

**CLOSING THE WASTE LOOP (CTWL)
RESEARCH & DEVELOPMENT (R&D) INITIATIVE**

**REQUEST FOR PROPOSALS (RFP) ON
SUSTAINABLE DESIGN OF AND VALUE RECOVERY FROM PLASTICS**

Research Area	Sustainable Design of and Value Recovery from Plastics
Publication Date	26 Mar 2018
Closing Date and Time	11 Jun 2018, 11.00 am
Proposal Submission	Applications shall be made via: Integrated Grants Management System (IGMS) at https://researchgrant.gov.sg by the closing date
Instructions and Format of Submission	Please refer to the following websites: https://www.nea.gov.sg/grants-awards/closing-the-waste-loop-initiative or via IGMS at https://researchgrant.gov.sg

CTWL R&D INITIATIVE RFP ON SUSTAINABLE DESIGN OF AND VALUE RECOVERY FROM PLASTIC

BACKGROUND

1. Plastic materials form an integral and important part of the global economy as they are inexpensive, lightweight and durable, and can be readily made into a variety of products for everyday applications.
2. The global production of plastic has increased twentyfold over the past fifty years, from 15 million tonnes in the 1960s to 311 million tonnes in 2014, and is expected to still double over the next 20 years.¹ The production of plastics consumes significant amounts of fossil fuels, both as feedstock and energy. It is estimated that 4% of the world's annual oil production is used as feedstock for plastics, and a further 3%-4% is used as energy for their manufacturing processes.² The production and disposal of plastics also generate carbon emissions, contributing to global warming.
3. Approximately 50%² of plastics, by their very design, are meant for single-use applications. Single-use plastics include mainly small-form packaging, such as sachets, tear-off plastic sheets and sweet wrappers; multi-material packaging made of several materials adhere together to enhance packaging functionality; and plastics such as polyethylene (PE), polyethylene terephthalate (PET) and polypropylene (PP) that are widely used for the packaging of foods and drinks. While offering high functionality, these materials are often unsuitable for reuse due to hygiene reasons, and difficult to recycle due to contamination by food residues.
4. Globally, it is estimated that 95% of plastic packaging material value, or US\$80 to 120 billion, is lost annually after the first use. When the costs of sorting and reprocessing are factored in, only 5% of material value is retained for subsequent use.³
5. To enhance resource use efficiency, it is imperative to keep plastics as resources in the economic loop for as long as feasible. The move to reduce single-use plastics and look for viable recycling technologies for plastics has become a worldwide initiative, calling for a collective effort from government agencies, manufacturers and the broader industry, research and technology providers, and public communities.

Current Status

6. Locally, 815,200 tonnes of plastic waste were generated in 2017, with only about 6% being recycled. The plastic waste that was not recycled was incinerated at the waste-to-energy incineration plants, with the resultant incineration ash sent to the offshore Semakau Landfill.
7. Recyclables including plastic waste collected under the National Recycling Programme (NRP) are sorted at local Materials Recovery Facilities (MRFs) into major

¹ PlasticsEurope, *Plastics – the Facts 2013* (2013); PlasticsEurope, *Plastics – the Facts 2015* (2015).

² Jefferson, H., Robert, D., and Edward K. 2009 "Plastic recycling: challenges and opportunities"

³ Expert interviews; Plastic News; Deloitte, *Increased EU Plastics Recycling Targets: Environmental, Economic and Social Impact Assessment Final Report* (2015).

categories such as PET, PP, low-density polyethylene (LDPE), and high-density polyethylene (HDPE). Sorted plastics are mostly baled and then exported to overseas for further processing. Despite having accessible recycling receptacles provided in public spaces under the NRP, the contamination of recyclable plastic waste with food waste continues to pose a challenge against achieving a high recovery rate for plastics. To add to the problem, it is still not economically viable to recycle certain types of plastics, such as multi-material packaging comprising different type of plastics and/or other materials.

8. In the recycling process, plastic waste is usually crushed into smaller pieces and blended to form a mixture of uniform and homogenous quality, which then undergoes extrusion into strands. After cooling, the plastic strands are cut into resins to be used as raw material for manufacturing new products.

9. As Singapore's recycling rate for plastic waste has been persistently low over the past few years, it is imperative to develop new strategies and approaches to shift the current *cradle-to-grave* consumption pattern of plastics to a more environmental friendly and sustainable *cradle-to-cradle* material cycle. The fundamental redesign and innovation of materials, formats, delivery models and after-use systems are required.⁴ This calls for a new way of thinking about the production, use and recovery of plastics as an effective material flow, aligned with the principles of the circular economy. The aim is to harness the benefits of plastics while addressing its drawbacks, so as to deliver drastically better system-wide economic and environmental outcomes.

SCOPE OF RFP

10. This RFP is a directed call for R&D⁵ proposals focusing on reducing the use of plastics, and making plastics more reusable and easier to recycle. Awarded proposals will receive funding support from NEA.

11. Proposals are sought for the following desired Outcomes. Applicants may submit one or more proposal(s), each of which to address one or more of these Outcomes.

General Use

Outcome A: To develop solution(s) which minimise the use of plastic while retaining the functional effectiveness of the material(s) for their intended application(s). The solution(s) shall exclude:

- merely substituting plastic with another compound(s); and
- merely reducing the amount of plastics used without any form of R&D.

⁴ The New Plastics Economy Catalysing Action, Ellen MacArthur Foundation.

⁵ Research and development activities, for the purposes of this RFP, refers to systematic, investigative or experimental activities that involve innovation and are carried out for the purpose of creating new or improved materials and products.

Outcome B: To develop solution(s) to process plastic waste, which is hitherto hard to recycle or reuse due to degradation in properties or mixing with other wastes, into high-value material(s) or product(s) of demand in Singapore and/or overseas. The Proposal shall include an explanation of why the demand for the processed material(s) or product(s) would be substantial enough for a sizeable volume of plastic wastes to be used. The solution(s) shall exclude:

- Mechanical sorting and segregation of plastic waste for recycling, sale or export.

Packaging Use

Outcome C: To develop plastic packaging material(s) that facilitate easy recycling using prevailing method(s). These may include, but are not limited to, mono-material⁶ packaging to replace the multi-material packaging with equivalent or better functionalities; compatible barrier materials; and adhesives that facilitate the separation of multi-material packaging. If modification(s) to prevailing recycling method(s) is/are required, the Proposal shall include details of such modification(s) and how it/they can be achieved at reasonably low cost and effort. The outcome plastic material(s) to be targeted shall exclude:

- Biodegradable⁷ materials;
- Oxo-biodegradable⁸ materials; and
- Compostable⁹ materials.

Outcome D: To develop cost-efficient solution(s) to separate flexible plastic packaging/multi-material packaging, of which plastic material is a key component, into its respective components, so as to facilitate

⁶ A material containing only one polymer (such as polyethylene). The use of small amounts of benign additives (such as removable coatings) is acceptable.

⁷ Biodegradable plastic is a plastic that can be broken down into its constituent monomers and metabolised through the action of naturally occurring micro-organisms, such as bacteria and fungi, over a period of time. Biodegradation refers to biochemical processes during which naturally occurring micro-organisms in the environment, convert the polymer into substances such as water, carbon dioxide and biomass.

⁸ Oxo-degradable plastics are made of conventional petroleum-based polymers (such as PE, PET, PP, PS and sometimes also polyvinylchloride, or PVC) to which an additive has been added (usually a transition metal compound), that accelerates their degradation when exposed to heat and/or light. The 'oxo-degradable' additives are typically incorporated into these conventional plastics as at the moment of conversion into final products.

⁹ Compostable plastic is one that is 'capable of undergoing biological decomposition in a compost site, such that the plastic is not visually distinguishable and breaks down to carbon dioxide, water, inorganic compounds, and biomass, at a rate consistent with known compostable materials (e.g. cellulose), and leaves no toxic residue.

the further recycling of these separated components. The solution(s) shall exclude:

- merely making commercially available solution(s) more cost-efficient without any research and development.

For Outcomes A and B

12. The resultant material(s) should preferably be recyclable in a technically feasible and economically viable way, without prohibitively high costs of pre-processing or material separation. If it were to contain any additive(s), the additive(s) should be benign¹⁰ to the recycling process (such as removable coatings), as well as to human beings and the environment.

For Outcomes A, B, C and D

13. The proposed processes should not result in significant environmental impact, whether in terms of water and energy consumption, raw material inputs, waste generation, emissions or pollution.

14. Applicants should ensure that project submissions are of interest and relevance to the local industry. As the early engagement of end-users of technologies during the R&D stage would facilitate and accelerate technology deployment and commercialisation, proposals with industry collaborators and commitments in the form of industry spending will be viewed favourably.

PROPOSAL REQUIREMENTS AND SUBMISSION

15. All Proposals submitted for the RFP shall include but shall not be limited to the following information:

- a) Detailed description of the research objective, scope and the scientific principles of the proposed technology;
- b) Details of the proposed technology such as chemical and physical properties of the material(s), processes involved, and their advantages over prevailing material(s) and/or technologies;
- c) Technology readiness level (TRL) of the project and key challenges to overcome (See Annex 1 for TRL definitions). Proposals with TRL of less than 5 should include plans for the development and demonstration of prototypes of the technologies proposed;
- d) Examples of market demand for the solutions developed;

¹⁰ Benign refers to a material or additive that has no negative impact on a recycling process. This could mean that any additives or part of the material that is not compatible with the process can be separated and recovered prior to it at a reasonably low cost; and should also not be, or transform into, any substance of concern.

- e) Information on how the requirements in the “Scope of RFP” (paragraphs 10 to 14) are to be fulfilled;
- f) Experimental or real world data or references as supporting documents;
- g) Project deliverables and timeline showing the milestones to be achieved and how the achievement of these milestones is determined;
- h) Proposed budget and payment schedule with justifications;
- i) Plans on translating the research to pilot, demonstration-scale and to eventual commercialisation;
- j) Research capabilities and relevance of project team members; and
- k) Indication of all in-kind services, funding, and tangible contributions by industry partners or any other partners towards the proposed project. In-kind services include labour, materials, and other services such as loaning of facilities and space.

16. The applicant shall recommend at least three (3) independent international expert reviewers in the RFP submission. The peer review process forms part of the project evaluation process to evaluate the scientific merits and international competitiveness of the proposals in this RFP call.

PROJECT DURATION AND SCHEDULE

17. The project duration shall not exceed three (3) years, from initiation through to the submission of the final project report. The proposed project schedule shall include major milestones, phases and timeline for submission of intermediate progress as well as final reports.

18. The Proposal shall state the key performance indicators used to evaluate the progress of the project. The Proposal shall also explain how the achievement of the major milestones and phases are to be evaluated and determined.

ELIGIBILITY AND FUNDING SUPPORT

19. This RFP is extended to all Institutes of Higher Learning (IHLs), public sector agencies, Singapore-registered companies and research organisations. The RFP is to support R&D work carried out in Singapore.

20. Successful Proposers that are IHLs, public sector agencies and not-for-profit organisations may qualify for up to 100% funding support for approved qualifying direct cost items.¹¹

¹¹ Please refer to the document “Instructions and Templates for Applicants” for the guidelines on qualifying direct cost items.

21. Singapore-registered companies and for-profit organisations may qualify for up to 70% of the approved direct qualifying costs. Only IHLs, public sector agencies and not-for-profit entities would be allowed funding support for Indirect Costs.¹² The Indirect Cost items include Overheads (up to 20% of approved qualifying direct costs excluding exceptional items¹³).

EVALUATION CRITERIA

22. Proposals will be evaluated against the following criteria:

S/N	Evaluation Criterion	Weightage (%)
1	Sustainable waste management solution for Singapore	35
2	Technological competency and manpower capability building	25
3	Value for money	25
4	Execution capabilities	10
5	Potential for other market applications	5
Total Score		100

CONTACT

23. The contact point for enquiries on the submission of project proposals and matters pertaining to this RFP are:

Ms Chia Hong Ling

DID: 6731 9528

Email: Chia_hong_ling@nea.gov.sg

Dr Mao Taohong

DID: 6731 9086

Email: Mao_taohong@nea.gov.sg

Office Hours: 8.30am to 5.30pm, Monday to Friday (Singapore time)

24. Applicants are to refer to submission instructions Integrated Grants Management System (IGMS) at <https://researchgrant.gov.sg> as the primary source of information. All information will also be made available at <https://www.nea.gov.sg/grants-awards/closing-the-waste-loop-initiative>.

¹² Indirect costs in research are those 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, utilities), and not through the actual performance of activities under the sponsored research projects.

³ Exceptional items are research scholarships.

25. For companies that do not have company accounts in IGMS, please provide the details and information (per Annex 2) to the above contact point for account registration early. Account creation may take 5-10 working days and late applications due to account registration will not be entertained.

26. Successful proposals will be notified in writing by Dec 2018.

Annex 1: Description of Technology Readiness Levels (TRL) 1 to 9

TRL	1	2	3	4	5	6	7	8	9
TRL	Basic principles observed and reported	Technology concept and/or application formulated	Analytical and experimental critical function and/or characteristic proof of concept	Component and/or breadboard validation in laboratory environment	Component and/or breadboard validation in relevant environment	System/subsystem model or prototype demonstration in a relevant environment	System prototype demonstration in an operational environment	Actual system completed and qualified through test and demonstration	Actual system proven through successful mission operations
Description	Lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties.	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.	Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high-fidelity" laboratory integration of components.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation (DT&E) of the system in its intended weapon system to determine if it meets design specifications.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation (OT&E). Examples include using the system under operational mission conditions.

Source: US Department of Defence, Technology Readiness Assessment (TRA) Guidance, April 2011

Annex 2: Registration details for Company

Step 1:

The NEA which is the **Programme Office (PO)** will require the following information to initiate the registration process with RGO.

Details of the New Company to be Created in IGMS

- **Full Name of Company:**
- **Local Company / Foreign Company:**
- **Public Company / Private Company:**
- **UEN (for Local Company) / Unique Identifier (for Foreign Company):**

Step 2:

Once RGO has created the **new** company in IGMS, RGO will notify NEA and NEA will then proceed to follow-up with the **new** company for the nomination and registration of the **Host Institute(HI) Admin** in IGMS.

Creation of Users for “Local” Companies

For new “Local” companies, the following steps will need to be done at the company:

- (1) The company will need to nominate a **HI Admin**.
- (2) The **HI Admin** will need to ensure that his/her **CorpPass** account has been setup.
- (3) 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.
- (4) After the **HI Admin** has been successfully registered in IGMS, the **HI Admin** will notify the PO with the information below, who will then e-mail to NRF_IGMS@nrf.gov.sg (and Cc the NRF Directorate responsible for the PO), so that RGO can change the role of the person from a **Principal Investigator (PI)** to a **HI Admin**:
 - **Full Name of HI Admin:**
 - **E-mail Address of HI Admin:**
 - **Designation of HI Admin in his/her company:**

The PO will be accountable for the creation of the **new** HI Admin in IGMS. The NRF Directorate responsible for the PO will need to be in the **Cc** loop for this e-mail request, and highlight to RGO if there are any issues.

- (5) Once the person has been changed from a **Principal Investigator (PI)** to a **HI Admin**, RGO will inform the **PO** and **Cc** the **NRF Directorate**.
- (6) 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.

*Note: Currently, **foreign** companies without a local UEN are still not eligible for CorpPass. This will only be available in the later part of 2018. Thus, in the meantime, below are the tentative procedures for the registration of **foreign** companies’ users in IGMS:*

Creation of Users for “Foreign” Companies

For new “Foreign” companies, the following steps will need to be done at the company:

- (1) All users from the company (i.e. **HI Admin, DOR, ORE, PI**) will “**Register**” themselves in IGMS, with reference to the bottom of the “**Custom Login**” section.
- (2) After all the users have been successfully registered in IGMS, the **HI Admin** will notify the **PO** with the information below, who will then e-mail to NRF_IGMS@nrf.gov.sg (and **Cc** the NRF Directorate responsible for the PO), so that RGO can **add** all the users, **tag** them to their foreign company, and **assign** the correct roles to all the users inside IGMS:
 - a. Full Name of **HI Admin**:
 - b. E-mail Address of **HI Admin**:
 - c. Designation of **HI Admin** in his/her company:
 - d. Full Name of **DOR**:
 - e. E-mail Address of **DOR**:
 - f. Designation of **DOR** in his/her company:
 - g. Full Name of **ORE**:
 - h. E-mail Address of **ORE**:
 - i. Full Name of **PI/s**:
 - j. E-mail Address of **PI/s**:
- (3) Once the above **Foreign Company users** have been added, tagged and assigned in IGMS, RGO will inform the **PO** and **Cc** the **NRF Directorate**.
- (4) All the **Foreign Company users** can then proceed to login to IGMS via the “**Custom Login**” section.
- (5) **Note:** The **HI Admin** in the foreign companies cannot add a new user. However, the **HI Admin** in the foreign companies can change the role of a user, or, delete an existing user in his/her company.