Research Innovation Enterprise 2020 Plan Winning the Future through Science and Technology

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RIE2020 Plan: www.research.gov.sg/RIE2020

INTRODUCTION

Our investments in research, innovation and enterprise will lay the foundation of our Future Economy... and transform Singapore into a Smart Nation.

Research, innovation and enterprise are cornerstones of Singapore's national strategy to develop a knowledge-based innovation-driven economy and society. Public investment in research and innovation has grown over the last 25 years. Under the last five-year Research, Innovation and Enterprise (RIE) 2015 Plan, the Singapore government committed \$16 billion over 2011 to 2015 to establish Singapore as a global research and development (R&D) hub. The government will be sustaining its commitment to research, innovation and enterprise, and will invest \$19 billion for the RIE2020 Plan over 2016 to 2020.

Plan	National Technology Plan 1995	National Science & Technology Plan 2000	Science & Technology 2005 Plan	Science & Technology 2010 Plan	Research, Innovation and Enterprise 2015 Plan	Research, Innovation and Enterprise 2020 Plan
Budget	\$2 billion	\$4 billion	\$6 billion	\$13.5 billion	\$16 billion	\$19 billion

Today, Singapore has a strong scientific base. Singapore's research quality has improved, ranking well above the world average. The number of PhDs being trained locally continued to increase from 7,522 in 2011 to 7,850 in 2015. The stock of Research Scientists and Engineers (RSEs) in the workforce has also experienced sustained growth.





¹ Field-weighted citation impact (FWCI) tracks how the number of citations received by Singapore's publications compares with the global average (represented by a FWCI of 1.00). For example, Singapore's FWCI of 1.82 in 2012 means that Singapore's publications received 82% more citations than the world average. Data source from Elsevier SciVal.

Singapore's universities have steadily risen up in global rankings and improved their research influence internationally. In 2015, the annual World University Rankings placed the National University of Singapore (NUS) and the Nanyang Technological University (NTU) in the 12th and 13th positions respectively², up from 22nd and 39th the previous year. From 2006 to 2015, NTU's field-weighted citation impact (FWCI) increased by 42%, while NUS' increased by 19%. The FWCI of NUS and NTU in 2014 were higher than other top Asian universities such as the University of Hong Kong, the University of Tokyo, and the Peking University³.

The growth of Singapore's universities as top research institutions is due to our focus on excellence in research and education, and our strong research infrastructure. This has enabled our universities to build up a strong faculty of world-class scientists. We have further strengthened Singapore's base by attracting home outstanding Singaporean scientists who have made their mark overseas, by providing them with opportunities to further their work in Singapore's vibrant research environment and to mentor our next generation of scientists. Our Research Centres of Excellence have also built strong teams around areas of cutting edge research, and are now regarded as being among the top centres in their respective fields internationally.

Singapore has also become a nexus for international R&D collaborations. The Campus for Research Excellence and Technological Enterprise (CREATE) established 15 joint research programmes between our local universities and 10 top overseas institutions (including Massachusetts Institute of Technology, Swiss Federal Institute of Technology in Zurich, and Shanghai Jiao Tong University). As of 2015, CREATE laboratories have collectively produced over 2,350 publications in leading academic journals and worked with more than 100 companies. The research outcomes have also led to eight spin-off companies.

There are currently more than 20 research institutes under the Agency for Science, Technology and Research (A*STAR) that straddle the spectrum from fundamental to applied research, producing breakthrough science in various fields. A*STAR has built strengths in the fields of biomedical engineering, biochemistry, molecular biology and genetics, chemistry and physics, and was named one of the Top 5 Cancer Innovators in Asia, 2010 to 2014⁴. A*STAR has strong partnerships with leading global research centres, such as with RIKEN on life sciences, biotechnology and materials science, and with the University of Southampton's Marine and Maritime Institute (SMMI) in marine and offshore.

By aligning its research with industry demand, A*STAR has been able to leverage its semiconductor R&D expertise to establish joint laboratories with industry partners such as Applied Materials, Inc., Dai Nippon Printing Co. Ltd., and Nikon. Biopolis has supported the growth of the pharmaceutical industry in Singapore, with A*STAR working with 30 leading pharmaceutical companies from around the world, including Chugai Pharmaceutical Co., Ltd and Novartis International AG. A*STAR's approach to open innovation has seeded a new Food, Nutrition and Consumer Care innovation cluster in Singapore that has attracted companies, and has led to the creation of over 1,000 R&D jobs. This encompasses global leaders like Nestle, Danone and P&G; specialty chemicals and ingredient companies like Dupont, DSM, Kerry and Ingredion; as well as major flavour and fragrance companies.

Hospitals and other healthcare providers that serve as academic medical centres enable partnerships between healthcare providers and universities to contribute toward the advancement of patient care through translational clinical research. The National University Health System (NUHS) translational and clinical research strategy and the SingHealth/Duke-NUS five-year Joint Strategic Research Masterplan aim to establish a base of outstanding basic and clinical science faculty, through strategic partnerships and multi-institutional collaborations with partners such as the Clinical Imaging Research Centre, Clinical Nutrition Research Centre, POLARIS (Personalized OMIC Lattice for Advanced Research and Improving Stratification), and the National Neuroscience Research Institute, so as to deliver high impact research discoveries.

² The ranking is by London-based education consultancy Quacquarelli Symonds and is based on normalised-weighted research citations.

³ NTU's and NUS' FWCI were 1.9 and 1.7 respectively in 2015, while the University of Hong Kong, the University of Tokyo, and the Peking University were scored at 1.7, 1.3, and 1.4 respectively.

⁴ Thomson Reuters 2015 State of Innovation Report.

The build-up of Singapore's R&D capabilities has fostered industry-science linkages. We have seen the growth of public-private research partnerships such as the Keppel-NUS Corporate Laboratory and the Institute of Microelectronics' Advanced Semiconductor Joint Labs. There are also more industry research consortia, such as the A*STAR Aerospace Research Consortium, Advanced Remanufacturing and Technology Centre, LUX Photonics Consortium, Singapore Diabetes Consortium, and Singapore Gastric Cancer Consortium. Singapore is emerging as a global hydrohub as a result of our investments in environmental and water technologies, and major global companies such as GE, Veolia, and Toray have been attracted to set up operations in Singapore.

New economic activity is being catalysed by our R&D investments and our start-up ecosystem is increasingly vibrant. In the information and communications technology sector, we have had successful start-up exits and the first unicorns born in Singapore, Garena and Razer. Singapore ranked 10th in the world (and first in Asia) for best start-up nations in The Global Startup Ecosystem Report 2015.

In RIE2020, we will build on the progress made to date and continue to leverage our public sector R&D investments to grow industry R&D capabilities, nurture innovative enterprises, and meet our national needs.

Through long-term planning and effective implementation, our investments in research, innovation and enterprise will secure our future. These will contribute significantly to our economy, and create more good jobs and opportunities for Singaporeans; improve healthcare for our population, especially our seniors; and transform our urban landscape for greater liveability and sustainability.

Singapore – Global Hydrohub

As a testament to the strong growth of Singapore's water industry, the number of water companies in Singapore has tripled since 2006. At present, the ecosystem consists of 180 water companies and 26 research centres. Examples of investors include Beijing Enterprises Water Group Ltd - a leading Chinese state-owned enterprise in water supply and sewerage treatment, and Nitto Denko Corporation - a leading diversified materials manufacturer and the first Japanese enterprise to set up a R&D centre dedicated to water treatment in Singapore. The excellence of Singapore's water companies is recognised overseas, leading to important projects such as Hyflux Ltd's desalination plant in Oman and Ley Choon's piping infrastructure works in Sri Lanka

Corporate Laboratory @ University Scheme – Fostering public-private research partnerships

The Corporate Laboratory@University Scheme has successfully attracted local and foreign companies to collaborate with Singapore universities to carry out industry-relevant research.

The Rolls-Royce@NTU Corporate Laboratory was established in August 2013 and has around 180 staff and students. A significant milestone for technology transfer was achieved by the Modular Power Conversion and Distribution (MPCD) team, which successfully designed and constructed a 270V power system that was delivered to Rolls-Royce Corporation, Indianapolis, USA for land demonstration.

The Keppel-NUS Corporate Laboratory was established in February 2014 and has over 40 staff. One team successfully conducted a joint deep-sea survey using autonomous underwater vehicles with its partner, UK Seabed Resources Limited. The valuable data gathered will contribute towards understanding the geophysical nature of the abyssal regions and assessing mineral nodule presence and factors affecting nodule growth in the region.

MAJOR THRUSTS

Under the RIE2020 Plan, Singapore is implementing four major strategic thrusts that build on the progress achieved under the RIE2015 Plan to create greater value in Singapore from our investment in research, innovation and enterprise:

• Closer Integration of Research Thrusts

Encourage stronger multi-disciplinary, multi-stakeholder collaboration to allow greater coordination of efforts nationally towards achieving our research goals, and to invest strategically in foundational and mission-oriented research.

• Stronger Dynamic towards the Best Teams and Ideas

Continued shift towards more competitive funding (from 20% of public funding for research in RIE2015 to 40% in RIE2020) to support the best teams and ideas, and more White Space funding (from \$1.6 billion in RIE2015 to \$2.5 billion in RIE2020) to allow greater flexibility in reprioritising funding towards areas of new economic opportunities and national needs as they arise over the next five years.

• Sharper Focus on Value Creation

Strengthen flow-through from research to its eventual impact in society and economy, through additional budget allocation towards public-private research collaborations and increased effort in helping companies expand their absorptive capacities for new technologies, to support our Future Economy and Smart Nation efforts.

Better Optimised RIE Manpower

Sustain a strong research and innovation workforce in the private and public sectors, where national and industry needs are highest, by building a strong Singaporean core supplemented with international researchers of high repute.

STRATEGIC TECHNOLOGY DOMAINS

To maximise impact, funding will be prioritised in four strategic technology domains where Singapore has competitive advantages and/or important national needs. These are:

- Advanced Manufacturing and Engineering (AME)
- Health and Biomedical Sciences (HBMS)
- Urban Solutions and Sustainability (USS)
- Services and Digital Economy (SDE)

Activities in the four strategic technology domains will be supported by three cross-cutting programmes to ensure excellent science, a strong pipeline of skilled manpower, and value creation. These are:

- Academic Research
- Manpower
- Innovation and Enterprise (I&E)

Key R&D schemes open for industry participation can be found in the I&E section on Page 37 (Growing a Vibrant National Innovation System), to encourage industry partners to collaborate with public research performers to carry out R&D in areas of immediate interest to industry. We are also encouraging strategic partnerships between our public research performers and industry partners in upstream R&D, so that our companies can pre-position themselves to seize opportunities globally from Singapore, using cutting-edge technologies.

RIE2020 PLAN

In the next five years (2016 to 2020), under the sixth science and technology plan for Singapore - the RIE2020 Plan - the government has committed \$19 billion to research, innovation and enterprise, to take Singapore to the next stage of development.

With continued commitment to research, innovation and enterprise, Singapore seeks to support and translate research, build up the innovation capacity of our companies to drive economic growth, and leverage science and technology to address national challenges.

Vision: Transforming Singapore into a Smart Nation

Singapore is transforming to become a Smart Nation, where citizens live meaningful and fulfilled lives empowered by digital technology, where digital connectivity leads to stronger community bonds and many more opportunities for Singaporeans to pursue their aspirations and contribute to Singapore's future.

This is a whole-of-nation journey that Singapore is embarking on, enabled by digital technologies. Digital technologies will impact how we live our daily lives, open up new possibilities for the way we manufacture goods and deliver services, expand healthcare options, and revolutionise the way we plan and run our city.

We are systematically putting in place the infrastructure, policies, ecosystem and capabilities that will power our Smart Nation effort. We are encouraging a culture of experimentation, and are working together with our citizens and our companies to co-create solutions and better serve our citizens, who are at the heart of our Smart Nation vision.

RIE2020 Framework

Technology Domains			
Advanced Manufacturing and Engineering (AME)	Health and Biomedical Sciences (HBMS)	Urban Solutions and Sustainability (USS)	Services and Digital Economy (SDE)
To develop technological capabilities that support the growth and competitiveness of our manufacturing and engineering sectors	To be a leading centre that advances human health and wellness, and creates economic value for Singapore and Singaporeans through the pursuit of excellence in research and its applications	To develop a sustainable and liveable city through integrated solutions for Singapore and the world	To develop, integrate and leverage Singapore's digital innovation capabilities to meet national priorities, raise productivity and support key services, create sustainable economic opportunities and quality jobs

Due to the pervasive and cross-cutting nature of digital technologies, AME, HBMS and USS domains will draw on and fund research in digital technology capabilities that support the research agenda within their domains

Academic Research

To build up a significant base of capabilities and a pipeline of ideas that can feed into applied and industrial research to drive the next phase of growth

Manpower

To build a strong research and innovation community

Innovation and Enterprise

To build up a strong core of innovative enterprises that drive value creation and economic competitiveness

RIE2020 Portfolio







ADVANCED MANUFACTURING AND ENGINEERING (AME)

To develop technological capabilities that support the growth and competitiveness of our manufacturing and engineering sectors

STRATEGIC GOALS IN RIE2020

- Support economic growth, create good jobs for Singaporeans and prepare our economy for the future
- Strengthen linkages across public research performers and both large and small enterprises to sharpen value creation from public R&D investments
- Build capabilities where Singapore can offer a differentiated value proposition, including making strategic bets ahead of industry to position Singapore for emerging opportunities

Manufacturing has been a key pillar of Singapore's economy as we progressed from a labour-intensive economy to an innovation-intensive one. As of 2015, manufacturing contributed close to 20% of gross domestic product, and employed more than 500,000 people. Our manufacturing sector will face increasing external competitive pressures and internal factor constraints, but these will be balanced by opportunities presented by the growth of ASEAN and Asia in both production capacity and consumption needs. Against this backdrop, R&D and technology play key roles in strengthening our existing manufacturing sectors, seeding new growth niches and boosting productivity.

Within the AME domain, eight key industry verticals have been identified for RIE2020, based on the potential for Singapore to achieve global leadership, the presence of new opportunities for growth, and the ability to generate good jobs for Singaporeans. These are:

- Aerospace
- Electronics
- Chemicals
- Machinery & Systems
- Marine & Offshore
- Precision Modules & Components
- Biologics & Pharmaceutical Manufacturing
- Medical Technology Manufacturing

Four cross-cutting technology areas have also been identified as essential enablers, which will undergird and support the verticals. These are:

- Robotics and Automation
- Digital Manufacturing
- Additive Manufacturing
- Advanced Materials

To maximise value creation, integrated strategies will be developed across the entire innovation value chain, drawing on the capabilities of stakeholders in the ecosystem, including government agencies, public research performers, universities, and industry. For example, inputs from industry will be sought in the conceptualisation of programmes supported by the Industry Alignment Fund (Pre-Positioning) scheme.

KEY SCHEMES OPEN TO PUBLIC RESEARCH PERFORMERS

Scheme	Description
Individual Research Grants	 Grants to individual researchers for bottom-up ideas that support capabilities needed by AME domain Open to all public research performers Awarded through open grant calls
Programmatic Grants	 To support thematic programmes that seed longer-term capabilities for future industry readiness Open to all public research performers via open calls / directed mechanisms
Industry Alignment Fund (Pre-Positioning) (IAF-PP)	 Forward-looking programmes to seed and build capabilities ahead of industry interest, so as to generate industry traction Projects require support from both A*STAR and the Economic Development Board (EDB) Open to all public research performers via open calls / directed mechanisms

CONTACT POINT

Ministry of Trade and Industry's Research and Enterprise Division (Research & Development) at: MTI-RnD@mti.gov.sg



Biomedical Innovations, Better Healthcare

HEALTH AND BIOMEDICAL SCIENCES (HBMS)

To be a leading centre that advances human health and wellness, and creates economic value for Singapore and Singaporeans through the pursuit of excellence in research and its applications

Healthcare is a huge and rapidly growing global market, with the biomedical sector remaining an important contributor to Singapore's manufacturing economy. We also seek to develop innovative healthcare services, drugs or devices that will deliver better health outcomes for our people and enable a sustainable healthcare system.

STRATEGIC GOALS IN RIE2020

In RIE2020, public research agencies plan to develop an ecosystem that better enables translation of research to improving health outcomes, including greater emphasis on Health Services Research to contain healthcare costs, and transform and enhance the efficiency of health services delivery. The ecosystem will be supported by building a strong core and pipeline of Singapore researchers, clinician-scientists, innovators, entrepreneurs and investors.

Five therapeutic areas of focus have been identified by the Ministry of Health (MOH) based on factors such as disease impact, scientific excellence in Singapore and national needs. These are (i) cancers, (ii) cardiovascular diseases, (iii) diabetes mellitus and other metabolic / endocrine conditions, (iv) infectious diseases, and (v) neurological and sense disorders. HBMS agencies will develop research roadmaps to determine specific problem statements and priorities for each of the identified therapeutic areas of focus. These will include pathways to translate research discoveries into healthcare solutions, innovative medicines or medical devices so as to create value.

Singapore's HBMS industry cluster will be developed into a vibrant ecosystem comprising multinational corporations, local enterprises and start-ups. Singapore will also be diversifying its industry focus beyond the pharmaceutical and biologics, medical technology sectors, to include personal care, and food and nutrition, which had demonstrated the potential for economic growth, and where R&D can play an important differentiating factor.

KEY SCHEMES OPEN TO PUBLIC RESEARCH PERFORMERS

Scheme	Description		
Administered by MOH's National Medical Research Council (NMRC) For more details, please refer to www.nmrc.gov.sg			
(i) Schemes open to researc	hers in all public research institutions		
HBMS Open Fund Large Collaborative Grant (LCG)	LCG, funding up to \$25 million over a maximum of five years, aims to support the best teams of researchers from public institutions to advance human health and wellness, and create economic value for Singapore and Singaporeans, through the pursuit of excellence in research and its applications. Key Elements		
	 Collaboration within as well as between the basic and clinical research communities is strongly encouraged. Interdisciplinary collaboration across institutions is important to integrate, coordinate and leverage the full spectrum of research capabilities in Singapore from basic science to clinical research. 		
	• LCG programmes should aim to make significant contributions to the advancement of study of therapeutic areas and help establish Singapore as a global leader.		
	• They should facilitate the discovery and application of basic science ideas relevant to the advancement of health (as well as the translation of clinical findings into practices and policies if any); and provide opportunities to support industry sectors integral to the HBMS economic strategy, namely pharmaceutical and biologics, medical technology, food and nutrition, and personal care. Pathway(s) to impact should be clearly articulated.		
HBMS Open Fund Individual Research Grant (IRG)	IRG, funding up to \$1.5 million over a maximum of five years, supports basic and translational clinical research that are relevant to human health and wellness, as well as research into the causes, consequences, diagnosis, prevention and treatment of human diseases.		
HBMS Open Fund Young Individual Research Grant (YIRG)	YIRG is a sub-category of IRG, and a first step for new investigators. Funding per project is up to \$0.3 million over a maximum of three years.		

Scheme	Description
National Innovation Challenge (NIC) on Active and Confident Ageing	The NIC on Active and Confident Ageing seeks to catalyse innovative ideas and research in Singapore that can positively transform the experience of ageing in Singapore ¹ , through three key research thrusts:
	 Lengthening of health span Finding better ways of delaying onset of disease and disability, to extend seniors' health span, so that our seniors continue to lead economically and socially active lives for much longer
	 Productive longevity Research and innovation that unlocks the talent, energies and productivity in longevity, to benefit individuals, society and our nation
	• Ageing in place Science and technology that can help seniors live independent and autonomous lives despite their physical frailty; innovative solutions to effectively support ageing in place, in a smart city
(ii) Schemes open to clinical	researchers in public healthcare institutions and universities
Clinician Scientist Individual Research Grant (CS-IRG)	CS-IRG, funding up to \$1.8 million over a maximum of three years, is provided to clinician-scientists to enable them to carry out medical research on a specifically defined topic.
CS-IRG New Investigator Grant (CS-IRG NIG)	CS-IRG NIG is a sub-category of CS-IRG and a first step for new clinician-scientist investigators. Funding per project is up to \$0.24 million over a maximum of two years.
Health Services Research (HSR) Grant	HSR Grant is for researchers conducting HSR and enabling the translation of HSR findings into policy and practice. More information will be provided on the NMRC website at a later date.
Singapore Translational Research (STaR) Investigator Award	STaR Investigator Award is a prestigious award which supports established world-class clinician researchers to undertake cutting edge translational and clinical research in Singapore. Each award is up to \$8 million (inclusive of five-year research grant, indirect costs and salary support). STaR Investigators must commit to a full-time appointment in Singapore and their proposed research conducted in Singapore.

Scheme	Description
Clinician Scientist Award (CSA)	CSA provides salary and funding support to selected outstanding clinician-scientists, who possess a consistent record of excellence in research, to enable them to continue with their internationally competitive translational and clinical research. There are two levels of awards:
	• Investigator Category: For clinician-scientists with good track records of research work and have demonstrated potential to become leaders in their field (three-year research grant of up to \$0.81 million and salary support).
	 Senior Investigator Category: For clinician-scientists who have demonstrated sustained, high levels of productivity and leadership in translational and clinical research (five-year research grant of up to \$2.1 million and salary support). They are expected to mentor MBBS- PhD students and junior clinician-scientists.
Transition Award (TA)	TA aims to assist budding clinicians who have just returned from formal research training to build up their capability in research, so they can transition to a stable independent research position or other independent research funding and eventually obtain independent research support. The award for a mentored research project includes a three-year research grant of up to \$0.45 million and salary support.
Clinician Investigator / Clinician Scientists Salary Support Programme (CI/CS SSP)	CI/CS SSP aims to encourage clinicians to participate in healthcare research by providing salary support for their research time, so as to contribute to the pipeline of clinician researchers. The programme is open to clinicians who spend between 10-60% of their time in research for NMRC-administered research projects. The funding for salary support will be channelled to the respective clinical departments to recognise their support for the clinicians' participation in research, with the flexibility for the departments to use the funds for research-related activities in the department.

Scheme	Description
Masters in Clinical Investigation (MCI) Programme	MCI, run by NUS, aims to equip clinicians with the basic methodological and practical skills necessary to design and conduct clinical investigations relevant to patient care. It also provides the foundation for clinicians to pursue advanced clinical research training. Scholarships are provided for outstanding clinicians (Singaporeans or Permanent Residents) selected for entry into the MCI programme. Recipients are obliged to serve two and half years years with the government or in positions directed by the government.
NMRC Research Training Fellowship	NMRC Research Training Fellowship aims to equip outstanding and talented clinicians, health science professionals (e.g. nurses, pharmacists) and biostatisticians with academic qualifications and skills necessary for pursuing research as a career. Up to \$0.5 million over two to three years (extendable to four years for PhD), or up to \$0.8 million for overseas full-time PhD training for a clinician. Funds tuition fees and other allowances related to the research
	training. A seed fund of \$30,000 is available for an awardee who returns from training of 12 months or longer (subject to the approval of a research proposal). Recipients are obliged to serve with the government or in positions directed by the government.

Administered by A*STAR and EDB

Industry Alignment Fund	IAF-PP supports public sector research aligned with industry outcomes
(Pre-Positioning) (IAF-PP)	for Singapore, through the development of integrated capabilities
	and programmes, which address major challenges faced by industry,
	or which have the potential to transform or disrupt existing industry
	sectors. IAF PP will allow A*STAR and EDB to catalyse and orchestrate
	R&D activities across research and academic institutes, hospitals,
	public institutions and companies, towards industry development
	outcomes and to achieve economic impact. This encompasses new
	programmes, as well as existing programmes that have demonstrated
	strong track record of success and industry potential.

In addition, there are schemes available to support research performers in R&D partnerships with health and biomedical companies in Singapore. Please refer to the I&E section on Page 37 (Growing a Vibrant National Innovation System) for information on these schemes. Companies and research performers may directly discuss potential partnerships, or connect with the Biomedical Sciences Industry Partnerships Office (BMS IPO), jointly established by A*STAR, EDB and MOH to facilitate partnerships between research performers and companies with a strong R&D commitment to Singapore. For more information, please contact info@ bmsipo.sg.

CONTACT POINTS

For schemes administered by NMRC: MOH_NMRC@moh.gov.sg For schemes administered by A*STAR: contact@a-star.edu.sg





URBAN SOLUTIONS AND SUSTAINABILITY (USS)

To develop a sustainable and liveable city through integrated solutions for Singapore and the world

Our goal is to create a vibrant and endearing city, which every Singaporean is proud to call home. We are already known internationally as a city in a garden. We will further improve our built and natural environment to offer an even higher quality of life for all Singaporeans, despite resource constraints and the challenges of climate change.

STRATEGIC GOALS IN RIE2020

In RIE2020, the USS domain will focus our energies collectively to enhance our living environment and address our resource constraints through an interdisciplinary approach. This includes devising new urban mobility solutions, creating and optimising liveable space, building the next generation smart grid, and lowering the energy consumption of used water treatment, seawater desalination, and NEWater production.

The USS domain will take an integrative approach to reap synergies at the intersection of the energy-waterland nexus. For example, energy can be recovered from used water treatment processes to reduce energy consumption. Treatment facilities can also be co-located to save land and enable sharing of feed and waste streams.

An integrative approach also optimises solutions to better meet Singaporeans' needs. In urban mobility, for example, research into different modes of transport, including public transport, self-driving vehicles, urban logistics, cycling, and walking, will allow the transport system to be optimised as a whole, improving connectivity, peak period congestion and travel time. Urban planning studies can also help to integrate new technologies like car sharing, or on-demand urban mobility solutions into our town planning. Besides technical research, an understanding of mobility patterns and demand through social behavioural studies will also inform engineers of the type of urban mobility solutions to build, and policy makers of transport planning.

USS agencies will also collaborate with industry partners to create economic value and establish Singapore as an international hub for sustainable urban solutions. There will be support for companies to embrace innovation through equity co-investment schemes, and research consortia formed from industry and research performers to co-create and commercialise these urban solutions. For example, the Separation Technologies Applied Research and Translation (START) Centre for water technologies, the Green Buildings Innovation Cluster integrated R&D hub at the Building and Construction Authority Academy, and Waste-to-Energy test-bed facility in Tuas will all serve to accelerate the translation of R&D to commercial use and encourage greater industry adoption. We will also build up manpower capabilities in the USS domain, through graduate scholarships and post-doctoral fellowship programmes.

KEY SCHEMES OPEN TO PUBLIC RESEARCH PERFORMERS

Scheme	Description
Capability Building Programmes	 Support the training of local research and innovation talent in USS fields
Industry Alignment Fund (Pre-Positioning) (IAF-PP)	 Supports collaborative research with companies to seed and build capabilities in areas ahead of industry need

KEY SCHEMES OPEN TO PUBLIC RESEARCH PERFORMERS AND INDUSTRY

Scheme	Description
USS Competitive Research Programmes for Energy (e.g. solar, power systems, green buildings, waste- to-energy, and green data centres), Water, Land and Liveability, and Urban Mobility	 Support cutting-edge research with potential impact to Singapore Open to science and technology areas that are relevant to the USS domain
USS Living Lab Initiatives for Energy (e.g. power systems, green buildings, waste-to-energy, and green data centres), Water and Urban Mobility	 Support piloting and test-bedding of new technologies in the USS space to accelerate their commercialisation and adoption

Names and eligibility criteria of funding schemes may vary depending on the implementing agency.

CONTACT POINT

USS Secretariat at: USS_Secretariat@nrf.gov.sg





SERVICES AND DIGITAL ECONOMY (SDE)

To develop, integrate and leverage Singapore's digital innovation capabilities to meet national priorities, raise productivity and support key services, create sustainable economic opportunities and high quality jobs

Rapid advances in Information and Communications Technology (ICT) have lowered the cost of digital sensors, expanded computing power exponentially, and achieved ubiquitous connectivity – this has fundamentally altered business models in the services sector and created a whole new digital economy. Developments in artificial intelligence and deep machine learning can also bring about even more disruptive innovation.

STRATEGIC GOALS IN RIE2020

Digital innovation will be used as a force multiplier to meet national priorities and enhance productivity in our services sector. Under the Smart Nation banner, three focus areas critical to our national needs where SDE can have a decisive impact are:

1. Urban Mobility

The fusion of traditional transport engineering with autonomous technologies, real-time analytics, modelling and simulation will transform how we plan routes, and dynamically manage real-time traffic events.

2. Healthcare ICT

Predictive analytics and machine learning, based on real-time data collected from Internet of Things (IoT) healthcare devices, will allow healthcare to be delivered in ways that empower our seniors to enjoy active and confident ageing.

3. Services Productivity

Automation of knowledge work, discovery of insight through data mining and creation of innovative digital applications can be tapped to improve the delivery of government and private sector services.

Under the Smart Systems Strategic Research Programme (SRP), we will support research centres that anchor strategic capabilities to support these verticals. These may be thematic (e.g. specific to Healthcare ICT) or cross-cutting (e.g. data science).

We will also support rapid translation of SDE R&D into new products and services by:

- Supporting R&D activities that encourage future-oriented multinational corporations in the ICT sector to grow their presence in Singapore and provide good jobs.
- Facilitating strong partnerships with, and between, large local enterprises (LLEs), small- and medium-sized enterprises (SMEs) and innovative start-ups to rapidly incorporate innovative technologies into their products and services.

We will also initiate the Emergent Areas Research Project Scheme and the Industry Alignment Fund (Pre-Positioning) Scheme. These will seed and build selected capabilities where demand is still nascent, so as to pre-position our enterprises to capture the global market.

KEY SCHEMES OPEN TO PUBLIC RESEARCH PERFORMERS

Scheme	Description
Smart Systems SRP Emergent Areas Research Projects	 Seed R&D capabilities in new / emerging areas through projects funding
Industry Alignment Fund (Pre-Positioning) (IAF-PP)	 Supports forward-looking research projects ahead of industry demand
Smart Systems SRP Strategic Capabilities Research Centres	 Anchor SDE R&D expertise in our research institutes and universities for deep capability building along strategic sub-themes, by providing economies of scale and some certainty of funding Each centre will be funded via a combination of assured and performance-based components (e.g. dollar matching for industry co-funding), potentially supplemented by other competitive grants attained by the centre
Smart Systems SRP Public Sector-Led Translational R&D Centres / Projects	 Fund translation of R&D that is driven by demand from the public sector, to address government needs

KEY SCHEMES OPEN TO INDUSTRY

Scheme	Description
Smart Systems SRP Private	 Encourage R&D translation, productisation, and adoption of public
Sector-led Translational	R&D outcomes by private sector, including building research-industry
R&D Centres / Projects	linkages in bringing technology / intellectual property to the market

In addition to schemes in the SDE domain, digital technology-related R&D can also be funded under each of the other three technology domains.

CONTACT POINT

SDE Secretariat at: SDE_Secretariat@nrf.gov.sg



Renewing Our Knowledge Base

SPURRING ACADEMIC RESEARCH EXCELLENCE

To build up a strong base of scientific capabilities and a pipeline of ideas that can drive the next phase of growth

Academic research, also known as foundational research, aims to support work that leads to creation of new knowledge. Academic research is crucial to ensure that Singapore remains at the forefront of science, and supports new discoveries that can feed into translational and industrial research in the future. At the same time, academic research helps enable quality education at our Institutions of Higher Learning, by infusing teaching with the latest thinking and discoveries.

STRATEGIC GOALS IN RIE2020

In RIE2020, the government will continue to support investigator-led, programme and centre grants, to sustain a broad base of capabilities with peaks of excellence. To support the best ideas and teams, a larger proportion of academic research funding will be given out through competitive grant calls open to all public research performers. We will also continue to support international collaborations with leading research institutions to develop Singapore's global networks and thought leadership.

KEY SCHEMES OPEN TO PUBLIC RESEARCH PERFORMERS

Scheme	Description
Administered by the National Research Foundation (NRF)	
NRF Fellowship	 Supports promising early-career researchers to carry out independent research in Singapore. Provides up to \$3 million over five years.
NRF Investigatorship	 Provides opportunities for mid-career researchers to pursue ground-breaking, high-risk research, and become scientific leaders. Provides up to \$3 million over five years.
NRF Competitive Research Programme	• Supports multi-disciplinary teams to conduct cutting-edge research with potential impact to Singapore. Provides funding support for programmes up to a period of five years.
Returning Singaporean Scientists Scheme	 Provides outstanding Singaporean researchers who have established themselves overseas with the opportunity to relocate their research back to Singapore.

Scheme	Description	
Administered by the Ministry of Education (MOE)		
MOE Academic Research Funding (AcRF)	 Supports research in our research-intensive Autonomous Universities (AUs)¹ that has academic significance and potential to create new knowledge that benefits Singapore and the larger academic community. The AcRF comprises three tiers: AcRF Tier 1 - core institutional funding to the four research-intensive AUs that is allocated within each AU through an internal 	
	 AcRF Tier 2 - supports research projects on a competitive basis across the AUs. Provides funding of up to \$1 million per project over three years. 	
	• AcRF Tier 3 - supports high-impact, multidisciplinary research programmes in the AUs. Provides funding of between \$5 million to \$25 million per programme over five years.	

CONTACT POINTS

For schemes administered by NRF: NRF_CRP@nrf.gov.sg For schemes administered by MOE: MOE_ARD@moe.gov.sg

> ¹ Autonomous Universities refer to the National University of Singapore, Nanyang Technological University, Singapore Management University, and Singapore University of Technology and Design.



Strong Singapore Core, Diverse Research Manpower

SUSTAINING A STRONG RESEARCH MANPOWER BASE

To build a strong research and innovation community

The backbone of a technological, knowledge-driven economy is good manpower. Sustained growth of Singapore's science and engineering manpower base is essential to building our intellectual capital and developing peaks of excellence in research, innovation and enterprise. Given Singapore's small size and population, it is critical to ensure diversity within our research manpower pool and sustain international research networks. Singapore needs to remain an attractive environment for international researchers at all levels, from students to scientific leaders, in order to be a leading R&D hub.

STRATEGIC GOALS IN RIE2020

In RIE2020, the government will continue to focus on the need to build a strong local core through increasing the pipeline of Singaporeans entering a research career to anchor our R&D capabilities and developing Singaporean PhDs who can become scientific leaders. We will continue to attract world-class scientists and engineers to undertake research in our AUs, research institutes and industry, and entrepreneurial researchers who can translate the research into commercial products.

The government will provide funding and training schemes to support researchers at different stages of their careers, and increase the industry linkages for postgraduate training. The government will also grow a pool of Programme Management, and Innovation and Enterprise manpower, building translational capabilities.

Strategic Goals	Key Initiatives
Ensure industry-relevance of skills for graduate students	 Support a higher proportion of PhD and Master's scholarships linked to industry and national priorities Increase industry linkages for postgraduate training through expansion of EDB's Industrial Postgraduate Programme and introduction of an Engineering Doctorate Enhance postgraduate training by providing training in quantitative skills and complementary skillsets Provide more opportunities for skilled researchers to be staff scientists or technologists Facilitate industry internships as postgraduate training Enhance circulation of manpower between industry and public researchers
Build a strong pipeline of manpower	 Step up efforts to excite students to pursue Science, Technology, Engineering and Mathematics careers Public sector to build up technological capabilities

KEY MANPOWER DEVELOPMENT PROGRAMMES

Programme	Description
MOE Research Scholarship	 Supports stipends and tuition fees of PhDs and Master's students enrolled in AUs AUs will also be able to use the funding to support postdoctoral and staff scientist positions Administered by MOE
A*STAR Scholarships	 Supports education and training at the undergraduate, PhD and postdoctoral levels at local and overseas universities Open to individuals with a keen interest in pursuing a career in science or engineering research Administered by A*STAR
EDB Industrial Postgraduate Programme (IPP)	 Funds PhD and Master's students to work on joint projects with industry Open to individuals keen to pursue postgraduate training in a corporate R&D environment Administered by EDB
MOH Talent Programmes	 Funds scholarships to train clinicians / health science professionals in healthcare research Open to clinicians and health care professionals keen on pursuing higher degrees in research or conducting clinical investigations Administered by MOH
Engineering Doctorate (EngD) Programme	 Supports a complementary PhD training track for industry-oriented graduate training Open to individuals keen to pursue a PhD more aligned with specific careers in selected industry(s) Pilot to start from 2017 in selected AUs

CONTACT POINT

MOE's Academic Research Division at: MOE_ARD@moe.gov.sg





GROWING A VIBRANT NATIONAL INNOVATION SYSTEM

To build up a strong core of innovative enterprises that drive value creation and economic competitiveness

A vibrant and robust Innovation and Enterprise (I&E) ecosystem enables research outcomes to be successfully translated into products, processes and services that benefit Singaporeans. This allows our industries to remain competitive and to capitalise on new growth areas.

STRATEGIC GOALS IN RIE2020

Over the past five years, the local landscape has seen the formation of more start-ups, larger financing deals and public-private research partnerships. In RIE2020, we will build a strong core of innovative enterprises, strengthen linkages between private-private and private-public entities, and create economic returns and good jobs from research and innovation. Four key priorities have been identified:

Key Priorities

Provide targeted support to help firms scale up

- Government will provide equity co-investment funds for start-ups. The support will cover early-stage seed funding to post-Series A, to help start-ups scale up.
- Government will partner MNCs and LLEs to co-invest into promising start-ups, incubators and accelerators. This will allow start-ups to access the management expertise and global supply / marketing networks of large firms.

Foster stronger collaboration and cohesion

- The role of Technology Transfer Offices in public research organisations will be expanded to include technology transfer, I&E education and incubation services to form integrated Innovation & Enterprise Offices (IEOs).
- Government will establish a central fund that supports national collaborative initiatives amongst IEOs.

Encourage greater industry participation

- Expanded the size of the Industry Alignment Fund, which supports collaborations between public and industry researchers.
- Intermediaries (e.g. Intellectual Property Intermediary, IPI) will be strengthened to facilitate the engagement between public researchers and industry.
- Government will catalyse the flow of talent to industry by supporting full-time secondments and parttime attachments of RSEs to enterprises.

Support domain-specific strategies

• Funding will be set aside for initiatives that address domain-specific needs.

KEY SCHEMES ADMINISTERED BY VARIOUS GOVERNMENT AGENCIES

In RIE2020, there will be more incentives for public research performers to work together with industry players. Economic agencies will work with research performers to strengthen alignment with industry development plans.

Scheme	Description
Administered by NRF	
Centralised Gap Funding	A national-level platform for public research performers to translate research outputs into outcomes with economic and social impact. Projects must aim to develop early technologies into working prototypes or functional processes that are closer to market, attracting private sector investments and/or partners to fully take technologies to market or implementation.
Centralised Core Funding	This scheme aims to build and develop the I&E capabilities of IEOs and other public research performers in a concerted approach across the entire local ecosystem. This is done through collaborative programmes and activities, leveraging on existing strengths and capabilities of IEOs and stakeholders.
I&E Cluster Fund	This scheme supports projects catering to the specific needs of each domain and to help capture value through translation of research to impact. As pathways to commercialisation vary across domains, are often complex, multi-factorial and may not be addressable through generic schemes, domains can tap on the I&E Cluster Fund for a broad range of possible applications. The Fund seeks to strengthen partnerships across companies, universities, research institutes and government to bring ideas quickly.
	universities, research institutes and government to bring ideas quickly to market, raise productivity, create jobs and grow the sector. Previous Innovation Clusters under RIE2015 have been folded under this initiative.
Early Stage Venture Fund (ESVF)	ESVF catalyses the formation of funds to invest into start-ups. Government will partner selected LLEs to invest into start-ups, thereby allowing start-ups to leverage their networks and resources for growth. The LLEs benefit via greater access to disruptive ideas and technologies from start-ups.

Scheme	Description
Administered by MOE, MOH, and A*STAR	
Decentralised Gap Funding	This scheme supports the development of demonstration prototypes hence reducing the risks involved in commercialising technology developed by public sector researchers. This scheme will be managed by the respective IEOs and they will be encouraged to obtain market validation through industry participation. Research performers can contact their corresponding administrators in MOE, MOH and A*STAR for more information.
Administered by A*STAR	
Industry Alignment Fund (Industry Collaboration Projects) (IAF-ICP)	IAF-ICP supports public research performers in strategic R&D projects with companies (including SMEs and start-ups). Potential economic impact is a key criteria. Companies are expected to provide tangible commitments (cash and in-kind) as part of the collaboration. This scheme is open to all research performers. It is governed by EDB / SPRING, A*STAR and NRF.
Administered by EDB	
Research Incentive Scheme for Companies (RISC)	RISC facilitates the establishment and expansion of private sector research laboratories in Singapore. Companies will be able to defray some of the cost arising from qualifying R&D activities in strategic areas leading to improved industrial competitiveness.
Administered by SPRING	
Startup SG Equity	Start-ups looking to raise capital for scale up could benefit from direct government co-investment. There will be a higher support ratio at the early stage to de-risk private sector investors, and higher investment quantum to support start-ups in high-tech sectors that require larger investments and longer runways to scale-up for success.

Scheme	Description
Administered by A*STAR and SPRING	
Secondment of Experts	Provide support for full-time secondments or part-time attachments of RSEs from research institutes and institutes of higher learning to provide technical expertise and strategic guidance to SMEs. This strengthens the SMEs' technological capabilities and innovation capacity, while allowing RSEs to gain industry exposure.

CONTACT POINTS

For schemes administered by NRF: nrf_ie@nrf.gov.sg For schemes administered by MOE: MOE_ARD@moe.gov.sg For schemes administered by MOH: moh_nmrc@moh.gov.sg For schemes administered by EDB: client_services@edb.gov.sg For schemes administered by SPRING: media@spring.gov.sg For schemes administered by A*STAR: contact@a-star.edu.sg

CONCLUSION A Brighter Future Together through Research, Innovation and Enterprise

In a competitive world changing rapidly with technological advances, our research, innovation, and enterprise efforts will be crucial to bringing Singapore and Singaporeans forward in the next stage of our development. We must continue to invest in science and technology to support growth and innovation, and exploit new knowledge to improve our standard of living, and diversify and create new industries. This will allow Singapore to continue to be a good home with many opportunities, where Singaporeans can pursue their dreams and progress together as one people.

"R&D is an investment in our own future. It's an expression of belief in Singapore and Singapore's future. If we want to be a knowledge-based economy, which thrives on innovation and enterprise, we must build this knowledge base on which we can build the future of Singapore – then R&D is where we have to invest."

Teo Chee Hean Deputy Prime Minister and Coordinating Minister for National Security Chairman, National Research Foundation Singapore All dollars (\$) given are in Singapore dollars unless otherwise stated.

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