, data are collected on a continuous basis on the performance of all these systems. The team now focuses on four crucial areas of research:

1. *Building-integrated photovoltaic technology* – With support from the Innovation and Technology Fund (Guangdong-Hong Kong Technology Cooperation Funding Scheme), the

team is investigating how thin-film solar photovoltaic modules can be efficiently and economically integrated into building facades.

2. *Wind power generation from buildings* – The team seeks to develop vertical-axis wind turbines within buildings for the purpose of power generation. It is studying the technical aspects such as blade construction, wind velocities and pressures around installed turbines, as well as the economic feasibility of supplementing conventional grid power to high rise buildings with wind power generated at the building itself.

3. *Ground-coupled heat pump technology* – With funding support from the Research Grants Council, it is studying the applications of this technology in hot-weather areas like Hong Kong. A leader in this field, the team has developed a software package for system design and operation performance simulation which will be useful for future designers of ground heat pump schemes.

4. *Solar cell development* – In collaboration with Zhongshan University, research on the development of cheaper solar cells, but as efficient as current thin film amorphous silicon solar cells, is now underway with the use of nanostructure counter electrodes.



## Energy Saving Measures at PolyU

PolyU has adopted new technologies and measures to reduce electricity consumption, a major source of greenhouse gas emission.

The state-of-the-art technologies adopted include the CO<sub>2</sub> demand control system in air-conditioned spaces. It consists of direct application of CO<sub>2</sub> sensor for real-time speed control of Primary Air-handling Unit and thus enabling variation of the amount of pre-treated fresh air supplied to suit actual requirement. Furthermore, motion sensors have been installed in all classrooms and selected meeting rooms to switch off lights and air-conditioning whenever the rooms are not in use.

Efforts have also been made to replace existing air-cooled chiller plants with more energy-efficient water-cooled ones at various buildings including Chung Sze Yuen Building, Ng Wing Hong Building and Chow Yei Ching Building. The use

of water-cooled chiller plants has been extended to new developments of the University including Lee Shau Kee Building and the two Hong Kong Community College (HKCC) buildings at Hung Hom Bay and West Kowloon. The building of HKCC at Hung Hom Bay also won the “Merit” Award in the Green Building Award 2008 launched by the Professional Green Building Council.

Existing air-cooled chiller plants on campus which have not yet reached their normal life expectancy are being retrofitted with water-mist saver (WMS) installations to improve their energy efficiency.

Besides, T8 fluorescent lamps have been replaced with the more energy-efficient T5 fluorescent lamps; fluorescent lamps used to illuminate all exit signs have been replaced by light-emitting diodes (LEDs), which have a longer life span and lower power consumption.

Other measures adopted include regular cleaning of cooling coils and fins of air-handling units; making announcements/distributing pamphlets to students and staff promoting awareness of energy saving; participation in various energy saving campaigns organized by the Government or NGOs, e.g. Power Smart Competition by Friends of the Earth, Energy Conservation Charter–Suitable Room Temperature by the Electrical and Mechanical Services Department of the HKSAR.

## “Green” Campaigns and Activities

The University helped promote waste collection and recycling in November 2008 and January 2009, when the PolyU Staff Association co-organized two rounds of used-item collection campaign on campus with the charitable organization Industrial

Relations Institute (IRI). Staff members donated used items ranging from electrical appliances, clothing, shoes and bags to DVDs for re-sale by IRI to low-income groups. There are also collection bins for waste paper, aluminium cans and plastic bottles placed at different locations on campus.

To spread the “green” message, the University has, for four years, jointly organized the “Greening Hong Kong by PolyU Alumni” with the Federation of PolyU Alumni Associations and the Leisure and Cultural Services, mobilizing alumni, staff, students, their friends and family members to plant shrubs and saplings at various parks in the territory.

Besides supporting Earth Hour 2009, the University in July 2008 became a committed “Carbon Audit – Green Partners” by signing the “Carbon Reduction Charter” launched by the Environmental Protection Department. Together with 36 other local organizations, it has undertaken to conduct or assist in conducting carbon audits on campus buildings and to initiate carbon reduction programmes in accordance with the charter.

## Further Academic Collaborations and Offers

PolyU academics are involved in teaching or research related to the issue of sustainability. The Faculty of Construction and Land Use has recently launched the \$6million Sustainable Urbanization Research Fund (SURF) to foster research collaborations on sustainable urbanization. More than 22 applications for grants were received from 40 members of staff, covering topics from pollution control, renewable energy and energy conservation, waste recycling, to transport efficiency.

To train up talents drawn to the environmental cause, PolyU has launched two new programmes: Bachelor of Science in Environment and Sustainable Development, the first of its kind in Hong Kong, and Master of Science/Postgraduate Diploma in Sustainable Urban Development. The bachelor programme covers knowledge in environmental sciences, aspects of engineering and management, economics, health and public policy. The postgraduate offers provide up-to-date knowledge in

sustainable urban development based on contemporary research findings, and are suitable for professionals including not just planners, surveyors, engineers, but also government officers and business managers.

## Ties with Purdue

Meantime, an international forum on sustainable urbanization organized in conjunction with Purdue University is scheduled for Fall 2009. Academics from the Chinese mainland, Taiwan as well as the University will address topics including

poverty, pollution, security, planning, technology, and healthcare. Academics from the Faculties of Construction and Land Use, Engineering, and Health and Social Sciences will deliver papers on topics including pollution, energy software and hardware technologies and planning.

As members of the International Strategic Technology Alliance, PolyU and Purdue University have decided to join forces in urbanization research with particular reference to the fast-developing Chinese mainland.





PolyU researchers are conducting numerous research projects on sustainability. The list below, though not covering all the projects, shows the wide range of research areas on the topic.

Research Areas & Projects	Researcher/ Department
Removal of heavy metals by biomass materials	Dr Thomas W H Lo, ABCT
Treatment of organic wastes by ozone	Dr Gilbert Y S Chan, ABCT
Hydrogen generation by renewable energy for fuel cell application	Dr C L Mak, AP
Electrodeposition and characterization of flexible ZnO/Cu <sub>2</sub> O solar cells	Prof. K H Wong, AP
Developing key factors for measuring construction sites' sustainability, evaluation on the sustainability performance of infrastructure projects, optimizing resources utilization in construction industry	Research Group for Sustainable Development Process in the Built Environment, BRE
Improving the sustainability of water-cooled multiple-chiller systems serving buildings	Dr K T Chan, BSE
Research on building environmental engineering	Prof. Francis Yik, BSE
Investigation on the feasibility and enhancement methods of wind power utilization in high-rise buildings of Hong Kong	Dr Lu Lin, BSE
Indoor air pollutant dispersion inside and around high-rise residential buildings	Prof. J L Niu, BSE
Research and applications on building energy efficiency principles and air-conditioning technology	Prof. S W Wang, BSE
Strategies for simultaneous temperature and humidity control for direct expansion air conditioning systems	Dr Deng Shiming, Dr M Y Chan, BSE/ Mr Xu Xiang Guo, RS
Indoor air pollution control	Prof. H Chua, CSE
Industrial wastewater treatment	Prof. H Chua, CSE
Applicability of green roof technology in dense residential districts to alleviate air pollution and heat island effect	Prof. Onyx Wai, CSE
Application of high efficiency and cost effective solar cells	Prof. Charles Surya, EIE Prof. K H Wong, AP
Application of hydroelectric technology in Stonecutters Island sewage treatment works	Dr Edward Lo, EE
Research on LED driver	Dr S C Tan, EIE
Development of a high-power freeform LED street lighting system	Prof. Ir Wing-bun Lee, Dr Sandy To, Dr Chi-fai Cheung, Dr Jin-bo Jiang, Dr Jin Wen-kui Wang, ISE
An eco-design and manufacturing program for electronic products with reference to the Energy Using Product (EuP) directive	Dr Winco K C Yung, Ir Albert Choi, Prof. T M Yue, ISE/ Prof. Lorraine Justice, Prof. Yanta Lam, SD
Satellite remote sensing of urban environmental quality	Prof. Janet Nichol, LSGI
A remote sensing study of the causative factors of Hong Kong's urban heat island	Prof. Janet Nichol, LSGI
Project on sea level change due to global warming	Prof. Xiaoli Ding, LSGI
Basic research relating to energy saving measures for weight reduction of moving vehicles and mechanical systems	Prof. Jian Lu, ME
Nuclear plants reliability	Prof. Jian Lu, ME
High resolution thermal imaging for organic light-emitting diodes (OLED) and organic photovoltaics (OPV)	Dr K L Chan, ME
New wind energy system development	Prof. Jian Lu, Prof. Yu Zhou, ME
Innovative low-emission and efficient burner technology	Prof. Yu Zhou, ME
Organic thermoelectric	Dr K L Chan, ME
Sound isolation of building structures	Prof. L Cheng, Dr Y S Choy, ME
Studies of sound quality of machinery	Dr R C K Leung, ME
Independent analysis and reporting for the public engagement process of the Council for Sustainable Development: Fostering a quality and sustainable built environment	Prof. Peter Yuen, Prof. Lee Ngok, Prof. Edwin Chan, PPRI

#### Departments

ABCT – Department of Applied Biology and Chemical Technology

AP – Department of Applied Physics

BRE – Department of Building and Real Estate

BSE – Department of Building Services Engineering

CSE – Department of Civil and Structural Engineering

EE – Department of Electrical Engineering

EIE – Department of Electronic and Information Engineering

ISE – Department of Industrial and Systems Engineering

LSGI – Department of Land Surveying and Geoinformatics

ME – Department of Mechanical Engineering

PPRI – Public Policy Research Institute

RS – Department of Rehabilitation Sciences

SD – School of Design