

PRESS RELEASE

28 January 2010

SUSTAINABLE URBAN DEVELOPMENT RESEARCH RECEIVES S\$50 MILLION BOOST FROM NRF

- *NRF's International Evaluation Panel recommends five research projects for funding under the 5th call of the Competitive Research Programme (CRP) Funding Scheme*
- *NRF's CRP grants have strengthened capabilities for internationally competitive high impact science and technology research to be done in Singapore*

1. The National Research Foundation (NRF), on the recommendation of its International Evaluation Panel (IEP) (see **Annex A**) for its Competitive Research Programme (CRP) Funding Scheme, announced today the award of grants, totaling S\$50 million to five research proposals under its second scenario-based grant call.

2. The second scenario-based CRP grant call is on "Sustainable Urban Systems" (see **Annex B**). This opened on 17 April 2009 and received 68 preliminary proposals (or white papers) submitted by Singapore-based researchers from the local universities, polytechnics, public research entities as well as private companies. Twelve white papers were selected by a local evaluation panel to be developed into full proposals. These full proposals were then sent for international peer review. The IEP met today to review the full proposals and recommended five for funding. NRF has accepted the panel's recommendation.

3. The five research programmes awarded funding are:

- **New Biotechnology for Processing Metropolitan Organic Wastes into Value-Added Products** (PI: Prof He Jianzhong, National University of Singapore)
- **Engineering Biology for Valuable Fuels** (PI: Prof Ching Chi Bun, Nanyang Technological University)
- **Sustainable Urban Waste Management for 2020** (PI: Dr Wang Jing-yuan, Nanyang Technological University)
- **Underwater Infrastructure and Underwater City of the Future** (PI: Dr Chu Jian, Nanyang Technological University)
- **Toward Efficient Sunlight Harvesting** (PI: Dr Zhao Yang, Nanyang Technological University)

(see **Annex C** for more details)

4 IEP Chair Dr Rita Colwell, Distinguished University Professor at the University of Maryland College Park and Johns Hopkins University, a former Director of the US National Science Foundation and a member of NRF's Scientific Advisory Board, said: "As a small nation with a dense population living in a limited land area, Singapore is well-placed to develop solutions to the global challenges of urbanization faced by

mega-cities around the world. The theme of “Sustainable Urban Systems” for the CRP grant call is therefore an excellent choice. The awarded R&D projects are very impressive. I hope the results of their research will help Singapore and other cities in the world deal with the complex challenges of rapid urbanization in a way that will allow such large urban centres to achieve an even higher quality standard of living.”

5 Added IEP member Mr Thomas Stagnaro, President and Chief Executive Officer, Americas Biotech Distributor, USA: “With global warming impacting the planet, efforts to mitigate this threat cannot be successful without industry collaboration. One awarded project which would require such industry involvement is the ‘Underwater Infrastructure and Underwater City of the Future’ ”.

6 “The CRP grants awarded over the past two-and-a-half years have built up a sizeable pool of researchers working on cutting edge use-inspired research in Singapore. This has greatly enriched the depth and breadth of the research landscape here. Early results have been promising – we look forward to significant research breakthroughs coming out of this programme that will result in major economic or societal benefit”, said Dr Francis Yeoh, Chief Executive Officer, NRF.

7 Dr Zhao Yang, Principal Investigator of the awarded CRP project on “Toward Efficient Sunlight Harvesting”, said, “We hope our programme on designing artificial systems capable of harvesting sunlight with high efficiency will greatly benefit various sectors of the clean energy industry in Singapore and beyond.”

8 The CRP Funding Scheme offers substantial funding support of up to S\$10 million per proposal, over three to five years. The grant funds a broad base of research programmes through a competitive bottom-up (investigator-led) approach, with submissions assessed via international scientific reviews. Through the scheme, NRF supports proposals that could help develop core capabilities for new industries of the future for Singapore (see **Annex D** for a description of the CRP Funding Scheme).

9 CRP grant calls are announced twice a year. The inaugural CRP grant call was launched on 16 April 2007. Five CRP calls have been made so far, with three general CRP calls from all fields of science & technology and two ‘scenario-based’ CRP calls on “Ageing” and “Sustainable Urban Systems”, respectively. Sixteen proposals have received the CRP award worth about S\$160 million from the three general calls. The inaugural ‘scenario-based’ CRP call on “Ageing” resulted in 4 awards totaling ~S\$40 million (see **Annex E** for a list of all funded CRP projects).

10 Since the first CRP call in April 2007, some research projects have made discoveries that could make significant impact to the industry and society. These include the project ‘Graphene Related Materials and Devices’ by lead PI Assoc Prof Loh Kian Ping from NUS, which reported significant developments such as the first room temperature chemical synthesis of carbon nanotubes in liquid and the first to demonstrate the use of graphene and its derivatives as optical elements in lasers. The potential exploitation of graphene research could lead to the creation of novel energy storage materials like lithium intercalated graphene batteries, electrochemical double layer storage capacitor, or as new molecules which could be applied in solar cells.

11 Another project ‘Lipidomics: Novel tools and applications’ by lead PI Assoc Prof Markus Wenk of NUS, reported the generation of the first antibodies against oxidized lipids which could be used to detect microbial diseases such as tuberculosis. The same programme also signed 12 Non Disclosure Agreements (NDA), 7 Research Collaboration Agreements (RCAs), 1 Contract Research (CR) and 2 Material Transfer Agreements (MTAs) with industry as well as venture capitalists.

12 With this 5th grant award, and a total of 25 projects, NRF will initiate a review of the scheme before any further grant calls. This would be carried out by the IEP together with invited experts from NRF’s Scientific Advisory Board and the NRF Board. The review will evaluate the effectiveness of the CRP funding scheme and recommend improvements for the future.

The National Research Foundation (NRF)

The National Research Foundation (NRF), set up on 1 January 2006, is a department within the Prime Minister’s Office.

The NRF sets the national direction for research and development (R&D) by developing policies, plans and strategies for research, innovation and enterprise, funds strategic initiatives, builds up R&D capabilities and capacities through nurturing our own and attracting foreign talent, and coordinates the research agenda of different agencies to transform Singapore into a knowledge-intensive, innovative and entrepreneurial economy. It provides secretariat support to the Research, Innovation and Enterprise Council (RIEC), chaired by the Prime Minister. A five-year budget of S\$5 billion has been allocated to the NRF in 2006 to achieve this mission.

The NRF aims to:

- Transform Singapore into a vibrant R&D hub that contributes towards a knowledge-intensive, innovative and entrepreneurial economy; and
- Make Singapore a talent magnet for scientific and innovation excellence.

For more information, please visit www.nrf.gov.sg.

For media queries, please contact:

Ms Jaime Goh
Manager, Corporate Communications
National Research Foundation
Tel: 6332 9141
E-mail: jaime_goh@nrf.gov.sg

**National Research Foundation
Competitive Research Programme Funding Scheme**

International Evaluation Panel	
1.	Dr Rita Colwell (Chairman) Distinguished University Professor, University of Maryland College Park and Johns Hopkins University Bloomberg School of Public Health, USA Former Director of the US National Research Foundation (concurrently NRF Scientific Advisory Board Member)
2.	Prof James Foley Stephen Fleming Chair in Telecommunications and Professor, Interim Dean, College of Computing, Georgia Institute of Technology, USA (concurrently NRF Scientific Advisory Board Member)
3.	Prof Dr Louis-François Pau Professor, RSM Erasmus University, Netherlands and Copenhagen Business School, Denmark (concurrently NRF Scientific Advisory Board Member)
4.	Dr Richard Roberts Chief Scientific Officer, New England Biolabs, USA Nobel Laureate in Medicine (1993)
5.	Mr Thomas Stagnaro President and Chief Executive Officer, Americas Biotech Distributor, USA
6.	Mr Peter Tan Founder and General Partner, JP Asia Capital Partners, Singapore
7.	Dr Richard Yen Founder and Managing Director, Ednovation Pte Ltd, Singapore
8.	Dr Hal Broderson Founder and Managing Director, Rock Hill Ventures, USA

SINGAPORE IN 2020

A UN Population Fund report (“State of World Population 2007: Unleashing the Potential of Urban Growth”) projected the development of at least 22 major urban centres with over 10 million people each around the world, that will house about 5% of the world’s population by 2015. Over 80% of the world’s urban population would live in the developing world.

Fast-forward to 2020...

In order to accommodate a growing population within a limited land area, Singapore has to increase the development and adoption of technologies in order to sustain a world-class, high quality standard of living for all.

Policy planners have to consider and balance many complex factors when planning for a resource-constrained, land-scarce Singapore. These include maintaining Singapore’s economic dynamism, protecting environmental quality and biodiversity, while providing a safe, healthy and comfortable living environment which is conducive for building cohesive communities.

In mega-cities all over the world, high-rise buildings increasingly dominate the urban landscape as overall urban density increases to near breaking point. There will be a huge demand for critical resources such as food and water, to meet the needs of a fast growing population. Concerns on infectious diseases and other health issues are high on the agenda of the city councils. In a carbon-constrained environment, greater energy efficiency is of increasing importance. Infrastructure investments are expected to surge as public agencies seek to ensure that facilities such as roads and housing are able to meet the escalating demand. Maintaining a clean and reliable water supply, clean air and a healthy balance of greenery with large urban built-up areas are also major challenges. At the same time, the threat of climate change demands innovative mitigation and adaptation measures.

This situation is not unique to Singapore. Asia is home to the fastest growing urban populations in the world. For cities in the region, such rapid urbanisation brings with it complex challenges in areas such as the sustainability of resources, security and risk management.

New technologies can be developed to provide solutions to these urban challenges. A review of existing systems can bring about new processes to improve efficiency and efficacy. Nevertheless, the opportunities caused by such urban challenges are tremendous and technological solutions to these problems would be highly sought after.

Below are some examples of technologies for the highly urbanized society in 2020:

- ***Efficient transportation system***
 - Transition to renewable energy powered transportation and environmentally friendly vehicles. Demand activated public transportation

system, laser guided driver aids or personalised automated vehicles for point-to-point transportation.

- Public transit systems which offer unparalleled convenience and accessibility.
 - New design of intelligent expressways.
 - Traffic control systems that could accommodate huge traffic volumes and contain features that could mitigate the deleterious consequences of accidents or heavy traffic build-up.
 - Ultra high efficiency fuel for automobiles through novel ways of fuel processing or through genetically modifying fuel yielding crops.
 - Technologies to minimize consumption of and reliance on non-renewable fuel resources.
- ***Sustainable renewable and alternative energy sources***
 - Generation of clean energy within Singapore's urban landscape.
 - Portability of devices requiring power.
 - Improving energy efficiency and the life span of batteries
 - Alternative approaches to harness energy for power transmission, telecommunication and electronic devices.
- ***Infrastructure and utilities***
 - Technology to reduce the impact of major utilities on neighbouring uses in a built-up urban environment,
 - Reduction of land needed for such utilities.
- ***Pollution issues***
 - Innovative environmental-friendly measures to reduce air pollution problems such as eco-efficient technology to eliminate green house gases and particulate matter.
 - New technologies to minimise noise and other nuisances in a dense urban environment.
- ***Communications***
 - Enhanced telecommunication network or data storage to support the masses.
 - Technologies to improve communication with better interfaces such as holography.
 - Display technologies and devices that are flexible and could be mounted on walls to minimize space.
- ***Food***
 - Alternative food sources to reduce Singapore's reliance on imported food and to detect contamination in food.
 - Synthetic biology applied to food production to improve the yield as well as the quality of food products.
- ***Waste management***
 - Technologies for waste with no universally accepted disposal methods.
 - Efficient waste-to-energy technologies that are scalable, with zero or low remaining residual which can be reused without further processing.

- Low environmental footprint systems for waste disposal (i.e. low emissions, utilities consumption and land requirement), near to cost parity with landfill costs and which could be sited in close proximity with human activity.
- Technologies to increase recycling yield and the value of recycled products.
- **Urban greenery and urban ecology**
 - Research to maintain Singapore's reputation as a garden city, such as the applications of greenery in urban settings for the well-being of city-dwellers.
- **Security**
 - Technologies that provide ultra-fast verification of personal identity such as biometric security systems.
 - Technologies enabling the efficient purchase of goods and services.
 - Home security systems for the detection of intruders.
- **Social studies**
 - Urbanization and mental health.
 - Problems of high density urban living, such as depression and anxiety, particularly among low income residents.
 - Innovative ways to build community spirit in a high-density living environment.
- **Building materials and design**
 - Advanced materials that have high strength-to-weight ratio that would enable higher structures to be securely built with superior environmental performance.
 - Building designs that deliver quality of living and greater degree of community interactions in highly built-up areas.
- **Public health**
 - Advance monitoring technologies to detect and eradicate vectors and rodents that create health hazards
 - Prediction and simulation of carriers of diseases to prevent outbreak of pandemic diseases in highly populated areas
- **Low cost advanced technologies for the masses**
 - Disruptive innovations that could enable advanced technologies to be made available to the general population.
- **Weather-proofing cities**
 - Urban climate observations and modelling and urban heat index
 - Solutions to mitigate the warming trend occurring in urban areas due to climate change and increased urbanisation.

This scenario-based CRP scheme aims to draw out research projects relevant to a highly urbanized, densely populated city such as Singapore. Such projects are expected to be multi-disciplinary in nature, and have a strong science base. The intent is for Singapore to become a world-class originator of innovative technologies, products and devices.

Principal Investigators are invited to identify a key urban challenge which Singapore will face in the future and propose a R&D programme to address this challenge. Proposals submitted should have high potential impact, if successfully developed. Incremental improvements of existing know-how and technologies are unlikely to be supported.

CRP 5th CALL: PROJECTS AWARDED FUNDING

1. New Biotechnology for Processing Metropolitan Organic Wastes into Value-Added Products

Like many urbanized cities, Singapore faces two great challenges: (1) how to process metropolitan organic wastes wisely and (2) how to generate sustainable clean energy economically. To address these two critical challenges simultaneously, this programme aims to harness the power of bacteria for converting organic wastes into sustainable bioenergy and other valuable products through integrated microbial reactions, process engineering and membrane separation. Successful implementation of this programme will not only allow Singapore to achieve the 60% organic waste recycling target (Singapore Green Plan 2012) but also to produce renewable clean energy. In the meantime, using bacteria to convert organic wastes into energy can reduce the emission of carbon dioxide.

This programme will bring together an interdisciplinary team consisting of academia and industry partners to demonstrate how the assimilation of biotechnology, advanced biosensors, and membrane engineering can lead to a new industrial process for converting metropolitan organic wastes into clean and marketable bioenergy in an economical and sustainable manner.



Asst/Prof He Jianzhong
Division of Environmental Science & Engineering
National University of Singapore

Asst/Prof He's research is focused on the anaerobic fermentation and degradation of xenobiotic compounds, environmental genetics and novel metabolism of microbes, and environmental application of genomics. She has been the first or corresponding author of ~20 papers published in high-impact journals and has been invited to speak at prestigious universities and international conferences. She has made several important publications, including one in *Nature*. Discover Magazine selected her work in *Nature* to be among the one hundred most important scientific discoveries of 2003.

Major Collaborators:

- Asst/Prof. Kun-Lin Yang (ChBE, NUS)
- Prof. Neal T. S. Chung (ChBE, NUS)
- Prof. Say Leong Ong (ESE, NUS)
- A/Prof. Renbi Bai (ESE, NUS)
- A/Prof. Kai-Chee Loh (ChBE, NUS)
- Asst/Prof. Yi-Pin Lin (ESE, NUS)
- A/Prof. Yen Wah Tong (ChBE, NUS)

Overseas Collaborators:

- Dr. Gary Anderson (Lawrence Berkeley National Laboratory, USA)
- Prof. Lisa Alvarez-Cohen (University of California at Berkeley, USA)
- Dr. Patrick Lee (University of California at Berkeley, USA)
- Asst/Prof. Tamar Kohn (EPFL, Switzerland)
- Prof. Yukishige Kondo (Tokyo University of Science)
- A/Prof. Wen-Tso Liu (University of Illinois at Urbana-Champaign, USA)
- Prof. John Justin Gooding (UNSW, Australia)
- Prof. Xianshe Feng (University of Waterloo, Canada)
- Dr. L. M. Vane (U.S. Environmental Protection Agency)
- Prof. Y.C. Jerry Jean (University of Missouri-Kansas City, USA)

2. Engineering Biology for Valuable Fuels

Energy has played a central role in Singapore's economy and will remain critical to the country's continued economic growth and development. Singapore is experiencing its highest energy demand growth in line with an expanding population and strong economic growth. Energy demand of China, India and ASEAN are estimated to grow at an annual rate of between 2.5% to 3%, a pace which is almost twice as high as the world's average (based on projections by the International Energy Agency). Increasing energy demands have spurred Singapore to look towards alternatives beyond depleting petroleum-based feedstocks as part of its long-term energy strategy to meet the country's rising energy needs. While ethanol and butanol are potentially great initial molecules to produce, advanced biofuels will be necessary if we do not want to spend the trillions of dollars world-wide to replace the current transportation infrastructure. What's more, ethanol, and most likely butanol, will never be used in jet fuels. Thus, production of renewable fuels similar to petroleum-based fuels will allow us to continue using our existing transportation infrastructure.

This programme integrates chemical engineering principles with biological science fundamentals and aims to convert inexpensive carbon sources into a new class of valuable fuels, which can be easily accepted by existing mode of transportation. This new class of biofuels will be produced from microorganisms engineered in this program. The main approach is by modifying the microbes' normal cellular machinery to increase the components that are required for production of energy rich molecules as biofuels. These end products, medium-chain hydrocarbons, will be a new class of biofuels in the coming decade.



Prof Ching Chi Bun
School of Chemical and Biomedical Engineering
Nanyang Technological University

Prof Ching Chi Bun is the current Chair of School of Chemical and Biomedical Engineering and the Director of Centre of Chiral and Pharmaceutical Engineering. Professor Ching previously held appointments as Head in Division of Chemical and Biomolecular Engineering (NTU), Professor in NUS (Department of Chemical and Environmental Engineering), Deputy Director of Institute of Chemical and Engineering Sciences (A*STAR), Director of Chemical and Process Engineering Centre (CPEC) in NUS, Programme Manager of the Safety, Health & Environmental Technology MSc course (NUS) and Vice Dean of Faculty of Engineering (NUS).

He is also a member of Institution of Chemical Engineers (U.K.), Chartered Engineer (U.K.), Fellow of Institution of Engineers Singapore, Professional Engineer of Singapore and Founder President and Honorary Fellow of the Society of Loss Prevention in the Oil, Chemical and Process Industries (Singapore).

Prof Ching is actively involved in research in the areas of development of novel chiral stationary phase and process for resolving pharmaceutical optical isomers, large scale adsorptive separation technology (SMB), crystallization study of enantiomeric drugs and intermediates, protein crystallization and engineering biology.

Co-Principal Investigators:

- Assoc Prof Chen Wei Ning William (NTU)
- Asst Prof Matthew Chang Wook (NTU)
- Asst Prof Jiang Rongrong (NTU)
- Asst Prof Susanna Leong (NTU)
- Asst Prof Thirumanan Thanabalu (NTU)

Collaborators:

- Asst Prof Poh Chueh Loo (NTU)
- Asst Prof Lee Jong Min (NTU)
- Asst Prof Lee Dong Yap (NUS)
- Prof Jay D. Keasling (University of California, Berkeley)
- Prof Andre Goffeau (Catholic University of Louvain, Belgium)

3. Sustainable Urban Waste Management for 2020

Based on current waste management concepts, waste resources are normally buried in landfills or incinerated. Such a waste treatment/disposal approach needs to be revised as natural resources are being depleted. With waste becoming a potential source for resource recovery, it would be especially relevant to resource-lacking Singapore and other cities in the Asia Pacific region.

The main objective of the proposed research programme is to develop sustainable urban waste management solutions for 2020, based on the decentralised “waste to resources” concept.

To achieve this goal, the following three ideas are proposed:

- Developing communities into renewable resource recovery centres
- Converting wastewater treatment plants into urban eco power stations
- Rapid land reclamation of closed urban dumping grounds



Associate Prof Wang Jing-Yuan
School of Civil and Environmental Engineering
Nanyang Technological University

Prof. Wang, currently Co-Director of NTU's Residues and Resource Reclamation Centre (R3C), is a licensed professional engineer in the US and has over 20 years of environmental consulting, research and teaching experience. His expertise includes solid waste resource management, contaminated site remediation and integrated environmental management. Prof. Wang's current research interests include waste to energy, decentralized resource recovery of wastewater and solid waste and integrated electrokinetic and biological remediation technology development. He has published 110 refereed journal and conference papers and has a patent.

Major Collaborators:

- Prof W.J. Ng (CEE, NTU)
- A/Prof S.K. Tan (CEE, NTU)
- A/Prof J. Chu (CEE, NTU)
- Asst Prof Victor Chang (CEE, NTU)
- Dr Philip Wong (CEE, NTU)
- Mr S.H. Lim (NEA)
- Ms Cherlyn Leong (JTC)
- Mr William Phay (Keppel)
- Mr S.O. Goh (SembCorp)

Overseas Collaborators:

- Prof Rainer Stegmann (TUHH, Germany)
- Prof J.S. Chang (NCKU, Taiwan)
- Prof S. S. Cheng (NCKU, Taiwan)

4. Underwater Infrastructure and Underwater City of the Future

In land scarce Singapore, space creation is a key strategic area that concerns the survivability and sustainability of the country. Presently, we have been using underground caverns and offshore reclamation for space creation. Both methods are not sustainable or economically viable in the long run. A new approach – going underwater-is proposed to make use of the sea space to construct underwater infrastructure and at the same time, use the top-side of the infrastructures as reclaimed land. Using the proposed method, we no longer need to import fill materials for land reclamation. Limited space can be used even more efficiently. Cylindrical structures can also be put together to form a watertight seawall and thus create space behind the seawall. With the possibility of constructing an underwater city, living under seawater will be a reality in the near future.

The proposed new approach has many advantages over the existing practices. It makes multiple use of sea space by making the space both above and below the reclaimed land available for recreation, living or infrastructural development. It combines reclamation, superstructure and underground constructions in one and thus is the most efficient and cost-effective approach for space creation and utilization. When designed strategically, the cylindrical structure groups can also function as effective shore protection elements against extreme waves such as storm surges or tsunami and seawater changes caused by global warming. They can also be designed to create energy using waves. The expected outcome of this research is the establishment of a new, efficient and sustainable method for space creation using less resources and to provide innovative solutions to the challenges to make space creation and underwater construction more cost-effective and socially attractive.



Assoc Prof Chu Jian
School of Civil and Environmental Engineering
Nanyang Technological University

Prof Chu Jian is the Director of the Centre for Infrastructure Systems, School of Civil and Environmental Engineering, NTU. He specialises in geotechnical engineering and was involved in many research and consulting projects in the areas of land reclamation, soil improvement, and coastal developments. He is the Chairman of International Technical Committee TC39: Geotechnical Engineering for Coastal Disaster Mitigation and Rehabilitation and the Coordinator of Working Group C in another international Technical Committee TC17: Ground Improvement under the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). He is a recipient of the R.M. Quigley Award from the Canadian Geotechnical Society in 2004. He has published 2 books and more than 180 technical papers in international journals and conferences. Prof Chu also serves as the Co-Editor for Geotechnical Engineering, the Journal of Southeast Asian Geotechnical Society, Associate Editor or Editorial Board Member for five international journals.

Co-Principal Investigators:

- Assoc Prof Susanto Teng (NTU)
- Assoc Prof Tan Soon Keat, (Dir of Maritime Research Centre and DHI-NTU Centre, NTU)

Major Collaborators:

- Assoc Prof Robert Tiong (NTU)
- Asst Prof Sulfikar Amir (NTU)
- Mr Lam Kok Pang (JTC)

Overseas Collaborators:

- Mr Knut H Andersen (Technical Director, Norwegian Geotechnical Institute, Norway)
- Dr Dale Berner (President, Ben C. Gerwick Inc., USA)
- Prof Odd E. Gjørv (Norwegian University of Science and Technology, Norway)
- Prof Richard S. Mercier (Director, Offshore Technology Research Centre, Texas A&M University, USA)
- Prof Andrew Whittle (Head, Dept of Civil & Environmental Engineering, MIT)

5. Toward Efficient Sunlight Harvesting

In a single hour, more solar energy strikes the Earth's surface than all fossil energy consumed globally in one year. Even with a tiny fraction of the earth-bound photons captured and utilized, humanity is endowed with a sustained, clean energy source for centuries to come. Widely distributed, truly renewable and free from geopolitical implications, solar energy has enormous long-term potential as a large-scale, carbon-neutral source of power. This programme brings together an interdisciplinary team of outstanding researchers and aims to learn from Nature, how to design artificial systems capable of harvesting sunlight with high efficiency and stability. Knowledge gained will benefit various sectors of the clean energy industry to better performance and lower costs.



Asst Prof Zhao Yang
School of Materials Science & Engineering
Nanyang Technological University

Dr Zhao's main research focus is on ultrafast relaxation dynamics of photo-excited states in organic and inorganic materials. He is a leading expert in electronic-structure and excitation-localization studies of light-harvesting complexes in purple bacteria. Dr Zhao has published extensively in high-impact journals such as Physical Review Letters, Physical Review B, Journal of Physical Chemistry B, and Journal of Chemical Physics.

Co-Investigators:

- Asst Prof Junling Wang (MSE, NTU)
- Asst Prof Tze Chien Sum (SPMS, NTU)
- Asst Prof Howe-Siang Tan (SPMS, NTU)
- Asst Prof Andrew Grimsdale (MSE, NTU)
- Asst Prof Handong Sun (SPMS, NTU)
- Asst Prof Can Xue (MSE, NTU)

Overseas Collaborators:

- Prof Robert Silbey (MIT)
- Prof James Barber (Imperial College)
- Prof Maria Michel-Beyerle (TUM)
- Prof Jianshu Cao (MIT)
- Prof R Ramesh (UC Berkeley)
- Prof Klaus Mullen (Max-Planck Institute)
- Prof Paolo Zanardi (USC)
- Prof Dongping Zhong (Ohio State)
- Prof Sailing He (RIT, Sweden)
- Prof Yuxiang Weng (IOP, Beijing)

NRF's Competitive Research Programme Funding Scheme

The National Research Foundation's Competitive Research Programme (CRP) Funding Scheme complements the existing Strategic Research Programmes that have been identified top-down, by funding a broad base of research ideas, through a competitive bottom-up approach. This will help to identify new potential strategic research areas in which Singapore can invest to develop core capabilities for new industries of the future.

The CRP Funding Scheme will support R&D programmes, each comprising multiple related projects under a unifying theme. Each award is for a maximum of S\$10 million per programme, over three to five years. There are expected to be two rounds of grant calls each year.

While the CRP Funding Scheme is open to all areas of science and technology, preference will be given to areas that fall outside of existing NRF Strategic Research Programmes, such as the Biomedical Sciences Translational and Clinical Research (BMS TCR), Environmental and Water Technologies (EWT) and Interactive and Digital Media (IDM).

Open to both public and private sector participants, the CRP Funding Scheme aims to encourage collaboration and partnerships between academia and industry. By funding at the programme level, a more coordinated and integrated support of high-impact inter-disciplinary research is possible as a larger budget can be allocated to fund a number of related projects to address a given problem.

The CRP Funding Scheme involves two types of calls: General and Scenario-based calls.

Overview of General and Scenario-based CRP

General CRP

The General CRP allows the Principal Investigators (PIs) to surface any new area of research with potential economic and societal benefits for Singapore through a bottom-up approach. Calls for the General CRP will be held annually. Each proposal should be submitted by a Lead PI, who is expected to be actively involved in the overall management of the programme and who will be accountable for the research and its deliverables.

CRP proposals are expected to have the following:

- i. High quality cutting-edge science;
- ii. High likelihood of building up research infrastructure and capabilities in Singapore;
- iii. Competent team consisting of members with credible track records;
- iv. Excellent execution of individual projects within the supported programme; and
- v. High potential to generate economic and societal benefits to Singapore by creating new industries or advancing existing industries.

Scenario-based CRP

The Scenario-based approach to identifying research programmes complements the General CRP scheme. The Scenario-based CRP aims to support R&D programmes that are use-inspired and able to produce technical breakthroughs to address big challenges and opportunities for Singapore.

In each Scenario-based call, NRF will articulate a future scenario that offers a major challenge or opportunity for Singapore. The research community will be invited to submit proposals for research programmes that will address key scientific and technological challenges presented by the given scenario.

In addition to the basic criteria for General CRP proposals, Scenario-based CRP proposals will also be evaluated on the following:

- i. Extent to which the proposed R&D programme address the challenges or opportunities posed by the given scenario;
- ii. Relevance and importance of the proposed R&D programme in terms of the economic, technological, social and environmental impact on Singapore; and
- iii. Quality of the proposed R&D programme, compared to similar international efforts elsewhere.

Eligibility

Principal Investigators from all Singapore-based institutions of higher learning (IHLs), public sector agencies and research institutions, not-for-profit hospitals and research laboratories as well as companies and company-affiliated research laboratories, are eligible to apply. Support for private sector organisations which are based in Singapore would be provided on a co-funding basis.

Only research conducted in Singapore may be funded under the CRP.

R&D proposals already funded by other Singapore agencies would not be considered under the CRP.

Evaluation of Proposals

Both the General CRP and Scenario-based CRP involve a two-stage proposal submission process. Proposals submitted will be evaluated and shortlisted by a Local Evaluation Panel in the first stage. Shortlisted submissions will be asked to be

developed into full proposals and sent for international peer review. The final evaluation and selection of projects to be awarded will be made by NRF on the recommendation of the CRP International Evaluation Panel (IEP).

Applications

Calls for both the General CRP and the Scenario-based CRP are publicised on NRF's Research, Innovation and Technology Administration (RITA) system. Interested applicants may find out more about the specific CRP calls that are open and submit their applications through the system.

For more information, please visit <https://rita.nrf.gov.sg>.

Annex E

List of all funded CRP from the 1st to the 4th call

S/N	Awarded Programmes	PI	Host Institution
1	Artificial mesoscopic structures for next generation electronic and photonic technology	Assoc Prof Ting Mei	Nanyang Technological University
2	Combined-cycle solar energy self-sustaining membrane distillation (MD) and membrane distillation bioreactor (MDBR) water production and recycling system	Assoc Prof Choo Fook Hoong	Nanyang Technological University
3	Graphene related materials and devices	Assoc Prof Loh Kian Ping	National University of Singapore
4	Lipidomics: Novel tools and applications	Assoc Prof Markus Wenk	National University of Singapore
5	Multi-functional spintronic materials and devices	Assoc Prof Ding Jun	National University of Singapore
6	Molecular engineering of membrane materials research and technology for energy development: Hydrogen, natural gas and syngas	Prof Chung Tai Shung, Neal	National University of Singapore
7	Biodegradable Cardiovascular Implants	Prof Freddy Boey	Nanyang Technological University
8	Biologically-Inspired Design, Nano-Fabrication and Nano-Lubrication of MEMS, NEMS, and Micro-Mechanical Devices	Asst Prof Sujeet Sinha	National University of Singapore
9	Theory and Practice of Coding and Cryptography	Prof Ling San	Nanyang Technological University
10	Towards Manufacturability of Carbon Nanotube-Based Printed Electronics	Prof Chan Bee Eng, Mary	Nanyang Technological University

S/N	Awarded Programmes	PI	Host Institution
11	Age-Related Neurodegenerative Disease – The Roles of microRNAs and Their Targets	Dr Stephen Cohen	Temasek Life Sciences Laboratory
12	An Integrated Approach to Overcome Sarcopenia and Frailty in Ageing Humans	Assoc Prof Ravi Kambadur	Nanyang Technological University
13	Autologous Cell Therapy for the Ageing Heart Using Reprogrammed Cells	Dr Winston Shim	National Heart Centre
14	Ischemic Stroke with a Focus on Intracranial Stenosis	Prof Peter Wong	National University Health System, Yong Loo Lin School of Medicine
15	Interface Science and Technology	Assoc Prof Christos Panagopoulos	Nanyang Technological University
16	Tailoring Oxide Electronics by Atomic Control	Prof Thirumalai Venkatesan	National University of Singapore
17	Nanonets: New Materials, Devices for Integrated Energy Harnessing & Storage	Assoc Prof Subodh Mhaisalkar	Nanyang Technological University
18	Frontiers in Magnetic Recording Research: Vision for 10 Terabits per square inch	Prof Charanjit Singh Bhatia	National University of Singapore
19	Membrane Protein Sciences – Tools for Rational Discovery of Novel Therapeutics and Diagnostics Targeting Integral Membrane Proteins	Assoc Prof Jaume Torres	Nanyang Technological University
20	Adult and induced pluripotent stem cells for neurological disorders and CNS repair	Prof George Augustine	Duke-NUS Graduate Medical School Singapore

CRP 1 awardees: 1-6

CRP 2 awardees: 7-10

CRP 3 awardees: 11-14

CRP 4 awardees: 15 - 20