

## **CITIES OF TOMORROW (CoT) R&D PROGRAMME**

### **GRANT CALL 4**

#### *FOR VERTICAL 5: CITY IN NATURE*

## **1. Definitions**

1.1 In this Call for Proposal, unless the contrary intention appears: -

- (a) “Host Institution” means the body or institution or administering organisation named in the Letter of Award as the “Host Institution” as the body responsible for undertaking and managing the Research;
- (b) “Partner Institutions” means the bodies or institutions named in the Letter of Award as the “Partner Institutions” as the bodies responsible for working together with the Host Institution to undertake the Research;
- (c) “Institutions” means collectively the Host Institution and the Partner Institutions and “Institution” shall mean any one of them;
- (d) “Investigators” means collectively, the Lead Principal Investigator, Team Principal Investigators and Co-Investigators;
- (e) “Collaborator” means any company, institution, incorporated body or other industry or academic collaborator, which is not an Institution or an Investigator but is to be engaged in the Research in collaboration with the Institutions or any of them;
- (f) “Lead Agency” means the government agency leading and driving the Research;
- (g) “Other Agencies” means the government agency/agencies participating in the Research other than the Lead Agency; and
- (h) “Research” means the research project selected and awarded a grant under the Cities of Tomorrow R&D programme.

## **2. Introduction**

2.1 Launched in 2017, the Cities of Tomorrow (CoT) R&D programme is MND’s flagship R&D programme to develop cutting-edge solutions for the Urban Solutions and Sustainability domain.

2.2 The vision of CoT is to establish Singapore as a highly liveable, sustainable and resilient city of the future, and as a vibrant urban solutions hub – a living model which features cutting-edge urban solutions. This will be achieved through the integrated development of R&D in 5 key verticals and 2 horizontals:

- Vertical 1: Advanced Construction
- Vertical 2: Resilient Infrastructure
- Vertical 3: New Spaces
- Vertical 4: Greater Sustainability
- Vertical 5: City in Nature
- Horizontal 1: Urban Environment Analytics and Complexity Science
- Horizontal 2: Smart and Advanced Facilities Management

*[Please see **Annex A** for the vision and research focus areas for each of the verticals and horizontals. Please see **Annex B** for an overview of Vertical 5: City in Nature.]*

### 3. **Call Topic**

3.1 Please refer to **Annex C** for the details of the Call Topic.

### 4. **Eligibility**

- 4.1 Principal Investigators (PIs) from all Singapore-based public research institutes (RIs) (e.g., Institutions of Higher Learning (IHLs) and A\*STAR RIs), companies, company-affiliated research laboratories or institutions and not-for-profit entities are eligible to apply.
- 4.2 The Lead PI who leads the Research must be based in Singapore<sup>1</sup>. Collaboration with Singapore-based organisations and experts, in the capacity of Co-Investigator (Co-I) or as Collaborator, is strongly encouraged to foster multi-disciplinary and translational research outcomes. Collaboration with foreign organisations and experts in the capacity of Co-I or as Collaborator is allowed, and strongly encouraged for areas with potential for introduction of new research capabilities and transfer of technical expertise into Singapore. Research work should be done in Singapore, and should not be carried out overseas unless expressly approved by the grantor.
- 4.3 Grant applicants are strongly encouraged to collaborate with industry partners to develop innovative solutions that can address the call objectives and demonstrate strong potential for real-world application within and beyond Singapore.
- 4.4 Where applicable, we encourage the integration of relevant real-world conditions or social and behavioural research to complement the R&D work under these grant calls, to ensure the practicality, user-centricity and acceptability of the solutions proposed.
- 4.5 PIs should submit proposals in accordance with the Call Topic(s) launched under the Grant Call. Please clearly indicate the Call Topic that the proposal will address in the Proposal Template.
- 4.6 R&D proposals already funded by other government agencies will not be considered under CoT. PIs will need to declare their other funding sources as well as participation in other funding initiatives during application. Proposals with similar scope, which are currently under evaluation by other funding initiatives, will not be considered until the results from the other funding initiatives are finalised.
- 4.7 Funding for private sector entities for (i) research projects with a total project budget of more than S\$500,000, or (ii) test-bedding/demonstration/scale-up projects with a total project budget of more than S\$2 mil, would be conditional on collaboration with a public research performer. Nonetheless, below these quanta, private sector Lead PIs are also strongly encouraged to collaborate with public research performers as far as possible.

---

<sup>1</sup> Lead PIs must maintain a minimum of 1 year employment with the Host Institution, starting from the closing date of the Grant Call

## 5. Funding Support

- 5.1 When budgeting for funding under CoT, the total cost of the project should include all approved direct costs<sup>2</sup> and indirect costs<sup>3</sup>. All expenditure should be budgeted inclusive of any applicable Goods and Services Taxes (GST) at the prevailing rates. The Lead PI should exercise due diligence and ensure that the proposed budget is correct and free from error.
- 5.2 Direct costs are incremental cost required to execute the programme. Supportable direct costs can be classified into the following cost categories:-
- (a) Expenditure on manpower (EOM);
  - (b) Equipment;
  - (c) Other Operating Expenses (OOE); and
  - (d) Overseas Travel.
- 5.3 For all direct cost items proposed for the project, please note that:
- (a) Host Institutions must strictly comply with their own procurement practices;
  - (b) Host Institutions must ensure that all cost items are reasonable and are incurred under formally established, consistently applied policies and prevailing practices of the Host Institution; and
  - (c) All items/ services/ manpower purchased/ engaged must be necessary for the R&D work.
- 5.4 For proposed Equipment to be purchased, please ensure that they are currently unavailable in the Host Institution. In the event where the Lead PI is aware that a similar Equipment is available in the Host Institution, but has still proposed to purchase such Equipment, the Lead PI has to provide the necessary justifications for CoT Directorate's approval. Please also note that there is a requirement to share Equipment purchased using NRF funds with other researchers in Singapore.
- 5.5 At the end of the Research, the CoT Directorate may enter a negotiation with the Host Institution to transfer ownership of any of the Assets to the CoT Directorate or any other person or body at no cost.

---

<sup>2</sup> More information on the non-fundable direct costs of research can be found in **Annex D**.

<sup>3</sup> Indirect costs are costs that are incurred for common or joint objectives and therefore cannot be identified readily and specifically with a particular sponsored research project, but contribute to the ability of the Institutions to support such research projects (e.g. providing research space, research administration and utilities), and not through the actual performance of activities under the sponsored projects.

- 5.6 The CoT will support 100% of the approved qualifying direct costs of a project for Singapore-based IHLs/public RIs. Private sector entities<sup>4</sup> will qualify for up to 70%<sup>5,6</sup> of the approved qualifying direct costs of a project, depending on the entities involved:
- (a) 30% for all non-Singapore entities based in Singapore (including non-Singapore not-for-profit);
  - (b) 50% for Singapore Large Local Enterprises; and
  - (c) 70% for Singapore Small Medium Enterprises, start-ups and not-for-profits.
- 5.7 Support for indirect costs, in the form of overheads, will only be provided for Singapore-based IHLs / public RIs. Funding support of 30% of the total qualifying approved direct costs will be allowed. Host Institutions will be responsible for administering and managing the support provided by CoT for the indirect costs of research. Indirect costs must be specifically provided for in the grant, and approved by the Grantor based on the nature of the research.
- 5.8 Please refer to the document “Guidelines for the Management of Research Grants” for information on Disbursement of funds, Variation requests, Audit and Progress reports and List of Non-Fundable Direct Costs for Research Projects.
- 5.9 Collaborators are not permitted to receive, directly or indirectly, any part of the funding, whether in cash or in the form of assets acquired using the funding or otherwise unless expressly approved by the grantor. All assets acquired using the funding must be located in Singapore and maintained within the control of the grantees.

## **6. Intellectual Property Rights**

- 6.1 Government agencies who are Institutions or Collaborators may co-own any Intellectual Property (IP) arising from the Research. If Government agencies choose not to co-own IP, they shall make this position known prior to award.
- 6.2 The Institutions shall keep and maintain a full, comprehensive and updated list of all Research IP, which shall be made available to CoT Directorate for inspection at any time.
- 6.3 The parties shall use best efforts to ensure that Research IP is properly managed and wherever feasible, fully exploited and commercialized. When required to do so by CoT Directorate, the Institutions shall attend such meetings as CoT Directorate may direct to discuss the potential for exploitation and commercialization of Research IP.

---

<sup>4</sup> Definitions of the different private sector entity types can be found in **Annex E**.

<sup>5</sup> Exemption: Temasek Life Sciences Laboratory will qualify for up to 100% of the approved qualifying direct costs and up to 100% of the indirect costs of a project.

<sup>6</sup> All funding support levels are accurate as of grant call launch, and may potentially be subject to future review and revision.

- 6.4 The Government and public sector agencies shall reserve a non-exclusive, non-transferable, perpetual, irrevocable, worldwide, royalty-free right and license to use, modify, reproduce and distribute the Research IP for non-commercial, R&D and/or educational purposes.
- 6.5 For projects funding non-Singaporean entities<sup>7</sup>, a Singapore Technology Licensing Office (STLO) must be appointed regardless of the involvement of the public research performer. The STLO will assist to manage RIE-sponsored foreground IP for maximum utility in Singapore, and provide fair access to Singapore entities in the public and private sector.

## **7. Data Management**

- 7.1 USS domain agencies are compiling a metadata catalogue to improve data discoverability for researchers. It seeks to encourage early (i.e. pre-award) data-related discussions between Lead agencies and Investigators and will serve as a central reference for datasets available within agencies for request, to be used exclusively for the Research. However, Investigators should note that to lower data/cybersecurity risks of the project, data from the catalogue may not be shared in the publicised form (see para 7.4).
- 7.2 Interested Investigators may write in to request for the metadata catalogue. Please note that access to the metadata catalogue, as well as any data subsequently requested from the Government and/or public agencies require the signing of Catalogue Undertaking by the requestor's institution/company as a pre-requisite.
- 7.3 To safeguard against data leaks/breaches, depending on the nature of the Research, the Host Institution, Partner Institutions and/or Collaborators may be required by the CoT Directorate to attain one of the data and/or cybersecurity standards certification listed below (hyperlinked) as a pre-requisite to receive data requested or execute the data collection (e.g. survey) for the Research. Exact requirements will be determined after evaluation and CoT Directorate will officially inform the applicants selected for award in writing<sup>8</sup>. Failure to obtain the required certifications may affect project progress leading to delays in payment milestones, and potentially termination of the award.

---

<sup>7</sup> Non-Singaporean entities are defined as companies with less than 30% local shareholding, determined by the ultimate individual ownership.

<sup>8</sup> Should there be new data request or new data collection works identified later over the course of the project, the CoT Directorate reserves the right to require additional certifications to be attained during the project's progress (i.e. after project is awarded).

<a href="#"><u>Cyber Security Agency (CSA) Cybersecurity Standards<sup>9</sup></u></a>	<b>Inforcomm Media Development Authority (IMDA) Data Security Standards</b>
Cyber Trust Essentials (CTE)	<a href="#"><u>Data Protection Essentials (DPE)</u></a>
Cyber Trust Mark Tier 2 - Practitioner	
Cyber Trust Mark Tier 3 - Promoter	<a href="#"><u>Data Protection Trust Mark (DPTM)</u></a>
Cyber Trust Mark Tier 4 - Performer	
Cyber Trust Mark Tier 5 - Advocate	

7.4 Any datasets shared by Lead agencies may be aggregated, anonymised and desensitised, where feasible, to lower the data classification/sensitivity. In the same vein, where feasible, any proposed data collection from human subjects (e.g. survey) by the Investigators should be anonymised as well. These efforts would help to reduce the inherent data/cybersecurity risks of the Research and minimise the need for data/cybersecurity standards certifications.

7.5 To facilitate data sharing, Host institutions are required to submit cleaned data that is collected or generated in the Research as identified by the CoT Directorate. Please note that data may be shared with other publicly funded projects in the future through the metadata catalogue, unless they are commercial data or bounded by NDAs, to maximise synergies across projects and minimise duplicative works.

## **8. Publications**

8.1 All public disclosure of project information (e.g., publications, abstracts, presentations, documentaries, media interviews, etc.) shall be subject to prior review and approval by the CoT Directorate. The CoT Directorate reserves the right to object to or require revisions to any such disclosure to ensure the protection of sensitive information and accuracy of represented information or reference made to government agencies.

---

<sup>9</sup> Cyber Trust Mark controls are also mapped to (and is a subset of) ISO/IEC 27001:2022. Applicants may use ISO/IEC 27001:2022 certification to meet all tiers of Cyber Trust Mark certifications.

## **9. Post-Research Support**

9.1 Based on agencies' experience, there is a need for a handover period as often, there are practical issues such as debugging or additional tests for compatibility with government systems required, depending on the nature of the research project. In this regard, to better reap project outcomes, the Host Institution shall ensure that the Lead PI, Co-I and Collaborators shall provide all necessary support for continued product development and technology translation of the Research, for a period of up to 9 months ("**Handover Period**"), as may be required by the CoT Directorate, depending on the nature of the project. The support required shall include but not be limited to the carrying out of training sessions and conducting of debugging, user acceptance tests and compatibility tests with existing government systems. The detailed terms of the Handover Period for each Research would be set out in the written agreement referred to at para 12.8 below. For the avoidance of doubt, the duration of the Research shall include the Handover Period.

## **10. Research Integrity Policy**

10.1 The Host Institution shall ensure that all necessary approvals for the research, including all ethics approvals, have been granted prior to the commencement of any research activities.

10.2 The Host Institution is responsible for establishing a research ethics and integrity policy and enforcing its compliance. In carrying out any Research, the Host Institution shall agree to:-

- (a) Comply with the provisions of any relevant laws of the Republic of Singapore, statutes, regulations, by-laws, rules, guidelines and requirements applicable to it, as well as all applicable policies and procedures adopted by CoT as the same may be amended or varied from time to time;
- (b) Have in place a research integrity policy which sets out the principles for the responsible conduct of research and procedures for investigating and responding to accusations of misconduct;
- (c) Provide training in responsible conduct of researchers, for all researchers;
- (d) Be held responsible for the conduct of research and researchers; and
- (e) Ensure compliance with best practice, as well as the ethical, legal and professional standards relevant to the research.

10.3 All PIs, research personnel and all other persons involved in the Research must comply with the research ethics and integrity policy, and other approval requirements needed to carry out the research programme. The PIs should undertake the following declaration:

- (a) In carrying out Research, agree to comply with the provisions of any relevant laws of the Republic of Singapore, statutes, regulations, by-laws, rules, guidelines and requirements applicable to it, as well as all applicable policies and procedures adopted by the CoT R&D programme as the same may be amended or varied from time to time;
- (b) Agree to hold primary responsibility for the responsible conduct of research, and shall abide and comply with the ethical, legal and professional standards relevant to research, in accordance to the research integrity policy of the Host Institution; and
- (c) Declare any potential conflict of interest that may arise from the purchase of equipment/ physical items or engagement of manpower/ services in the course of carrying out Research.

## 11. **Evaluation Criteria**

11.1 Proposals will be evaluated based on the following criteria:

- (a) Potential Contribution to CoT Objectives**
  - Relevance of proposed research in contributing to objectives/targets stated for the CoT Call Topic.
- (b) Potential for Breakthrough and Innovation**
  - Quality and significance of proposed research, including value for money, and the potential for breakthrough/innovation to advance knowledge and understanding within its own field or across different fields.
- (c) Potential for Application and Deployment in Singapore and Commercialisation/Export<sup>10</sup>**
  - Potential for application of research outcomes in Singapore by a public agency and potential for solutions to be replicated in Singapore beyond a single site/project.
  - Feasibility for commercialisation/ export in areas where Singapore has a competitive advantage.

---

<sup>10</sup> To strengthen the commercialisation aspects/considerations of research outcome, USS Innovation & Enterprise (USS I&E) Office may be brought in to aid in the evaluation of the proposals.



**(d) Execution Strength and Technical Competency of Research Team**

- Quality of plans for execution and delivery of the research programme and goals, including the appropriateness of the proposed milestones and deliverables (specific to evaluation of full proposal applications)
- Quality, significance, and relevance of the recent research record of the Lead PI and Co-Is and the strength of the applicant group, including likely synergy in delivering research and potential for international leadership.

**12. Letter of Award & Acceptance**

12.1 The CoT Directorate is under no obligation to award research grant in whole or in part to any proposal. The CoT Directorate may require proposals to be revised as it sees fit to enhance research outcomes, facilitate integration of research concepts and technologies, and optimise funding resources. Specific data/cybersecurity standards certifications required (if applicable) will also be communicated to the applicant in writing for the selected proposal for award. **The CoT Directorate's decision on project and funding support will be final** and shall be abided by the applicants.

12.2 Successful applicants will be informed by the CoT Directorate of the award of the grant. Notification in the form of a Letter of Award will be sent to the Director of Research (DOR) for the respective Lead PI's Host Institution, and copied to the Lead PI.

12.3 The Letter of Award will include the following:

- (a) Statement of Acceptance;
- (b) Terms and Conditions of the Grant;
- (c) Guidelines on Grant Management;
- (d) Performance Indicators and Milestones;
- (e) Schedule and Budget Details; and
- (f) Data/Cybersecurity Standards Certification Requirements.

12.4 The Acceptance Form must be acknowledged by all of the following:

- (a) The Director of Research (or equivalent);
- (b) The PI; and
- (c) The Co-Investigators (Co-Is).

12.5 Upon acceptance of the CoT grant, the PI, Co-Is and Host Institution are bound by these clauses and all other terms as specified in the Letter of Award.

12.6 The PI or Co-Is cannot also be the authorised officer representing the Institution (i.e. DOR). In such cases, another officer duly authorised by the management of the Institution shall approve on its behalf.

12.7 The Acceptance Form and Annexes (if applicable) should be returned to CoT Directorate within a pre-determined time frame from the date of the Letter of Award. The date on which the Statement of Acceptance is signed shall be taken as the date of acceptance of the Award.

- 12.8 After the acceptance of the Award, as may be required by the Lead Agency, the Lead Agency, Host Institution, Partner Institutions, Collaborators and/or Other Agencies shall enter into a written agreement that is consistent with the obligations assumed under this Research and that includes conditions about: -
- (a) the role of each party in the Research;
  - (b) the provision of cash or in-kind contributions to the Research by each party;
  - (c) the work to be undertaken by each party and its technical/scientific contributions;
  - (d) terms relating to Intellectual Property ownership and commercialization;
  - (e) the detailed terms of and each party's obligations during the Handover Period; and
  - (f) any other obligations to be fulfilled as laid out in this set of guidelines.
- 12.9 The Investigators are responsible for putting in place research collaboration agreements where and when applicable.

### 13. Submission Instructions

- 13.1 Please download the Integrated Grant Management System (IGMS) Training Guide from the IGMS system at <https://www.researchgrant.gov.sg/Pages/TrainingGuides.aspx> for all instructions and guidelines on the submission process and information relating to the Grant Call.
- 13.2 Lead PI and Co-Is from organisations that are not registered in the IGMS are advised to contact [CoTV5@nparks.gov.sg](mailto:CoTV5@nparks.gov.sg) as soon as possible. Applicants are advised to allow sufficient time (at least 2 weeks) for their respective organisation to be registered, including registering their respective researcher profiles in the IGMS prior to submitting proposals. Refer to **Annex F** and the Grant Call FAQs for further information.
- 13.3 All applications and supporting documents for the CoT Grant Call must be submitted through IGMS at <https://www.researchgrant.gov.sg/>. Once PIs have submitted their documents online, their applications will be routed to the Director of Research (or equivalent) of their respective Host Institution for online endorsement. Separate submissions outside of IGMS will not be considered.
- 13.4 Please note that it is mandatory for applications to be lodged in the IGMS system and endorsed by **28 March 2025, 2:00pm, Singapore time (UTC +08:00)**. **Late submissions or submissions from individual applicants without endorsement from the Host Institution will not be entertained.**
- 13.5 For enquiries on the Grant Call, please email to [CoTV5@nparks.gov.sg](mailto:CoTV5@nparks.gov.sg). For other enquiries pertaining to IGMS system, please email IGMS helpdesk at [Helpdesk@researchgrant.gov.sg](mailto:Helpdesk@researchgrant.gov.sg).

- 13.6 Applications are considered to be successful only if all relevant documents are submitted in IGMS. The Research Administrative Office from IHLs or equivalent outfits in companies are required to ensure information submitted by their researchers for the grant call are compiled according to the requirements set out. Incomplete submissions may be rejected. A soft copy of the application documents should also be sent by email to the CoT Directorate at [CoTV5@nparks.gov.sg](mailto:CoTV5@nparks.gov.sg). The application documents required for the submission can be downloaded from the “Research proposal” section under “Research Details” after the applicant login to IGMS and navigate to “Proposals”, view “Proposal information”. The documents required to be submitted are:
- (a) Form A – Full Proposal (including capability indicators); and
  - (b) Form B – Budget.

It is advised to restrict each attachment to be less than 4MB.

- 13.7 Please follow the naming convention and format for labelling of softcopy attachments:

Attachment	Naming Convention	Format of attachment
Full Proposal Template	<i>[Topic Code]FP_ Project title</i>	MS Word
CVs	<i>[Topic Code] CV_ Project title</i>	MS Word
References (optional)	<i>[Topic Code] References_ Project title</i>	MS Word
Budget Template	<i>[Topic Code] Budget_ Project title</i>	MS Excel

**Important: Where relevant privileged or confidential information is needed to help convey a better understanding of the project, such information should be disclosed and must be clearly marked in the proposal.**

- 13.8 In case of discrepancy between the information in the IGMS application form and the attachments uploaded, the information in the attachments shall be taken as final.
- 13.9 As part of the CoT R&D Programme evaluation process, project submissions will be subject to a round of peer review by domain experts, followed by evaluation by a Project Evaluation Panel. Research teams applying for the grant call are invited to recommend peer reviewers for the CoT Evaluation Committee’s consideration under the “Reviewers” section of the application form in IGMS.
- 13.10 The final decision on the peer reviewers will be decided by the Evaluation Committee. Please refer to the following guidelines when recommending peer reviewers:
- (a) Potential reviewers should not have a real or perceived conflict of interest to any members of the research team (e.g. from the same institution as the research team; recently published work with members of the research team; have personal connections with the members of the research team etc.)
  - (b) Potential reviewers should be experts in the related field. Researchers cited in the reference list may be recommended as potential peer reviewers.

## Annex A: Vision and Research Focus Areas for CoT Verticals and Horizontals

The CoT programme was developed by MND Family in conjunction with our partner agencies, with the aim of delivering outcomes in collaboration with the research community and industry partners. CoT's RIE2025 focus areas will be expanded with new areas of emphasis in light of new drivers and challenges. 5 verticals, and 2 horizontals which represent specialisation in fields that are cross-cutting, have been identified to address key issues of national concerns (see Figure 1).

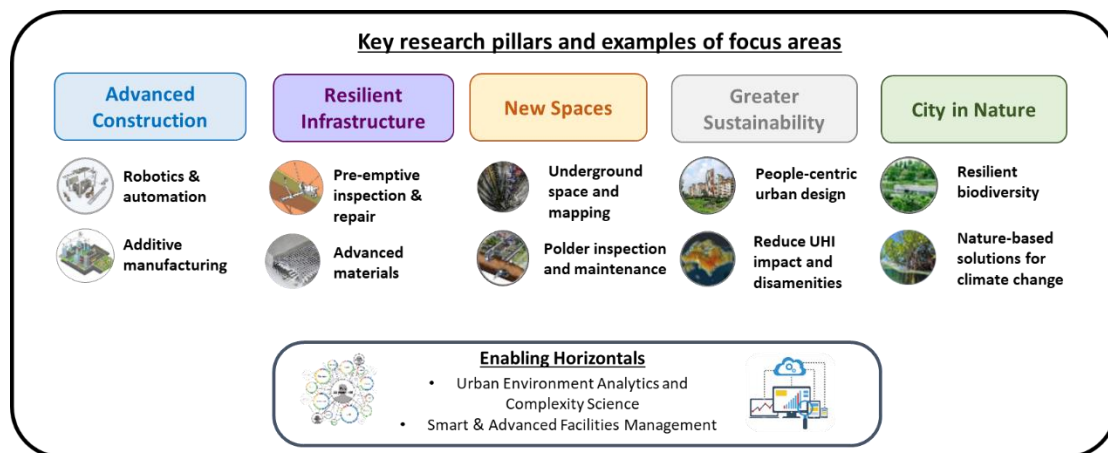


Figure 1. CoT's RIE2025 focus areas

The vision and research focus areas for each of the verticals and horizontals are as follows:

### Vertical 1 - Advanced Construction

**Vision:** To achieve a highly productive, integrated and technologically advanced construction sector that can build faster and more sustainably, while optimising limited manpower and resources

#### **Key Research Focus Areas:**

- *Additive manufacturing* – Advance the use of 3D printing technology for construction in Singapore's tropical climate and densely populated high-rise environment
- *Robotics and automation* – Facilitate robotics deployment and develop technologies to streamline processes such as Design for Manufacturing and Assembly (DfMA)
- *Advanced materials for the Built Environment* – Develop cost-effective and sustainable construction materials with enhanced materials properties
- *Safe and productive construction* – Develop productive innovations to enhance safety and improve construction productivity
- *Advanced project management* – Enhance coordination across the construction value chain and optimize resource utilization by leveraging on smart/digital technologies

## **Vertical 2 - Resilient Infrastructure**

**Vision:** To achieve a robust, flexible and well-maintained city, to ensure our infrastructure remains reliable and cost-effective throughout their lifespan.

### **Key Research Themes:**

- *Building inspection and repair* – Enhance traditional inspection and repair methods to be more productive and cost-effective, such as the use of emerging smart/digital technologies
- *Reliable M&E services* – Leverage technology advancement to intelligently and remotely inspect and maintain key M&E services to enhance reliability and durability
- *Advanced building materials to improve maintenance and durability post-occupancy* – Develop cost effective and environmentally friendly alternative materials to enhance the durability and performance of building and repair materials

## **Vertical 3 - New Spaces**

**Vision:** To ensure sufficient space capacity to support Singapore's continued economic and population growth, yet maintaining a liveable environment through creating and/or maximising underground and sea space.

### **Key Research Themes:**

- *Sustainable land reclamation processes* – Develop advanced technology through scientific research in reclamation design processes and explore alternative reclamation materials in order to reclaim and maintain reclaimed land more sustainably and productively
- *Innovative mooring solutions* - Explore feasible designs for innovative solutions and structures to optimise the mooring of bunker barges to reduce the anchorage space used for the mooring of bunker barges and harbour crafts in Singapore's sea space through pilot trials
- *Cost-effective underground construction and maintenance* - Develop more cost-effective and productive construction and maintenance solutions in Singapore's underground developments
- *Accurate and detailed underground mapping* - Develop new mapping methods that can map underground geology and services with higher resolution and depth to guide future underground developments

#### **Vertical 4 - Greater Sustainability**

**Vision:** To achieve a high quality and sustainable living environment that is inclusive, resource-efficient and adaptive to climate change

##### **Key Research Themes:**

- *Built Environment (BE) adaptation to climate change* – Adaptation measures to enhance outdoor thermal comfort amidst rising temperatures and protect our coastlines against sea level rise.
- *Enhancing liveability* - Develop solutions to mitigate disamenities experienced by residents, improve living environment as well as enhance health and well-being.
- *Support people-centric design and policy making* - Develop a social science approach to understand people-to-people as well as people-to-place interactions. This will contribute towards establishing an evidence-based methodology that informs designs and guidelines, enhancing social connectivity and community bonding

#### **Vertical 5 – City in Nature**

**Vision:** To support our national ambition to create a ‘City in Nature’ through enhancing and leveraging natural capital to meet sustainability goals.

##### **Key Research Themes:**

- *Safe, productive, and multi-functional greenery* – Develop solutions to improve urban greenery operations and management, and its integration with the built environment
- *Biodiversity monitoring to improve adaptive management of urban biodiversity* – Develop tools and techniques to improve the efficiency of biodiversity monitoring, so as to enhance the conservation and management of native flora and fauna
- *Managing human-nature relationships* – Improve our understanding of human-nature relationships, so as to inform policies and solutions that further enhance the physical and mental well-being benefits of urban nature
- *Nature-based solutions for inland climate change adaptation* – Investigate climate-related ecosystem services and biodiversity to inform the planning and design of blue-green infrastructure and multi-functional landscapes, as nature-based solutions to strengthen resilience against climate change

## **Horizontal 1 - Urban Environment Analytics and Complexity Science**

**Vision:** To deepen capabilities in urban analytics and complexity science, and improve the urban planning process with data-driven tools for evidence based decision making.

### **Key Research Themes:**

- Evidence-based Urban Planning with Data Analytics, Modelling and Simulation
  - *Land use activity and mobility* – Enable more integrated and efficient land use-transport modelling to enable continued optimization of land use allocation, travel demand and urban logistics
  - *Impact of the built environment on health & wellbeing* – Develop data-driven methodology to quantify relationship between wellbeing and different aspects of the built environment, and propose urban planning and design solutions to create more liveable neighbourhoods and foster healthy communities
  - *Polycentric development* – Simulate impact of future polycentres on existing developments to inform development quantum phasing and related policy and planning decisions
  - *Connectivity for people and ecology* – Promote positive user experiences of recreation spaces through data-informed urban planning and design approach, and mitigate negative human-wildlife interactions
  
- Complexity Science for Urban Solutions
  - *Liveable city: Adaptive and inclusive towns for all ages* – Develop planning parameters to strengthen adaptability of the built environment in response to residents' changing needs and foster more robust community networks
  - *Circular economy for sustainable development* – Understand the resource flows, networks and interdependency among businesses to augment resource circularity and efficiency
  - *Green-blue environment and quality of life* – Identify synergies between components of urban-nature system to enhance urban greenery initiatives for a healthier and more comfortable environment

## **Horizontal 2 – Smart and Advanced Facilities Management**

**Vision:** To achieve a high-quality built environment through facilities management (FM) which integrates across FM disciplines, aggregates demand, and drives execution in an efficient manner

### **Key Research Themes:**

- *Centralised network intelligence and coordinated deployment of robotics for optimal FM operation* – Develop predictive measures to optimise operations and solutions to better manage FM operations through leveraging on AI technologies and deployment of robots

## **Annex B: Overview of CoT Vertical 5 – City in Nature**

As one of the five pillars under the Singapore Green Plan 2030, the “City in Nature” vision aims to further restore and integrate nature into Singapore’s urban fabric, so as to strengthen our distinctiveness as a highly liveable city, while mitigating the impacts of urbanisation and adapting to climate change. This ongoing transformation into a “City in Nature” seeks to conserve and extend Singapore’s natural capital island-wide, through the following four key strategies: 1) expanding our nature park network; 2) intensifying nature in gardens and parks; 3) restoring nature into the urban landscape, and; 4) strengthening ecological connectivity between green spaces.

To provide a scientific foundation to support these transformative efforts, CoT has set up a new City in Nature research vertical (CoT V5) under RIE2025. This new research vertical will build upon existing R&D efforts in greenery and biodiversity, such as those under RIE2020, to strengthen our ecological and climate resilience, and will also seek to inform nature-based solutions<sup>1</sup> for social resilience.

Led by NParks, CoT V5 has been allocated \$17.9M in research funding under NRF’s Urban Solutions and Sustainability domain. As addressing the complex challenges involved in transforming Singapore into a City in Nature will require perspectives from a wide range of disciplines, research efforts under CoT V5 will seek to harness scientific expertise, technical capabilities, and practitioner experience that reside across various local research institutes, agencies, and companies, as coordinated by NParks.

Broadly, CoT V5 aims to enhance:

- (a) Climate resilience by improving ecosystem capacity to adapt and respond to disturbances brought about by climate change (e.g., increased urban heat island effects, inland flooding due to extreme rainfall events) using nature based solutions.
- (b) Ecological resilience by adopting an evidence-based approach to plan, design and monitor biodiversity conservation outcomes more effectively.
- (c) Social resilience by gaining a better understanding of how dimensions and detailing of landscape elements affect mental and physical health (e.g., psychological response, cognitive performance), which allows more effective planning and design of public spaces towards enhanced health outcomes and social cohesion.

### **Key Research Themes**

Key R&D focus areas under CoT V5 are as follows:

- (a) *Safe, productive, and multi-functional greenery* – Develop solutions to improve urban greenery operations and management, and its integration with the built environment
- (b) *Biodiversity monitoring to improve adaptive management of urban biodiversity* – Develop tools and techniques to improve the efficiency of biodiversity monitoring, so as to enhance the conservation and management of native flora and fauna

---

<sup>1</sup> Nature-based solutions are design solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience.



- (c) *Managing human-nature relationships* – Improve our understanding of human-nature relationships, so as to inform policies and solutions that further enhance the physical and mental well-being benefits of urban nature
  
- (d) *Nature-based solutions for inland climate change adaptation* – Investigate climate-related ecosystem services and biodiversity to inform the planning and design of blue-green infrastructure and multi-functional landscapes, as nature-based solutions to strengthen resilience against climate change

## **Annex C: Grant Call Topic**

**Grant Call ID/ Topic Code:** CoT\_V5\_GC2025\_10

**Call Topic:** Effects of greenery on outdoor thermal comfort perception across land use and form

**Research Theme:** R&D Theme 4 – Nature-based solutions for inland climate change and adaptation

### **1. Background**

1.1 **Outdoor Thermal Comfort (OTC)** refers to the condition of mind that expresses satisfaction with the outdoor thermal environment. It is influenced by various environmental factors such as air temperature, humidity, air velocity, and radiant temperature, but also the behavioral, psychological, physiological state of the outdoor space users.

1.2 There are two main types of OTC indices used in Singapore:

- (a) Simple Indices — computed based on direct measurements of the environment (e.g. Heat index, Wet Bulb Globe Temperature).
  - Wet Bulb Globe Temperature (WBGT) is used to communicate heat stress advisory<sup>1</sup>.
- (b) Rational Indices — derived from heat budget models of human body (e.g., Universal Thermal Climate Index (UTCI), Physiological equivalent temperature (PET)).
  - E.g. Usage in academic research to infer thermal acceptability ranges in Singapore<sup>2</sup>.

1.3 We note past and on-going studies on thermal comfort perception and acceptability only considered specific land use and urban forms at one time. As such, there is no systematic take in Singapore to calibrate thermal comfort perception and acceptability baseline across land-use and landforms for different socio-demographic and lifestyle groups. E.g.

- (a) Heng and Chow (2019)<sup>3</sup> in Singapore Botanic Gardens only.
- (b) Wong et al. (2013)<sup>4</sup> in outdoor leisure areas only.

---

<sup>1</sup> NEA Heat Stress Advisory: <https://www.nea.gov.sg/media/news/news/index/new-heat-stress-advisory-launched-to-guide-public-on-minimising-risk-of-heat-related-illnesses>

<sup>2</sup> Kohler, M. & Philip, C. H. (2020). Outdoor thermal comfort acceptability calibration. Cooling Singapore 1.5, D2.2. <https://doi.org/10.3929/ethz-b-000432324>

<sup>3</sup> Heng, S. L. & Chow, W. T. L. (2019). *How 'hot' is too hot? Evaluating acceptable outdoor thermal comfort ranges in an equatorial urban park*. International Journal of Biometeorology, 63(6), 801-806. <https://doi.org/10.1007/s00484-019-01694-1>

<sup>4</sup> Wong et al. (2013). *Thermal comfort in outdoor urban spaces in Singapore*. Building and Environment, 59 (2013), 426 – 435. <http://dx.doi.org/10.1016/j.buildenv.2012.09.008>

- (c) Philip, C. H. (2020)<sup>5</sup> in commercial and residential urban park only.
- (d) SMU (2024)<sup>6</sup> in parks and commercial settings only.

1.4 Studies elsewhere have noted the presence of tree coverage in the surrounding environment affects outdoor thermal comfort perception, and areas with higher tree coverage typically elicit positive thermal perception or experience. For example, Louafi et al. (2017)<sup>7</sup> and Dzyuban et al. (2022)<sup>8</sup> identified such effects at areas with hot and dry climate. Locally, studies such as Philip (2020) found that thermal comfort acceptability ranges differ across land use, and that range was lower in commercial land use compared to urban pocket park setting. Moreover, such local studies were not specific to distil the type and mechanisms on how greenery can affect thermal comfort perception, and the exact contribution of greenery to improving or moderating thermal comfort perception in Singapore remains unclear.

## 2. Objectives and Scope of Call for Proposals

### 2.1 Objectives

- (a) Calibrate** thermal comfort perceptions and acceptability ranges against OTC indices (both simple and rational) across land use, urban form, and socio-demographic and lifestyle groups.
- (b) Uncover** the mechanisms behind the impact of greenery on thermal comfort perception. Specifically, to answer:
  - b.1. How the different types of greenery could moderate thermal comfort perception.
  - b.2. How one's dynamic experience of greenery (i.e. thermal history) could affect their thermal comfort perception (e.g. presence of greenery 10 minutes before the survey).
- (c) Demonstrate** the improvement of thermal comfort perception with greenery via proof-of-concept landscape design.
- (d) Develop** on decision-support guideline on utilizing greenery at the local and microscale to assist agencies and developers achieve acceptable thermal comfort.

*Projects are also encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.*

---

<sup>5</sup>Philipp, C. H. (2020). *Index Overview Urban Heat Island and Outdoor Thermal Comfort*. Cooling Singapore 1.5, D4.4.

<https://doi.org/10.3929/ethz-b-000432329>

<sup>6</sup>SMU (2024). Cooling Singapore 2.0: Understanding Urban Heat, SMU City Perspective. Available at: <https://cityperspectives.smu.edu.sg/sites/wcs-2024/smu-landing/cooling-singapore%202.0.html?t=1728219819835>

<sup>7</sup>Louafi et al. (2017). *Effect of vegetation cover on thermal and visual comfort of pedestrians in urban spaces in hot and dry climate*. Nature & Technological, 17, 30-42.

<sup>8</sup>Dzyuban et al. (2022). *Evidence of alliesthesia during a neighborhood thermal walk in a hot and dry city*. Science of The Total Environment, 834. <https://doi.org/10.1016/j.scitotenv.2022.155294>

## 2.2 Technical Deliverables

### **(a) Calibration of thermal comfort perceptions and acceptability ranges against OTC indices** across land use, socio-demographic and lifestyle pattern:

#### a.1. Factors to minimally include:

- OTC indices: WBGT, UTCI, PET.
- Land use: Parks, Residential, Business/ Commercial, Industry.
- Urban form: building height and density, sky view factor, types of greenery.
- Socio-demographic: different age groups
- Lifestyle pattern: green space user

#### a.2. Assessment on the need for recalibration of perception and acceptability range, and recommendation on the frequency and sample size needed.

### **(b) Model and report** on how greenery would affect or moderate thermal comfort perceptions and acceptability ranges.

#### b.1. To leverage on findings from Deliverable **(a)**.

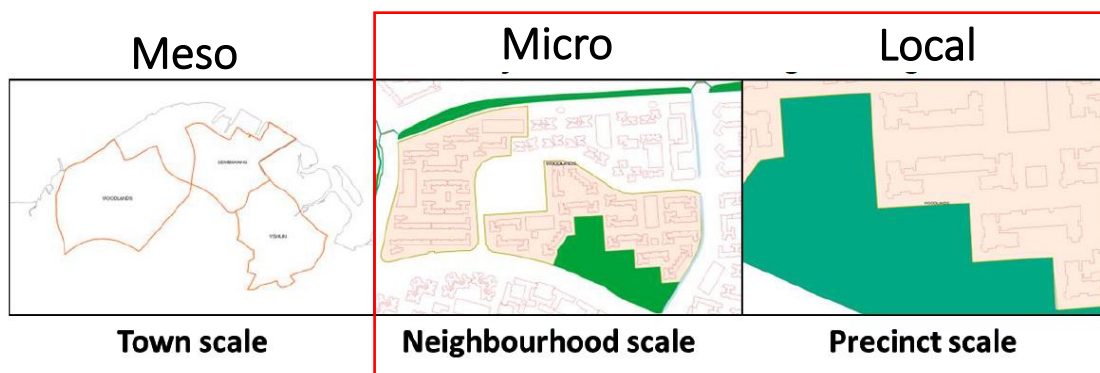
#### b.2. To minimally understand their relationships with:

- Quantification of greenery, such as leaf area index, sky view factor by greenery, average vegetation height.
- Quantification of urban forms, such as building height.
- Differences across socio-demographic and lifestyle groups, and influences of their dynamic experience of greenery/ thermal history (e.g. presence of greenery 10 minutes before the survey).

### **(c) Proof-of-concepts (POC)** of using greenery in landscape design at the local scale that could improve thermal comfort perception based on findings from Deliverables **(a)** and **(b)**. The POC should demonstrate effective greenery designs in at least 2 sites to be determined with agencies. Proposals are to recommend at least 2 possible sites/settings for agencies' consideration.

### **(d) Decision-support guideline** on utilizing nature-based solutions at the local and microscale to assist agencies and developers in achieving acceptable thermal comfort for users or residents of the space.

#### d.1. Guidelines to synthesize findings from Deliverables **(a)**, **(b)** and **(c)**, as well as existing literature/ research of heat stress impact across the population.



*Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.*

## 2.3 Impact Outcomes

*In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:*

- (a) The deliverables of the project should collectively provide a common framework for planning agencies (e.g. URA, PUB, JTC, NParks etc) and urban designers to utilize nature-based solutions (i.e. parks and greenery) to improve outdoor thermal comfort.

## 3. **Funding Support**

- 3.1 The Call for Proposals offers funding support up to S\$1.4 million (including all direct and indirect costs) (i.e., for meeting all objectives/ deliverables). Proposals more than S\$1.4 million will require strong justifications.
- 3.2 This Call for Proposals offers funding support for a period up to 3 years. Proposals spanning more than 3 years will require strong justifications.

## 4. **Agencies Involved**

- 4.1 The following agencies will be involved in the project to provide technical direction to ensure that the project meets the objectives and scope of the Call Topic.

**(a)** National Parks Board (Lead Agency)

- 4.2 Further clarifications before the project award should surround the stated Call Topic requirements. All clarifications and queries should be submitted directly to the CoT Directorate at [CoTV5@nparks.gov.sg](mailto:CoTV5@nparks.gov.sg) during the open grant call process, i.e., research teams should not contact agencies directly. CoT Directorate will respond to the clarifications and queries, by periodically updating the Grant Call FAQs document with the relevant answers, on the [CoT V5 4<sup>th</sup> Grant Call website](#) and [IGMS website](#) to ensure equal accessibility to all additional information. Please refer to these websites for the latest version of the FAQs. Agencies involved will work with research teams to provide further technical advice and discuss potential study sites during the proposal scrubbing stage.

**Annex D: Non-Fundable Direct Costs for NRF-Funded Projects**

*This list may be subject to revision.*

Type of Expenses	Description
Salaries of Lead PIs / Investigators / Project Leads	Not allowable, to ensure no double-funding of salaries and related costs, as the salaries are already supported from other sources (e.g. faculty salaries are supported separately by the IHL as it is in support of the IHLs' core mission).
Salaries of teaching staff / teaching substitutes	Not allowable, as this is already being supported from capitation grants.
Undergraduate tuition support	Not allowable, as this should be supported under the respective scholarship grants and bursary schemes.
Salaries of general administrative support staff	Not allowable, as this is an indirect cost*.
Costs related to general administration and management	Not allowable, as this is an indirect cost*. This includes common office equipment, such as furniture and fittings, office software, photocopiers, scanners and office supplies.
Costs of office or laboratory space	Not allowable, as this is an indirect cost*. This includes renovation/outfitting costs, rent, depreciation of buildings and equipment, and related expenditures such as water, electricity, general waste disposal and building/facilities maintenance charges.
Personal productivity tools & communication expenses	Not allowable, unless the use of mobile phones and other form of smart devices were indicated in the methodology for the Research/I&E Project. All other costs under this expense type is an indirect cost*.
Entertainment	Not allowable, as this is an indirect cost*.
Refreshment	Not allowable, unless this is related to a hosted conference or workshop for the Research/I&E Project. All other costs under this expense type is an indirect cost*.
Audit fees (Internal and external audit) and Legal fees	Not allowable, as this is an indirect cost*.
Fines and Penalties	
Professional Membership Fees	
Staff retreat and team-building activities	
Patent Application	Not allowable, as this should be supported from overheads given to I&E Office (IEO)*. This includes patent application filing, maintenance and other related costs.

\* Note: Indirect cost items should be supported from overheads or other funding sources.

**Annex E: Definitions of Different Private Sector Entity Types**

S/N	Type	Criteria
1	Non-Singapore entities based in Singapore	<ul style="list-style-type: none"> <li>• &lt;30% local shareholding , determined by the ultimate individual ownership</li> </ul>
2	Large Local Enterprises (LLEs)	<ul style="list-style-type: none"> <li>• ≥30% local shareholding; and</li> <li>• More than \$100M in annual turnover</li> </ul>
3	Small Medium Enterprises (SMEs)	<ul style="list-style-type: none"> <li>• Have Group Annual Sales Turnover of not more than \$100M, or maximum employment of 200 employees</li> <li>• To qualify as an SG entity, the entity must also have at least 30% local shareholding, i.e. local equity held directly or indirectly by Singaporean(s) and/or Singapore PR(s)</li> </ul>
4	Start-ups	<ul style="list-style-type: none"> <li>• Registered for less than 5 years at time of grant application</li> <li>• Has individual ownership of more than 50% at reference year; and</li> <li>• Employs at least 1 worker</li> <li>• To qualify as an SG entity, the entity must also have at least 30% local shareholding</li> </ul>
5	Not-for-profits	<ul style="list-style-type: none"> <li>• Registered as a public Company Limited by guarantee, society or charity trust</li> <li>• Main purpose is to support or engage in activities of public or private interest without any commercial or monetary profit, and are prohibited from distributing monetary residual to their own members</li> <li>• To qualify as an SG not-for-profit, the entity must meet all 3 of the following criteria:               <ol style="list-style-type: none"> <li>(1) Registered and physically present in Singapore;</li> <li>(2) Core funding (i.e. excluding competitive grant funding) is derived entirely/mostly from SG entities;</li> <li>(3) Managed by a Board, which is at least half appointed by SG entities</li> </ol> </li> </ul>

## **Annex F: SOP for Creation of New Companies/Institutions in IGMS**

1. Before you begin, please familiarise yourself with the various training guides on navigating the IGMS system. The various guides and manuals will help you understand the roles of various users in the IGMS and the application process. These documents can be downloaded from: <https://www.researchgrant.gov.sg/Pages/TrainingGuides.aspx>
2. Please be informed that companies or institutions who wish to apply for grants in IGMS will need to be registered in IGMS for first time application. The registration of the company or institution within IGMS is mandatory as part of the proposal submission workflow.
3. Please refer to the SOP below for the **creation of a new company/institution within IGMS**.

Steps	Details
1	<p><b>[For all]</b></p> <p>To register a new entry in IGMS, companies/institutions will need to send an e-mail to <a href="mailto:CoTV5@nparks.gov.sg">CoTV5@nparks.gov.sg</a> with the following details:</p> <div style="border: 1px solid black; padding: 5px;"> <p>Subject: Creation of new Company/Institution in IGMS for CoT Grant Call 4, Vertical 5, Project 10</p> <p>Details of the New Company/Institution to be Created in IGMS</p> <ul style="list-style-type: none"> <li>• Full Name of Company:</li> <li>• Indicate Local Company or Foreign Company:</li> <li>• Indicate Public Company or Private Company:</li> <li>• UEN (for local company) or CorpPass issued UEN or Unique Identifier (for foreign Company):               <ul style="list-style-type: none"> <li>• For Foreign Company, please provide the screenshot from CorpPass email/profile page indicating the Foreign Entity's CorpPass issued UEN, for verification purpose.</li> <li>• More details on how to register CorpPass for Foreign Company, please refer to the following link: <a href="https://www.corppass.gov.sg/help/CP_User_Guide_03B_Admin_Corppass_Admin_Registration_Foreign_Entities.pdf">https://www.corppass.gov.sg/help/CP_User_Guide_03B_Admin_Corppass_Admin_Registration_Foreign_Entities.pdf</a></li> </ul> </li> </ul> </div>
2	<p><b>[For all]</b></p> <p>After the respective company/institution has been registered on IGMS, please proceed to register an account on IGMS using CorpPass. To set up a CorpPass account, please visit <a href="http://www.CorpPass.gov.sg">www.CorpPass.gov.sg</a>. For foreign company users who have an existing IGMS account registered via “For overseas users without SingPass” route, please refer to <b>step 2a</b>.</p> <p>An Open Researcher and Contributor ID (ORCID) is also necessary to complete the application. Please register for a ORCID at: <a href="https://orcid.org">https://orcid.org</a> and update the user profile on the IGMS system with the ORCID.</p>



	<p>Thereafter, the Lead PI will be able to add the Co-Is' name in the IGMS when he/she fills up the application form.</p>
2A	<p><b>[For foreign company user with existing IGMS account registered via “For overseas users without SingPass” route”]</b></p> <p>When registering an account on IGMS using CorpPass, please ensure to use the same email address that was used for the existing IGMS account.</p> <p>In order to continue accessing past transactions in IGMS, it is important that the following steps are done to (i) update the Foreign Entity’s CorpPass issued UEN in IGMS (i.e., <b>step 1</b>), and (ii) register using CorpPass with the same email address.</p>
3	<p><b>[For Lead PI]</b></p> <p>Lead PI who will be submitting the application under their company/institution will need to check with his/her company/institution, whether there is already a HI Admin assigned. If not, please refer to <b>step 3a for the creation of new HI Admin</b>.</p> <p>To complete a proposal submission, <b>3 distinct roles</b> are required from any company or institution to endorse the proposal, namely:</p> <ul style="list-style-type: none"> <li>• Lead Principal Investigator (PI);</li> <li>• Office of Research (ORE); and</li> <li>• Director of Research (DOR)</li> </ul> <p>Grant application is only considered to be submitted after the PI had submitted the proposal on IGMS for ORE’s verification and DOR’s endorsement.</p> <hr/> <p><b>[For HI Admin]</b></p> <p>HI Admin will manage the roles of the users in their company or institution. He/She needs to assign the relevant roles such as “ORE”, “DOR”, "HI Finance", "HI HR", and "Data Admin", etc to other IGMS users in the company/institution.</p> <p>A HI Admin can concurrently hold the role of Lead PI. He/She will be able to select different profiles upon login to IGMS:</p> <ul style="list-style-type: none"> <li>• Login as HI Admin – to maintain company / institution &amp; user profiles</li> <li>• Login as PI – to apply for grant call.</li> </ul>
3A	<p><b>[Creation of new HI Admin]</b></p> <p>In the case of creation of new HI Admin, after the company/institution has been created in IGMS, <u>NParks will inform them to nominate</u> an HI Admin. The following steps will apply:</p>

	<p>(1) The company/institution will need to nominate a HI Admin. The HI Admin (including all other intended IGMS users) will need to ensure that his/her CorpPass account and ORCID account has been setup (refer to step 2 for more details).</p> <p>(2) The HI Admin will need to login to IGMS using his/her CorpPass account to register/update his/her profile inside IGMS. Please note that the IGMS would grant him/her the Principal Investigator (PI) role by default.</p> <p>(3) After the HI Admin has been successfully registered in IGMS, the HI Admin will notify NParks CoT with the information below:</p> <ul style="list-style-type: none"> <li>• Full Name of HI Admin:</li> <li>• E-mail Address of HI Admin:</li> <li>• Designation of HI Admin in his/her company:</li> </ul> <p>NParks CoT will arrange with Research Grant Officer (RGO) to change the role of the person from a Principal Investigator (PI) to a HI Admin.</p> <p>(1) After the role has been updated from Principal Investigator (PI) to HI Admin in IGMS, NParks CoT will inform the company/institution.</p> <p>(2) Once granted the role as a HI Admin, he/she can proceed to assign the relevant roles (e.g. "DOR", "ORE", etc.) to the various users within his/her organisation.</p>
--	---