



Annual Report 2021



International Space Exploration Coordination Group – ISECG

ISECG was established in response to the “The Global Exploration Strategy: The Framework for Coordination” (GES) which was released in May 2007. This GES Framework Document articulated a shared vision of coordinated human and robotic space exploration focused on solar system destinations where humans may one day live and work.

The purpose of ISECG is to provide a forum to discuss interests, objectives and plans in space exploration and to support promotion of interest and engagement in space exploration activities throughout society. The work of ISECG results in documents, papers, findings, and recommendations that are critical in informing individual agency decision making. In 2020-2021, ISECG’s membership increased by seven, to 27 organisations, demonstrating the increasing global importance of space exploration.

INTERNATIONAL SPACE EXPLORATION COORDINATION GROUP

ISECG Secretariat

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All ISECG documents and information can be found on:

<http://www.globalspaceexploration.org/>

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1 Executive Summary

During 2021 global interest in space exploration has further grown and ISECG membership has expanded to 27 agencies. Many of these space agencies have renewed their focus on the exploration of the Moon.

Following the 'Supplement August 2020' to the Global Exploration Roadmap (GER), ISECG has developed a corresponding lunar surface concept of operations (CONOPS) for ISECG's lunar surface exploration scenario. The CONOPS undertaking resulted in desired functional allocations for each of the surface elements along with a summary of findings. This work was presented at the 72nd International Astronautical Congress IAC 2021 in Dubai, UAE.

In the area of advanced technologies, 2021 was highlighted by the completion of the In-situ Resource Utilisation (ISRU) Gap Assessment Report. The gap analysis was informed by the GER mission scenario and identified the assessment of 'Autonomous Systems', 'ISRU', and 'Nuclear Power and Propulsion (NPP)'. It revealed opportunities for international coordination and cooperation, along with specific recommendations for closing the identified gaps. Furthermore, synergies were identified between applications in missions journeying to the Moon and to Mars. The results of the ISRU gap analysis in particular was presented at Luxembourg's Space Resources Week, and at the Space Resources Roundtable (SRR/PTMSS)¹.

In 2021 ISECG formed the Engagement Tiger Team initiative about 'Public Engagement in Future Lunar Exploration'. The benefits associated with lunar exploration, International collaboration and the value to humanity were key messages.

Space agencies consider the work of ISECG supportive of their own national priorities, and during 2021 the Commercial Working Group and Emerging Space Agencies Working Group were formed. These were consistent with the desire by member Agencies to engage in focused international strategic exchange on commercialization opportunities and coordination to build new strategic partnerships especially with new emerging space Agencies.

ISECG agencies welcomed six new members in 2020 and a further new Agency in 2021:

- New Zealand Space Agency NZSA

The ISECG published four webnews articles in 2021, addressing the following topics:

- New members joined ISECG Mexico (AEM) and Portugal (PTS)
- Publication of the "ISECG Annual Report 2020"
- New Member joined New Zealand (NZSA)
- ISECG Senior Agency Managers meeting to advance coordination in Moon and Mars exploration

¹ Jointly hosted by the Canadian Metals & Minerals Plan Secretariat, and the Colorado School of Mines.

2 Highlights, Achievements and Special Projects in 2021 Update

Lunar Surface Exploration Scenario Concept of Operations

Following the 'Supplement August 2020' to the Global Exploration Roadmap (GER), ISECG has developed a corresponding lunar surface concept of operations (CONOPS) for the lunar surface exploration scenario. The CONOPS development focused on Phase 1 and Phase 2A of the lunar surface exploration scenario, as the ISECG has emphasized near-term missions and activities to understand potential collaboration opportunities, while continuing to study future pathways. The CONOPS has driven discussions on operational trade-offs and assumptions for the various surface elements based upon a set of ground rules and assumptions. Representative contingency scenarios were also evaluated within the CONOPS effort. The CONOPS undertaking resulted in desired functional allocations for each of the surface elements along with a summary of findings. For more details on the effort, refer to IAC-21-A5-1-5 "Lunar Surface, Concept of Operations for the Global Exploration Roadmap Lunar Surface Exploration Scenario".

Technology and Gap Assessment Analysis

In the area of advanced technologies, 2021 was highlighted by the completion of the ISRU Gap Assessment, and the thorough report released. Detailed gap analysis activities focused upon the assessment of 'Autonomous Systems', 'In-situ Resource Utilisation (ISRU)', and 'Nuclear Power and Propulsion (NPP)'. Technology gaps identified were related to, but not limited by, the current GER mission scenario. It revealed opportunities for international coordination and cooperation, along with specific recommendations for closing the identified gaps. Furthermore, the gap closure analyses also considered synergies between applications in missions to the Moon and to Mars.

The gap assessment analysis on 'Autonomous Systems' focused on various topics, including Vehicle Autonomy, Crew Autonomy, Crew Health and Performance Autonomy, Food Production, Robotic Caretakers and Stowage Management. The 'Autonomous Systems' report was published on the ISECG Advanced Technologies webpage.

The analysis of ISRU technologies focused on identification of Strategic Knowledge Gaps (SKGs), assessment of key ISRU domains, along with their associated crosscutting challenges, opportunities for partnership, and private sector involvement. Key ISRU domains include, among others, in-situ propellant and consumable production, in-situ construction, and in-space manufacturing. This ISRU gap assessment report was completed in April 2021, and released on the ISECG website.

With this completed milestone, the results of the ISRU gap analysis was subsequently presented successfully at Luxembourg's Space Resources Week, and at the Space Resources Roundtable (SRR/PTMSS)².

The TWG's gap assessment in the area of 'Nuclear Power and Propulsion' progressed throughout the year and will unlock key power and propulsion solutions for the exploration of the Moon, Mars, and beyond. This report is set for completion in 2022.

Engagement Tiger Team

In 2021, 12 Agencies came together to form the Engagement Tiger Team initiative about 'Public Engagement in Future Lunar Exploration'. The Tiger Team supported by the SCWG, proposed key messages related to benefits associated with lunar exploration including the benefits for

² Jointly hosted by the Canadian Metals & Minerals Plan Secretariat, and the Colorado School of Mines.

International Agencies collaborating together to conduct space exploration, its value to humanity and the advantages of paving a future together in exploring the Moon and beyond. Outputs from the Engagement Tiger Team are available for inclusion into the GER.

3 Outlook for 2022

ISECG Working Groups

Exploration Roadmap Working Group (ERWG) and International Architecture Working Group (IAWG)

The ERWG and IAWG will focus on developing an update to the GER (2018) and GER Supplement (2020) in order to reflect advancements in agency plans and capture increased definition of ISECG lunar exploration scenarios. The working groups will target release of an updated lunar supplement in the late summer timeframe to support agency and government funding discussions. The IAWG will continue working on refinements to the IAWG products including the areas of objectives, concept of operations, and support technology gap assessments through lunar surface element description studies.

Technology Working Group (TWG)

In 2022, the TWG will continue to advocate coordination and collaboration in technology development efforts of individual ISECG space agencies in support of the updated GER per the GER Supplement of 2020.

In particular, the TWG will be completing the gap assessment analysis on Nuclear Power and Propulsion, including the following areas: Nuclear Thermal Propulsion, Fission Power for Surface Missions and Multi-MWe Nuclear Power for Electric Propulsion. The completed gap assessment reports are planned to be released in the Spring/Summer 2022 time frame.

Following the NASA TABs categorization mapping to the new NASA Taxonomy 2020 architecture, the TWG will be working on updating their GER Critical Technologies and agency technologies mapping to this new taxonomy. The TWG will also continue to advance the high-level analysis of the overall technology portfolio, to identify key areas of collaboration and significant technology gaps in the context of the GER.

Strategic Communications Working Group (SCWG)

The SCWG will continue to implement and coordinate communication of the ISECG work, its products and activities. A major activity in 2021 was the Tiger Team initiative about 'Public Engagement in Future Lunar Exploration'. The Tiger Team Engagement activity gathered key messages related to benefits associated with lunar exploration, and in particular related to the GER Supplement. It also captured lessons learned from communication to the broad public and how we might utilise social media and its growth. The Tiger Team having achieved its objectives has been invited to continue with the SCWG under a combined meeting format. Further activities of the SCWG will comprise the publication of ISECG news and milestones through its webnews, as appropriate, and the preparation of the ISECG Annual Report 2022. Furthermore, the SCWG will support ISECG publications and ISECG contributions to international conferences especially in 2022, ISECG's 15th Anniversary. With advice from the Engagement Tiger Team, the SCWG is also looking to leverage wider ISECG messages through space media interviews and social media channels to reach out to a wider audience of space professionals in both space developed and emerging space agencies, plus reaching further into a growing interested space aware public, especially within the younger generations.

Science Working Group (SWG)

To aid inclusion of scientific goals and objectives into the ISECG community, the SWG is expected to re-establish chairs and a community of agency scientists in 2022. The SWG talents will assist with ensuring the proper alignment of updated ISECG products with the science community goals, including reviews of the new lunar supplement, science whitepapers and the ISECG Benefits documents.

Emerging Space Agencies Working Group (ESAWG)

The ESAWG was confirmed as an official ISECG Working Group in May 2021 after an emerging space agencies tiger team was established to consider methods to integrate small and large agency activities to further the accomplishment of space exploration and GER goals. In 2021, the ESAWG organized monthly telecons to share on each agency's activities and WG's vision and supported presentation and/or plenary sessions to promote emerging space countries' exploration activities and public awareness

The ESAWG will continue to accommodate needs and perspectives of emerging space agencies in ISECG activities and establish networking with non-member emerging agencies and relevant expert groups associated with emerging space countries.

The ESAWG will aim to formulate collaborative exploration projects by coordinating with other ISECG WGs and exchanging new ideas and methods to promote collaboration among emerging agencies and with established agencies.

Commercialization Working Group (CWG)

The CWG was formed in September 2021 with a focus on identifying new pathways that Government Space Agencies can engage with private space sector stakeholders. The members of the CWG range from emerging to well established space agencies, allowing a wide breadth of experience, knowledge as well as different perspectives to be applied to new space age where space exploration will see contributions from both public and private sectors.

The CWG will aim to explore and define collaboration mechanisms, policy tools, procurement approaches, legal framework etc., that are required to facilitate the emergence of public-private partnerships.

Major International Events Related to Space Exploration

Underlined events will include ISECG presentations. (Status April 2022)

NOTE: Changes of dates are possible due to the Corona virus pandemic

- **37th Space Symposium**
Colorado Springs/USA, 4th-7th April 2022
 - **Global Conference on Space for Emerging Countries (GLEC 2022)**
Quito, Ecuador, 16-20th May 2022
 - **73rd International Astronautical Congress (IAC)**
Paris FRANCE, 18-22nd September. 2022
 - **74th International Astronautical Congress (IAC)**
Baku, Azerbaijan, 2-6th October 2023
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Annex I

Publications

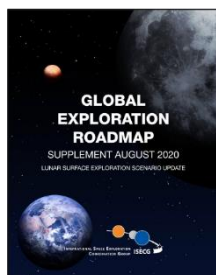
ISECG Webnews 2021

- New members joined ISECG Mexico (AEM) and Portugal (PTS)
- Publication of the "ISECG Annual Report 2020"
- New Member joined New Zealand (NZSA)
- ISECG Senior Agency Managers meeting to advance coordination in Moon and Mars exploration

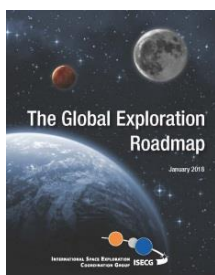
ISECG Publications 2021

- IAC-21-A5-1-5 "Lunar Surface, Concept of Operations for the Global Exploration Roadmap Lunar Surface Exploration Scenario"

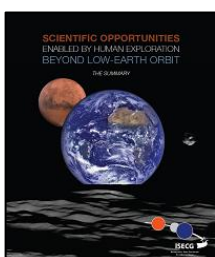
Major ISECG Documents



[Global Exploration Roadmap, Supplement August 2020 – Lunar Surface Exploration Scenario Update](#)

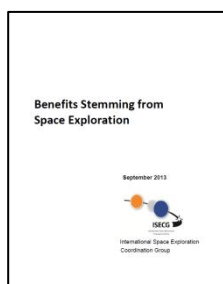


[The Global Exploration Roadmap \(GER\), January 2018](#)



[Scientific Opportunities enabled by Human Exploration beyond Low Earth Orbit – The Summary](#) (summary version)

[Scientific Opportunities enabled by Human Exploration beyond Low Earth Orbit – A ISECG Science White Paper](#) (full version)



[Benefits Stemming from Space Exploration](#)



[ISECG Terms of Reference](#)
















More ISECG documents and published papers
can be found at [ISECG Publications](#).






Annex II

ISECG Members (status of March 2022)

ISECG AGENCIES WORLD MAP



Australia		Australian Space Agency (ASA)
		Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Brazil		Agência Espacial Brasileira (AEB)
Canada		Canadian Space Agency (CSA)
China		China National Space Administration (CNSA)
Europe		European Space Agency (ESA)
France		Centre National d'Études Spatiales (CNES)
Germany		German Aerospace Center (DLR)
India		Indian Space Research Organisation (ISRO)
Italy		Agenzia Spaziale Italiana (ASI)
Japan		Japan Aerospace Exploration Agency (JAXA)
Luxembourg		Luxembourg Space Agency (LSA)
Mexico		Agencia Espacial Mexicana (AEM)
Norway		Norwegian Space Agency (NOSA)
New Zealand		New Zealand Space Agency (NZSA)

Poland		Polish Space Agency (POLSA)
Portugal		Portugal Space (PT Space)
Republic of Korea		Korea Aerospace Research Institute (KARI)
Romania		Romanian Space Agency (ROSA)
Russia		State Space Corporation (Roscosmos)
Switzerland		Swiss Space Office (SSO)
Thailand		Geo-informatics and Space Technology Development Agency (GISTDA)
Ukraine		State Space Agency of Ukraine (SSAU)
United Arab Emirates		United Arab Emirates Space Agency (UAE Space Agency)
United Kingdom		United Kingdom Space Agency (UKSA)
USA		National Aeronautics and Space Administration (NASA)
Vietnam		Vietnamese National Space Center (VNSC)

Annex III

ISECG Working Groups

ISECG Working Groups

Exploration Roadmap Working Group (ERWG)

The ERWG leads the human spaceflight road-mapping effort, which is intended to establish a common roadmap, and common framework to promote partnerships in realising exploration missions. A summary of their work is communicated in regular updates of the GER.

International Architecture Working Group (IAWG)

The IAWG leads multilateral reference architecture work, develops shared requirements, identifies critical functions and technologies and shares innovative architectural concepts. The IAWG is currently building concepts to augment the GER mission scenario, focusing specifically on characterising human missions to the lunar surface based on robust international partner contributions.

Strategic Communications Working Group (SCWG)

The objectives of the SCWG are to provide a clear, consistent and coordinated communication of the ISECG mandate, its products and activities, to support the development of ISECG products, as well as to support the exchange amongst members on stakeholder engagement activities. Major activities of the SCWG include the development of ISECG webnews, the preparation of the ISECG Annual Report and the facilitation of topical exchanges amongst members. The SCWG is fostering an exchange on lessons learned and best practices among ISECG members in communicating and delivering benefits resulting from investments in space exploration.

Science Working Group (SWG)

The Science Working Group coordinates with the international science communities on exploration planning and activities as required for the generation of ISECG products. Through the development of the Science White Paper, the SWG has established a Science Advisory Group, developed links into the global science community and coordinated activities with relevant science organisations. The SWG will continue to do so, recognising the strong role of science and the scientific opportunities in future exploration efforts.

Technology Working Group (TWG)

The goal of the Technology Working Group is to identify and raise awareness on critical technology gaps related to the GER, and to advocate coordination and collaboration in technology development efforts of individual ISECG members in support of the GER. The strategic nature of technology investments and the desire of members to focus investments to maximise their contribution potential while enabling meaningful and achievable opportunities for all participating ISECG members must hereby be recognised.

Commercial Working Group (CWG)

The CWG will focus on identifying new pathways that Government Space Agencies can engage with private space sector stakeholders. The members of the CWG range from emerging to well established Space Agencies, allowing a wide breadth of experience, knowledge as well as different perspectives to be applied to new space age where space exploration will see contributions from both public and private sectors.

Emerging Space Agencies Working Group (ESAWG)

The ESAWG will consider methods to integrate small and large agency activities to further the accomplishment of space exploration and GER goals. The ESAWG will aim to formulate collaborative exploration projects by coordinating with other ISECG WGs and exchanging new ideas and methods to promote collaboration among emerging agencies and with established agencies.

Annex IV

ISECG at a Glance: Scope and Background

ISECG, the International Space Exploration Coordination Group serves as the forum where space agencies work together on means of strengthening individual exploration programs, facilitating collaborations and advancing the Global Exploration Strategy (GES) through the coordination of participating members' mutual efforts in space exploration. ISECG also supports promoting interest and engagement in space exploration activities throughout society. By the end of 2020, ISECG membership counted 27 government organisations responsible for space activities³.

The **scope of ISECG** is broad and strategic. Its activities are based on the following **principles**:

- Open and inclusive
 - ISECG receives inputs from all interested space agencies that invest in and perform space exploration activities.
 - ISECG provides for consultations among all agencies with a vested interest in space exploration.
- Flexible and evolutionary
 - Existing consultation and coordination mechanisms are taken into account.
- Effective
 - ISECG workshops and products provide value to individual participating members.
- Of mutual interest
 - ISECG activities benefit all participants and respect national prerogatives.
 - ISECG activities allow for optional participation based on the level of interest.
 - ISECG participants focus on developing non-binding products - findings, recommendations and other outputs as necessary – based on consensus.

Background

In May 2007, an initial group of 14 space agencies jointly released “[The Global Exploration Strategy: The Framework for Coordination](#)”. It describes a shared vision of coordinated human and robotic space exploration focused on solar system destinations where humans may one day live and work.

The GES identifies a common set of **exploration themes and benefits**:

- New knowledge in science and technology
- A sustained presence – extending human frontiers
- Economic expansion
- A global partnership
- Inspiration and education

One of the many Framework document findings was the need to facilitate information exchange among individual agencies regarding their interests, plans and activities in space exploration. Therefore, the GES called for a voluntary, non-binding coordination mechanism among interested space agencies. This call led to the establishment of **ISECG** by the participating agencies including the formulation of [Terms of Reference](#) (ToR).

³ In alphabetical order: AEB (Brazil), AEM (Mexico), ASA and CSIRO (Australia), ASI (Italy), CNES (France), CNSA (China), CSA (Canada), DLR (Germany), ESA (European Space Agency), GISTDA (Thailand), ISRO (India), JAXA (Japan), KARI (Republic of Korea), LSA (Luxembourg), NASA (United States of America), NOSA (Norway), NZSA (New Zealand), POLSA (Poland), PT Space (Portugal), ROSA (Romania), Roscosmos (Russia), SSAU (Ukraine), SSO (Switzerland), UAE Space Agency (United Arab Emirates), UK Space Agency (United Kingdom) and VNSC (Vietnam).