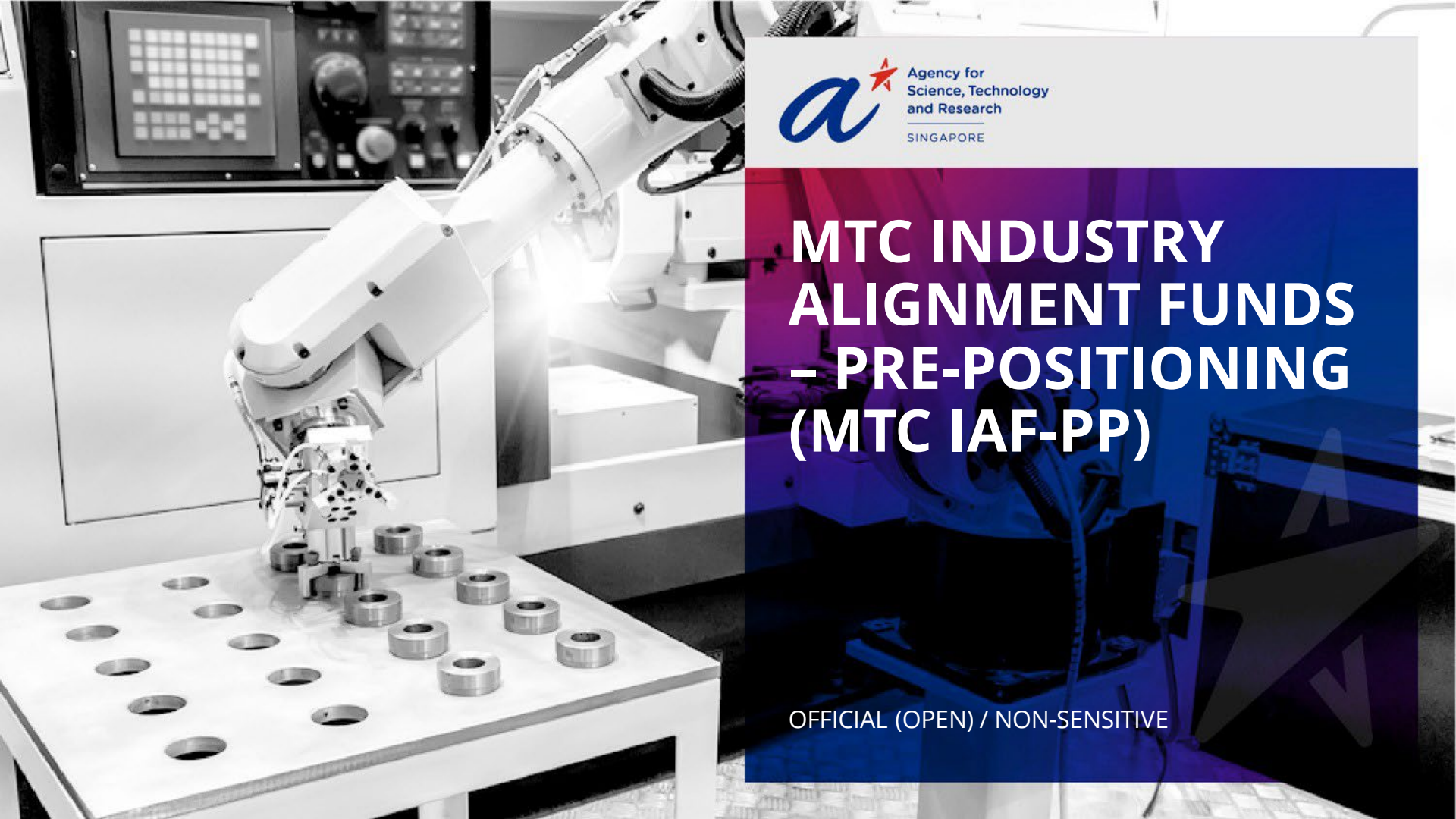


Agency for Science, Technology and Research
SINGAPORE

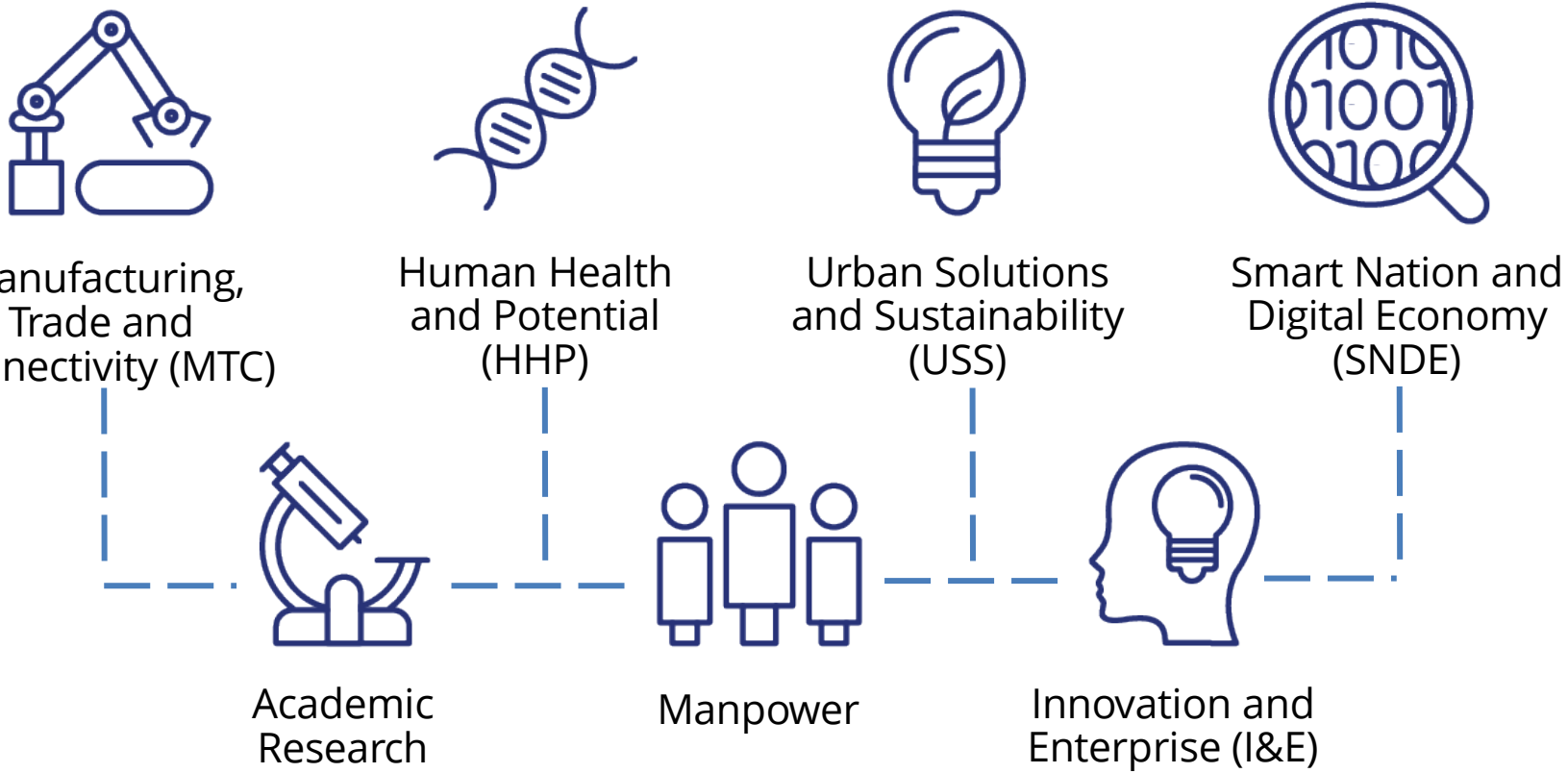
MTC INDUSTRY ALIGNMENT FUNDS – PRE-POSITIONING (MTC IAF-PP)

OFFICIAL (OPEN) / NON-SENSITIVE

CREATING GROWTH, ENHANCING LIVES

Contents

RIE2025: KEY STRATEGIES AND FRAMEWORK



MANUFACTURING, TRADE AND CONNECTIVITY (MTC)

Manufacturing

- Aerospace
- Energy & Chemicals
- Electronics
- Precision Engineering (Additive Manufacturing)
- Precision Engineering (Laser & Optics)
- Marine & Offshore
- Food Manufacturing
- Biopharmaceutical Manufacturing

Trade

- Logistics

Connectivity

- Aviation
- Sea Transport

As of 21 November 2023 – more details in Annex

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MTC IAF-PP Overview

- To develop industry-ready capabilities towards deepening the alignment of public sector research
- To develop multidisciplinary and integrated programmes with early industry involvement
- Supports new programmes, as well as existing programmes that have demonstrated strong track record of success and industry potential
- Supported programmes should be aligned with RIE2025 domain themes and strategies
- The maximum duration of IAF-PP projects should not exceed 5 years
- Programmes requesting funding of ≥$10M (incl. overheads) are required to set up a Scientific Advisory Board (SAB). Applicants to include list of proposed SAB members and their credentials in Full Proposal.

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Governance

- **Strategic Oversight Committee** (SOC)
  - Makes decisions on all IAF-PP policies and programmes
  - Comprises CE A*STAR, MD EDB and CE NRF

- A*STAR has been tasked as the **Implementing Agency (IA)** and reports to the SOC

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Key Differences between IAF-PP & IAF-ICP

	IAF-PP	IAF-ICP
Funding Initiative Goals	IAF-PP projects are expected to lead to **industry investments within 3-5 years.**	IAF-ICP projects aim to foster industry-relevant public sector R&D efforts and encourage public research performers to collaborate with industry, with a **line of sight to potential economic outcome.**
Alignment to RIE2025	Must be aligned either to **MTC (for MTC IAF-PP)** or **HHP (for HHP IAF-PP**) domain objectives.	**Pan domain**, can be aligned to MTC, HHP, SNDE or USS domains. Projects can also be cross-domain.
Nature of awarded Projects	IAF-PP projects are awarded to develop platform technologies, applicable to a particular industry ecosystem. This can include consortiums.	IAF-ICP projects are awarded to research performers to co-develop new capabilities and technologies with a specific company.
Industry commitment	The research performer is required to secure industry commitment **during the IAF-PP project**.	**Upfront industry commitment** is required as a condition of the fund award.

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Eligibility Criteria

Programme directors (PD) / lead Principal Investigator (PI) should:

a. Hold at least a 0.7 full-time equivalent (FTE) primary appointment in a Singapore publicly funded research or tertiary institution;

b. Run a laboratory or research programme that carries out research in Singapore; and

c. Have a track record of leadership ability in coordinating research programmes, as well as achieving productive research outcomes.

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General Assessment Criteria

- Programmes supported by IAF-PP are expected to lead to industry investments within 3-5 years

- Key criteria:
  - Potential for industry development and economic impact
  - Alignment of programme to MTC domain strategic outcomes and ability to deliver RIE2025 outcomes (Details at https://www.nrf.gov.sg/rie2025-plan)
  - Pre-positioning for value creation and value capture in Singapore
  - Potential to attract industry R&D spending (IRS) and investments (e.g. joint lab, co-development of project, creation of high-quality jobs)
  - Differentiation and competitiveness at regional or global level

Key Performance Indicators (KPIs)*

KPI	Definition	Data Collection Methodology
Amount of industry spending on R&D (IRS)	This refers to the investment that a company from the MTC sector commits to spend in Singapore on R&D activities as a result of projects funded by MTC IAF-PP in RIE2025. It comprises cash and/or in-kind contributions. Industry R&D spending should be segmented by sector and enterprise.	Data to be reported via company declarations that accompany annual progress reports, mid-term reviews and final reports. ▪ Company contributions leading up to R&D industry spending should be accounted for via Research Collaboration Agreements (RCAs) and not service agreement (SAs)/contracts. ▪ RCAs must be submitted for verification of the declared IRS commitment. ▪ Admissibility of IRS contributions found in Clinical Trial Agreements (CTAs) would be considered on a case-by-case basis. ▪ Site of R&D spending must be in Singapore. ▪ Public sector contributions (cash/in- kind) are excluded from IRS computations.

* Additional KPIs may be set at project level for tracking of outcomes.

Key Performance Indicators (KPIs)*

KPI	Definition	Data Collection Methodology
No. of industry projects	This measures the total number of R&D projects (excluding services projects) undertaken by companies from MTC sector as a result of projects funded by MTC IAF-PP in RIE2025. Industry projects should be segmented by sector and enterprise.	Data to be reported via annual progress reports, mid-term reviews and final reports.

* Additional KPIs may be set at project level for tracking of outcomes.

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Tracking Indicators (TIs)*

TI	Definition	Data Collection Methodology
Amt of industry cash funding	This refers to cash funding received from private sector industry sources for R&D projects as a result of projects funded by MTC in RIE2025. Industry cash funding should be segmented by sector and enterprise segment.	Data reported via company declarations that accompany annual progress reports, mid-term reviews and final reports. Company contributions leading up to R&D industry spending should be accounted for via Research Collaboration Agreements (RCAs) and not service agreements/contracts. Site of R&D spending must be in Singapore. Public sector contributions (cash/in-kind) are excluded from IRS computations.

* Additional TIs may be set at project level for tracking of outcomes.

Tracking Indicators (TIs)*

TI	Definition	Data Collection Methodology
No. of patent applications	This measures the number of complete patent applications that have entered national phase (in MTC fields) filed by public research performers as a result of projects funded by MTC IAF-PP in RIE2025.	Data reported via annual progress reports, mid-term reviews and final reports.

* Additional TIs may be set at project level for tracking of outcomes.

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Industry R&D Spending (IRS)

Admissible in-kind contributions:

- Manpower
- Equipment
- Technical Software (purchased from 3rd party)
- Consumables

Non-admissible in-kind contributions:

- Overhead costs
- Operational costs like rental, outfitting fees, utilities, admin costs, cleaning fees, post-project deployment work
- Products like company manufactured software and products, generic non-technical computer software (e.g. Microsoft Office)
- Others like travel costs, relocation costs, equipment depreciation costs, R&D contribution from other statutory boards or ministries

Examples of Admissible and Inadmissible In-Kind IRS

Admissible in-kind (direct R&D related spending)	**Non-admissible in-kind** (indirect R&D related spending)
Manpower • persons with scientific contributions to the project, or project management	**Indirect costs** • Non-R&D headcounts • Non-R&D equipment or consumables • Infrastructure costs e.g. construction costs, rental • Non-R&D operating costs e.g. utilities, admin costs, cleaning fees, post-project deployment work
Equipment • purchased from third party or manufactured by Industry Partner in collaboration (pro-rated for the period of project)	**Manpower costs** of research personnel based outside of Singapore
Technical Software from third party	**Company-manufactured technical software** and **non-technical software** e.g. Microsoft Office
Consumables	**Others** e.g. overseas travel, relocation costs

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Application Process

Applications to IAF-PP are evaluated on a quarterly basis.

Applicants are invited to submit their IAF-PP Letter of Intent (LOI) to the MTC IAF-PP Secretariat (iaf_pp_mtc@hq.a-star.edu.sg) by the quarterly submission deadlines indicated on our website IAF-PP (a-star.edu.sg).

Important Note:

- Applicants must use the latest version of the LOI template that can be downloaded from the website IAF-PP (a-star.edu.sg).
- All applications must be endorsed by the Research Office of the Programme Lead's Institution.
- Incomplete applications may result in the application being rolled over to the next quarter for evaluation. Please ensure that all applications are complete before submitting, and that all the necessary supporting documentation (e.g. Letters of Support) are included.

Industry Engagement

- Applicants are encouraged to contact Enterprise or their institute's Tech Transfer Office during the scoping stage to understand key industry trends, market landscape, and identify potential industry partners/users of their technology. Early with EDB (proposals involving MNCs/LLEs) and/or ESG (proposals involving SMEs) are also encouraged.

- **Full proposal should be accompanied by letters of support from potential industry partners** that address the following:
  - How the proposed work scope is differentiated from and compares with international efforts
  - How the company may use outcomes from the project
  - What forms of formal collaboration will the company enter with the programme, if successful
  - What milestones the company would like to see next
  - Company's potential cash/in-kind contribution to the programme

Evaluation Process for IAF-PP LOIs < $25M

- LOIs are submitted directly to Secretariat mailbox.

- LOIs are reviewed by the **LOI Review Panel** via circulation or PI presentation.
- LOIs supported by the LOI Review Panel will proceed to the full proposal (FP) stage.

- PI has up to 3 months to prepare FP. **Not part of evaluation timeline.*

- PI to present FP to the **IAF-PP Review Panel**. **FPs may be sent for expert review prior to panel review.*
- FPs recommended for funding by IAF-PP Review Panel are **endorsed by SOC** via circulation.

- IA will obtain budget approval from appropriate authority before issuing **Letter of Award**.

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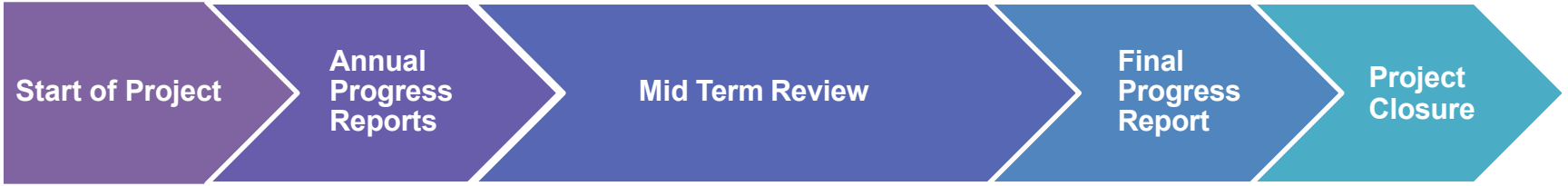
Post-Award Project Management



- Follow the A*STAR Grants T&Cs and Guidelines
- All projects are required to **submit annual progress reports** within 2 months from the end of each FY.
- Projects that **do not demonstrate adequate progress** may be required to present to the respective review panel.

- All projects are required to undergo at least **one mid-term review**. Final review is conducted before the end of term. Projects with awarded budgets ≥$10M are required to submit an SAB report with their mid-term and final reviews.
- Projects will be reviewed by the **IAF-PP Review Panel**.
- **Projects that are not on track** will be required to provide recovery plans, which can include downsizing and re-scoping. Projects that are unable to provide convincing recovery plans may be closed early.
- Final report is due within 3 months following end of term, and Final Statement of Accounts is due 6 months after end of term.

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THANK YOU

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Annex

Manufacturing, Trade & Connectivity (MTC)

Domain Focus Areas for MTC IAF-PP, Programmatic and IRG

The following document gives a brief outline of the focus areas for each of the MTC domain, for the sole purpose of preparing grant applications for the MTC IAF-PP, Programmatic and IRG Funding Initiatives.

Grant applications should address the following:

- The specific problem in the domain focus area/key capability/application that the proposal is attempting to address
- A clear description of the proposal's approach, and how it is differentiated from other international efforts
- IP development and IP value capture plans
- (IAF-PP) Extent of local value capture in Singapore, and potential for new/differentiated products or services in or via Singapore
- (Programmatic/IRG) How the proposal aims to build scientific excellence and capabilities

Grant applications in other areas of physical sciences and engineering are welcome for submission, but such applications must clearly articulate how they aim to address the challenges and needs of the MTC domain, and the pathway towards commercialization in Singapore (https://www.nrf.gov.sg/rie2025-plan/manufacturing-trade-and-connectivity).

Note: Focus areas for Satellites and MedTech will be included in due course.

Precision Engineering (Additive Manufacturing)

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Aerospace/Space	• Fast efficient computational/digital models for quick robust evaluation of parts and processes • Composite Materials (Metal, Polymer & Ceramics) • Lightweighting & Generative Design • End-to-End Hybrid AM process & system integration • Integrated end-to-end digital workflow • Post Processing (Hot Isostatic Pressing, machining)	• Materials and design for lightweighting & high temperature (metal, polymer, ceramics & composites). • New AM material for the aerospace sector e.g. specialised metal alloys, specialised ceramic-metal composites, high-temp high-performance polymer composites, Continuous Fibre Reinforced Polymers (CFRP).
		• Development of composite materials and hybrid multi material printing capabilities. eg: 4D printing for deployable structures and smart components with increased functionality & sensorization, structural battery power storage systems, multi material printing.
		• Development and optimization of print repeatability. • Development of standards for in-process monitoring for various AM technologies • Powder recyclability for AM sustainability
		• HIP capability, advanced robotic machining, internal surface finish technologies, integrated process development • Automation of post-processing with AM • In-process monitoring systems • Material-process-property correlations and machine variability • Optimization of post processing for part quality (HIP, heat treatment, surface finish, etc.)
M&O, Maritime and Land Transport	• Digital Models for rapid part qualification • Metal alloys & metal composites • Polymer & polymer composites • Wire-based & Powder-based large format printing (metal & polymer) • Hybrid Manufacturing • End-to-end Hybrid AM process & system integration • Integrated end-to-end digital workflow	• Integration of topology optimization and process development (Building of additional functions based on industry needs, development of digital twin and models)
		• Development of novel advanced materials, such as high-entropy metals, metal and ceramics, composite matrices, Continuous Fibre Reinforced Polymers (CFRP) • Metallic Additive Materials for AM processes and corrosion resistant steel. • Development and industry acceptance of sustainable AM materials
		• Building and scaling of large-scale Directed-Energy Deposition (DED) and hybrid platforms with integrated smart systems • Smart/Reconfigurable Factory with AM, including integrated part inspection methods, eg automatic inspection, quality assurance, non-destructive testing, etc. • Development of part build strategies with large format 3D printing and DED based technologies for new builds and repair
		• Development of novel post-processing methods such as internal channel support removal, etc. • Development of HIP processes • Hybrid Processing combining AM with joining, casting, and CNC/robotic machining etc. • In-process monitoring system • Improvements to process repeatability and parts reliability • Development and integration of blockchain into workflows for tracebility and IP protection
Precision Engineering & Complex Machinery	• Integrated CAD/CAM workflow & end-to-end digital workflow • End-to-end Hybrid AM process & system integration • In-process close-loop feedback • Integrated End-to-end digital workflow • Post Processing (advanced machining)	• Advanced material and multi material printing technology (metal, polymer, ceramics, composites)
		• Optics printing systems - improved optics fabrication and resolution especially in micro-optics • Development of smart machines (inclusive of capability to print micro-size features with high consistency and high throughput) • Integration of software and hardware to enable quality control including process stability. • Efficient fine feature printing (point-based, line-based or layer-based technology)
		• In-process monitoring system and closed-loop feedback, for process stability and consistent quality. • Component to module fabrication: Design for function. • Resolution coupled with fast speed and large area output (micro features, hybrid processing)
		• Data analytics for AM: Requirement for smart AM machines • Component to module fabrication: post-processing • Part traceability, certification, and standardisation
	• Tissue/Organ Engineering	• Customised surgical guides & models to suit specific procedures

MedTech, Healthcare, Drugs and Food	• Implants • Pharmaceuticals/Supplements • Food Printing for the Aged • Cellular Agriculture • Medical Devices • Point of Care Healthcare • End-to-end Hybrid AM process & system integration • 4D printing (smart materials & smart devices)	• Tissue Engineering (scaffolds) using AM, regenerative medicine, Tissue Implants and Tissue Model for material and product testing (Short Term), wound restoration (regeneration) • Customised implants & prosthetics, new testing methodologies for customised implants and prosthetics • Personalized medicine, small volume manufacturing for new drug testing, nutrition adjustment for seniors, printing optimization to ensure better organoleptic profile of novel foods/meats • Cellular agriculture and production of agricultural products • Smart implants and other medical devices; Implants and other medical devices with embedded advanced electronics, such as stents.
		• Safe, more biocompatible, biomimetic and printable materials/material formulations. • New materials with enhanced biocompatibility meeting product-specific requirements.
		• Printer compatibility with material, improvements to printing speeds, improving functions of products, finishing and biocompatibility of products to ensure safety and efficacy.
		• Data processing & standards: Data quality and reliability to ensure reliable product outputs • Comprehensive downstream eco-system development including regulatory, prototyping, manufacturing for translation and implementation.
Built Environment	• Multi Materials • Autonomous Gantry 3D printing • Structural and Non Structural • Design • Carbon-Neutral (Negative) Concrete • 4D Materials Façade • Energy Net-Zero Building	• New construction materials/ composite materials and advanced materials • Integration of metal and concrete, printing of rebar and concrete simultaneously for better bonding properties • Integration of metal – carbon fiber and graphene • Conductive materials – integration of services / optical fibers / solar cells • Higher load bearing and structural applications and capabilities • Development of carbon capture concrete (carbon negative materials in construction)
		• Large-scale, portable, reconfigurable, customisable platforms, autonomous/ robots • New printer systems and printing methodology for multi-materials • Integration of sensors for construction 3D printing Construction of smart structures, bridges, habitats, ancillary buildings for data and user analysis • 4D Printing • Intelligent building, building components that respond to external stimuli for thermal efficiency • Development and optimisation of processes for concrete 3D printing with re-bars / in-fills
		• New printing methodologies and processes for large parts (non-structural and structural)
		• Development of standards to be adopted by BCA, HDB and developers as part of building codes. • Development of accredited procedures and processes for building components, ie walls, ceilings, floors • Develop testing certification programme with TUV-SUD, ASTM and BCA • Researchers/ skilled manpower trained in robotics and automation of building processes • Setting up a Joint Research Lab with BCA Academy and Industry Partners to train and integrating Industry 4.0 for Construction 3DP
CleanTech	• Large Format Printing • Solid-state printing • Powder-bed & sintered based AM • Electric Motors • Renewable Energy Infrastructure • Generative Design • Composite Materials • Recycled Feedstock (Metal, Polymers) • Sustainability in design, process and delivery • End-to-end Hybrid AM process & system integration	• Design and simulation of 3D printed renewable structures • Advanced AM Materials & new printing technologies for CleanTech applications and products such as battery, fuel cells, water membranes, thermal management products, electrochemical energy storage
		• Large format metal and polymer printing technology for products such as wind turbines nacelles • Large scale 3D printing of renewable energy structures
		• Capability for parts repair, replacement and remanufacturing technology with AM
		• Standards for new AM materials and applications in the renewable space

Precision Engineering (Laser & Optics)

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Flat Optics/Metalenses	• Modeling and simulation • Design • New material development • Fabrication techniques	• Broadband / achromatic and efficient flat optics (imaging, lenses, fibre integration, structured light)
		• Flat optics system integration (imaging, 3D sensing, HUD/HMD)
		• Deep-UV & resilient flat optics • Soft X-ray/EUV flat optics
		• Engineered micro-optics
Fibre Lasers	• Laser sources • Laser system and components	• Wavelength-tunable DUV generation • Ultrashort (<10 fs) pulse generation
		• High power beam combiners at near IR and eye safe wavelengths (>1 kW) • Hollow core fibre based combiners and splitters
		• Beam delivery hollow core fibre near IR, 1 kW and ultrafast lasers • Beam delivery hollow core fibre (VUV) • Hollow core fibre for > 5 mm applications (delivery, supercontinuum source)
Image Processing and Metrology	• Intelligence for automated inspection • 3D inline inspection	• Deep learning with small number of samples (HMLV) • High speed processing • Low contrast features detection & identification
		• Freeform / complex geometric surface inspection • High resolution X-ray inspection (< sub µm)
Functional Coatings for Optics	• Coating materials • Coating processes	• Coatings for DUV-UV-VIS-IR optics • PVD process for applications with high thermal stability up to 400 degrees Celsius
		• PVD-based hybrid coating for ultra high temperatures & wear protection
		• Computational materials design & multifunctional development for new coatings & processes for harsh environments

Aerospace

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Digitalisation and Automation	• Data Analytics • Visual Analytics • Artificial Intelligence • Robotics/Cobots • IOT • 5G Applications	• Leveraging aircraft / equipment data to create new service offerings, e.g. aircraft health monitoring, resource optimisation
		• Automation of manufacturing / maintenance processes, e.g. high-mix low-volume applications
		• Improving shopfloor intelligence and decision-making for operations/processes in the hangars or workshops
Advanced Materials	• Polymer Composites • Ceramic Composites • Metal Alloys • Functional Coatings • NDI/NDT	• Development of advanced materials for new applications, e.g. in harsh environment, lightweighting of aircraft structures
		• Improving manufacturability to reduce production costs, and repairability
		• Enhanced inspection techniques for in-service aircraft / engine parts to improve accuracy, turn-around time etc.
Modelling & Simulation	• Digital Twin • Integrated Computational Materials Engineering • Model-based systems engineering	• Digital twins for manufacturing processes (e.g. AM, welding, cold spray) for parameter optimisation and to support the enhancement of materials and manufacturing processes.
		• Development of material models and integration of the models of various length scales in an Integrated Computational Materials Engineering (ICME) approach, to enhance understanding of associated processing methods and mechanical properties.
		• Model-based systems engineering (MBSE) to companies' product / system development process covering system requirements, design, analysis, verification and validation, from the conceptual design phase to development and later life cycle phases.
Additive Manufacturing	*Refer to Precision Engineering (Additive Manufacturing) Aerospace/Space Focus Area.*	
Autonomy	• Sensors • AI / Algorithms	• Sensors / software for new or improved autonomous performance of aircraft system
		• New aircraft concepts for urban air mobility applications
		• Unmanned Traffic Management (UTM), and UTM integration into manned airspace
Sustainable Aviation	• Electrification • Alternative Fuels • Alternative Shopfloor Processes	• Development of supporting materials, electronics and systems (e.g. battery management system) for use in More-Electric Aircraft and future electrical propulsion systems
		• Sustainable aviation fuels (SAF), alternative fuels (eg hydrogen) and their associated materials analysis and metrological needs, to support industry adoption.
		• Development of more sustainable or environmentally friendly alternatives to existing shopfloor processes, e.g. to reduce reliance on harmful chemicals or to reduce energy requirements.

Marine & Offshore

Focus Areas/Technology Verticals	Key Capabilities and Applications
Offshore Renewable Energy	• Predictability of operating environment • Design, implementation & operations of offshore renewable energy systems, including floating offshore wind • Coupled vessel + marine robotics for operations & maintenance
	• Metocean platform, including for Southeast Asian seas
	• Intelligent asset management of offshore wind and ocean energy systems
Marine Electrification and Clean Fuels Supply Chain Solutions	• Predictability of operating environment Vessel or platform for production, offloading, transport and storage Vessel or platform powered by LNG and clean fuels Risk assessment for clean fuels
	• Design concept of a smart FPSO and other platforms for LNG, novel energy or CO_2, and ammonia/LH_2 or CO_2 carrier Intelligent asset management
	• Design of a vessel with operating range & endurance similar to that of fossil-fuel powered vessels via digitalisation and AI Tool for Ship Design, including hull, propeller and other key systems, electrification, and novel techniques e.g. wing-in-ground
	• Simulation of gas leakage + explosion, and assessment of impact on platforms, gas carriers or terminals to identify safety considerations to facilitate design, planning and operations. e.g rapid prediction of plume dispersion for safety monitoring + leak source identification
Smart Ocean Systems	• Cyber Physical systems with real-time predictability and control • Autonomous and remotely operated systems, and robotics, including coupled human-machine and vessel – underwater robotics / aerial vehicle operations • Biomimetic systems for underwater or surface vehicles
	• Smart systems for greater efficiency, reliability, safety and resilience, through enhanced decision support, intelligent asset management, and enabling life-extension (e.g. existing FPSOs)
	• Autonomous systems for maintenance of offshore wind farms and ocean energy systems: autonomous inspection, including to define and enhance operating envelopes of coupled systems with man-in-the-loop via remote control
	• Biomimetic swimming mechanisms to enhance operational endurance of ocean systems, targeted at underwater vehicles for applications on (i) inspection of subsea pipelines + telco/power networks, (ii) deep sea mining ops, and (iii) seabed surveys
Nearshore Infrastructure addressing SG national priorities	• Smart multi-purpose, multi-body, nearshore infrastructure for habitats and other socio-economic uses complementary with coastal defence networks
	• Design, implementation and operations of large-scale floating systems, involving dynamics of coupled bodies, including fatigue and stress analysis
	• Design, implementation and ops of deepwater cages + other novel concepts for sustainable aquaculture farms, inc. use of ocean energy

Logistics

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Digitalisation	• Artificial Intelligence • Machine Learning • Low Code Platforms • Data Analytics • Digital Control Tower • Supply Chain Planning	System-level AI for real-time advisory • AI Toolkit for reduced failed deliveries • AI-based logistics planning optimisation
		Supply Chain Control Tower • Control tower use case development • Solution test bedding
		AI-enabled planning and modelling • Urban logistics simulator
		Data Driven Optimisation • Dynamic network configuration and simulation • Flexible order management and re-planning • Predictive analytics in supply and demand planning
Robotics & Automation	• Automated Guided Vehicles • Auto Vanning/Devanning • Goods to Man Machines • Robotic Arms for Picking • Smart Warehouse	Next Generation Distribution Centres & Warehouses • Auto vanning and devanning • Warehouse control platform • Robotics for cold chain warehousing
		Flexible Fulfilment Solutions • Learning from demonstration for automated microfulfilment onboarding • Optimal secondary packaging configuration and automation • Integrated packaging customisation • Planning and scheduling
		Autonomous Mobile Robots • Goods-to-Persons AMRs • Unit Transport AMRs
		Enabling Technologies for Lights-Out Warehousing • Lidar Sensing Robotics
IoT Connectivity	• Low Cost IoT • Remote Condition Monitoring • Track and Trace	IIoT solutions for harsh environments
		IIoT-enabled end-to-end supply chain visibility
		Low-cost, low-power, low-maintenance active IIoTs • Energy harvesting IIoT tracker
Modelling and Simulation	• Digital Twins for: • Warehouse • Manpower • Route Optimisation • Supply Chain Risk Management	Supply and Demand Forecasting • Demand-driven inventory planning across channels
		Intelligent vehicle routing and scheduling • Job consolidation and matching functions • Dynamic pricing functions for job matching
		Digital twinning for warehouse operations
Packaging Solutions	• Sustainable Packaging • Green Pallet • Cold Chain Packaging	Sustainable Packaging Materials • Plastic and paper materials with improved recyclability and/or increased recyclable content • Degradable bioplastics packaging
		Cold Chain Solutions • Temperature sensitive labels • Traceable cold chain packaging • Novel materials for ice packs
		Next generation reusable or upcyclable packaging design
Platform Solutions	• Interoperable Platform to enable: • Cross-border Digital Connectivity & Data Sharing Enabled by Trust Technologies and Sharing Economy	Trusted Data Platform • Federated microservice-based supply chain collaborative platform • Authentication and onboarding framework for massive IoT devices

		• Secure privacy-preserving data exchange
		Collaborative last-mile logistics • Platforms for logistics ecosystem for pooling and dynamic assignment of trucks • Collaborative fulfilment for quick commerce and return management
		Warehouse-as-a-Service • Inventory management for multi-client warehousing • Cloud-based warehouse management system
		Collaborative first mile logistics • Automated container inspection • Automated container end-to-end return to service

Electronics

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Heterogenous integration	• GaN • GaAs • SiGe • CMOS • Photonics	Next generation simulation of materials and manufacturing processes • Package Design Technology Co-optimization (P DTCO) to meet power, performance, area and cost requirements
		Innovative solutions for cross-layer interconnects • Advanced Through Die/Stack • Wafer Via/Nano TSV Technologies for packaging scaling of high performance products such as Field Programmatic Gate Array (FPGA)
		Bonding techniques to bring wafers and chips together • Advanced Bonding for 2.5D and 3DIC for very high density routing and interconnects
		Optimized chiplet placement for power, performance and area assisted by AI • Heterogeneous Multi Chiplet System in Package
Wide bandgap	• SiC • GaN for clean energy, energy storage systems • E-mobility, defense & space • Telecom infrastructure	• SiC as substrates to ongoing GaN-on-SiC HEMT efforts
		• GaN-on-SiC and GaN-on-Si RF HEMT for mmWave and beyond applications • Gallium oxide as longer-term material for advanced power devices on 6'' • GaN-based HEMT fabrication and packaging
Sensors and actuators	PVD-based PZT • Piezoelectric ultrasonic transducers, speakers, micro-mirrors • PZT piezoelectric actuation	
	AlN with higher concentrations of scandium • Photonic IC • Multispectral LiDAR sensor • RF resonators • Piezoelectric micromachined ultrasonic tranducers (PMUT) • ScAlN multi-physics	
	Ge infrared sensors • Waveguides, ring resonators, gratings • Metasurfaces, photonic crystals • MEMS emitters and detectors • Ge infrared chemical sensing	
mmWave and beyond	• Reference design flow for SatCom • RF & mmWave ICs/modules, GaN-on-Si power amplifiers • SiGe beamformer IC • 77Ghz radar RFCMOS	
	• Heterogeneously integrated front end modules for RF & mmWave • Fan Out Wafer Level Packaging (FOWLP) & Si interposer platforms • RF/ mmWave package level characterization	
	• THz design blocks LNA, PA, LO, mixer • RF MEMS Sub-mm^2 ScAlN based MEMS filters, phase shifters & timing devices • MEMS based metasurface for mW level THz beam steering • Photonic components	
Edge AI	• Ultra low power Microcontrollers (MCUs) and compute modules • Sensor fusion, Sensing (100uW) and detection (1uW) • Hardware-software optimization	
	• Machine Learning (ML) resistant, non-volatile memory (NVM) based, non-CMOS root of trust • Cross device deep learning side channel attack (>95% accuracy) • Hardware security	

	• Scalable neural network (NN) accelerators and compute in memory array • Cryogenic capabilities for quantum

Aviation

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Next Generation Air Navigation Services	• Performance improvement & workload reduction • Enable seamless operations within Singapore FIR & beyond • Strengthen resilience in ANS systems	• Decision support & analytical tools to optimise airspace management, air traffic flows and aircraft movements on ground
		• New airspace design architecture and concept of operations to maximise airspace capacity, enhance efficiency and reduce workload of air traffic controllers
		• Open ATM architecture platform and associated tools (including ATM twin)
		• System for comprehensive coverage of comms within Singapore's Flight Information Region (FIR)
Automated & Smart Airport	• Digital Airport • Robotics & Automation • Autonomous Assets	• Sensorisation of airport assets and enabling smart & efficient operations through optimisation engines
		• Mobile & dexterous robotics systems to automate manpower-intensive operations
		• Automate towing of baggage & cargo
		• Fleet management systems for improved productivity and dynamic response to disruptions
Unmanned Systems and Advanced Air Mobility	• Autonomous Control Technologies • Advanced / Hybrid Propulsion Technologies • Digitalised Remote Monitoring / Communications	• AI-enabled communication & control and flight dynamics planning for autonomous navigation
		• Intelligent battery management system & cooling solutions • Electrification and propulsion technologies
		• Optimisation of flight performance and noise reduction
		• Development of auto flight deviation detection & diagnostics
Sustainable Air Transport	• Sustainable Aviation Fuel (SAF) • Hydrogen Technologies	• Validation of SAF production pathways, feedstock and life cycle assessment to align with global standards
		• Hydrogen fuel cell powered airside ground vehicles

Sea Transport

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Next generation port	• Full automation of cargo terminals • Smart port maintenance & inspection of port equipment • Next generation vessel traffic management • Port call optimization	• Maritime simulation platform
		• AGV deadlock detection
		• Wharf-side coning/ deconing of twist-locks • Next generation vessel traffic management system
		Additive manufacturing for marine parts (refer to Precision Engineering/Additive Manufacturing for details)
Smart shipping	• Smart fleet (ship-shore) operations • Smart harbour craft operations • Autonomous shipping	• Digital metaocean predictor based on oceanographic models • Vessel performance prediction • Structural health management (digital twin) of vessels
		• Immersive technologies tools to create walkthough of vessels • Next generation navigational research training simulator that takes into consideration of human factors and skills for MASS
		• Maritime autonomous surface ships (MASS)
Maritime green technologies	• Full electric harbour craft and port infrastructure • Circular economy for terminals • Alternative fuels, eg. biofuels, ammonia, hydrogen • Carbon capture, utilisation and storage	• Simultaneous removal od SOx and NOx • NOx removal from ship exhaust gas for vessels
		• LNG-fueled vessels • LNG bunkering vessels
		• Electrification of terminal equipment

Food Manufacturing

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Food Technology and Functional Food Innovation	Productisation in Stratified Nutrition	Asian Children Nutrition (2-7 years old) • Functional food development for brain development and mental health support • Natural (organic) ingredients and reformulation into final food products for 'clean label' Asian Elderly Nutrition (55+ years old) • Complete food structures development with enhanced bioavailability of nutrients and improved organoleptic and sensorial properties • Fortified food formulation such as bioactives for healthier aging and elderly medical issues like dysphagia Asian Food Gut Microbiome • Novel functional products formulation such as prebiotics, probiotics, postbiotics and synbiotics • Fermentation techniques and cost effective novel delivery methods development such as encapsulation or coating materials for food formats productisation • Microbiome associated interventions e.g. design of food products, to improve nutritional uptake *Proposals deemed more suitable for other existing programmes (e.g. Singapore Food Story, Human Potential) would be directed accordingly for better governance and prevent duplicative funding. In general, biomedical and clinical studies are unlikely to be supported under MTC funding.*
Sustainability	Food Side Stream Valorisation	Green Extractions • Novel green solvents for extraction of bioactive compounds, biopeptides, enzymes, biopolymers • Development of cost-effective, scalable green extraction technologies e.g. novel enzyme-assisted technology, solvent-free technologies, combinations of novel techniques Biomass Processing Techniques • Fermentation technology innovation e.g. microbes for improved biomass conversion of lignin, saccharification and lipid accumulation, strain engineering for solid state fermentation, synthesis of chemicals/bioactives etc. • Nanotechnology development for entrapment and release of biomass waste for improved biomass conversion Processing Systems Design • Biocatalytic membrane systems development for upcycled food products • Pre-processing/separation system design of homogeneous food waste to facilitate downstream value adding activities and commercialisation • Food-grade processes and spoilage preventive systems development at side stream source
	Sustainable food packaging	Novel biopolymers/nanomaterials • Novel circular polymer materials, natural polysaccharides, and their derivatives • Bio-based composites and nanocomposites for enhanced biodegradability or recyclability Coatings/green additives development for plastics • Cellulose-based polymers, polyesters • Water-based coating materials • Biodegradable-based additives • Food-grade fillers Performance improvement of sustainable material • Improved physicochemical properties of biopolymer-based films (including development of manufacturing technologies) • Enhancement of mechanical and barrier properties of materials

		• Controlled degradation of materials • New sustainable wood and non-wood fibres innovation • Novel impulse drying technologies optimisation • Fibre preparation and processing technique development

Biopharmaceutical Manufacturing

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Biopharmaceutical Manufacturing	Small molecules, Biologics and New Modalities	Biologics • Sensing and modelling, simplification and acceleration of closed loop control of biological systems • Sustainability and resilience of supply chain • Compliance agility, making compliance automatic
		New Modalities (Cell Therapy) • Scalable manufacturing platforms • Characterisation and quality • Predictive modelling & system analytics
MedTech	Sensor Development & Miniaturization	• New laser and flat optical-electronics design and fabrication capabilities for but not limited to i.e. multi-spectral sensing, substrate-enhanced Raman, spectroscopy nanooptics, laser doppler, photoacoustic at component, sub-system and system level • Ultrasound component, sub-system, system design • Hybrid imaging systems • Non-invasive biochemical sensing through 1) new material development, 2) enzyme development & 3) flexible electronics
	Resilient & Sustainable MedTech Manufacturing	• Net zero cold chain and clean room management e.g. production, transport, storage • Lyophilization process engineering • Sustainable medical application materials • Alternative approaches to critical supplies • Enzyme Engineering
	Next-Gen Fluidics Chip Development	• Next-generation microfluidic chip design i.e. bonding, channel resolution, sustainable material, packaging, label-free, multi-plexing • Integration with silicon photonics/integrated circuits
	Design & Development, Critical Supplier Development	• Product (sub-system/system) design & development • Verification and validation • Design for manufacturing, sustainability, cost-effectiveness • Pilot manufacturing • Qualification of suppliers and contract manufacturers • ISO13485 processes and facility
	Requalification for Alternative Sterilization	• Requalification into alternative sterilization i.e. vaporized hydrogen peroxide, x-ray • Optimized instrumentation, software, database and testing for sterilization • Standards/guidance development and certification • Alternative sterilization technique development and optimization

Energy & Chemicals

Focus Areas/Technology Verticals	Sub-Focus Areas	Key Capabilities and Applications
Specialty polymers	**Alternative feedstock and monomer innovation** • Develop novel and eco-friendly methods to obtain next-generation sustainable polymers from alternative renewable feedstock (biomass and CO2) **Material Circularity and viable End-of-Life solutions** • Improve recycling and reprocessing plastics into high-quality recyclates **Polymer process Innovation** • Green processes and chemicals for polymer processing and End-of-Life solutions including the use of digital tools (AI/ML).	These outcomes should target application areas and use cases in the Petrochemicals and Specialty Chemicals industry sectors. • **Reduce dependence on fossil fuel based plastics**: To develop new polymers made of renewable feedstock. • **Reduce reliance on virgin plastics:** New green high-performance polymers with improved recyclability without physical property deterioration with green processes. • **Reduce use of unsustainable chemicals and energy intensive processes:** Develop sustainable polymer manufacturing processes
Electronic chemicals & materials	**Battery Materials** **High-performance battery materials** • Li-alternative materials (Na,Mg,Al) that are cheaper with higher charge capacity and potential niche applications. **Solid-state batteries** • Solid-state batteries using solid electrolyte instead of liquid for improved energy density and safety. **Battery End-of-Life(EoL) management and recycling** • Sustainable/recycled materials used in battery manufacturing.(electrode substrate, separators, casing) • EoL management of batteries through automation of battery diagnostics, facilitating 2nd life applications and remanufacturing of the batteries (including urban mining). **Proposals seeking battery-related funding should ensure that they have strong industry relevance.**	**Battery Materials** • To focus on **battery chemistries** that can command higher price premiums and are not currently dominated by large battery players. • Contribution to **advanced materials development**, processing, and battery circularity • To support the overall battery ecosystem in Singapore