Lunar Innovation Park – Initial Surface Infrastructure to Kickstart a Space Resource Based Economy

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ABSTRACT

Executive Order 14369 "Ensuring American Space Superiority" (White House 2025) was signed by the White House in December of 2025 and calls upon the United States of America (USA) to "pursue a space policy that will extend the reach of human discovery, secure the Nation's vital economic and security interests, unleash commercial development, and lay the foundation for a new space age." The Executive Order (EO) identifies several key priorities including: returning humans to the Moon by 2028; laying the foundations for lunar economic development; fostering economic growth in American space markets; and establishing initial elements of a permanent lunar outpost by 2030. Based upon previous national guidance and NASA's Moon to Mars Objectives (NASA 2023), it is expected that a significant portion of a robust and sustainable lunar economy will be based on large-scale In Situ Resource Utilization (ISRU) for the production and sale of commodities and feedstock for construction and manufacturing. Such large-scale ISRU operations are only possible with supporting infrastructure and services to facilitate production and distribution of products. While organizations like NASA, Defense Advanced Research Projects Agency (DARPA), and the NASA Lunar Surface Innovation Consortium (LSIC) have worked to chart a course to a lunar resource-based economy, a clear path with practical implementation has yet to emerge.

Other space-capable nations are beginning to rapidly establish themselves in cislunar space and compete for space resources and territory. These nations are pursuing space with the expectation that these activities will lead to significant economic benefit and have the potential to tip the balance of national power in their favor. The solar system's resources are the key to humanity's future and if in-situ resources and advanced technologies are used, then rapid bootstrapping can radically accelerate a solar system economy with vast potential (Metzger et al. 2013). The US space industry and venture capitalists are also investing significant time and resources to develop technologies, systems, and define architectures towards the creation of a lunar resource-based economy. Some commercial entities aim to produce and sell lunar ISRU-based commodities such as propellant, water, oxygen, Helium-3, and feedstock for manufacturing and construction. Other companies aim to provide services in support of a cislunar space ecosystem including power, communications, mobility and logistics. However,

many potential investors with similar ambitions remain on the sidelines waiting for NASA to initiate a formal and lasting effort to capitalize on space resources with a realistically achievable near-term plan. Establishing Lunar surface infrastructure systems and operations are expected to have the biggest impact towards encouraging investments, enabling commercial operations and kickstarting a lunar economy.

This paper introduces the Lunar Innovation Park (Park) - a concept for establishing the minimum viable infrastructure needed to kickstart Lunar surface operations and commercial development. The Park is permanent co-located infrastructure built up over a series of Commercial Lunar Payload Service (CLPS) scale missions and uses existing and emerging NASA and industry technologies to make the Park feasible in the near term. The first two missions could be completed perhaps in as soon as two years from initiation. The Park will reduce costs and risks for subsequent technology development missions and commercial operations by providing services such as: power, local and direct to Earth communications, Positioning, Navigation and Timing (PNT), robotic regolith manipulation, logistics, and perhaps most importantly, the ability to land spacecraft in extreme proximity within the Park. In addition, the Park will provide an opportunity for technology demonstration, maturation, and risk reduction that will enable future Artemis “Foundational Exploration” and “Sustained Lunar Evolution” segments and lower cost for long-duration science missions. Finally, the Park can play a significant role in addressing the USA Executive Order mandate to “lay the foundation for lunar economic development”, and “establish lunar infrastructure and standards that enable implementation of space priorities and a robust space industrial base”. The Park can be established in the time frame specified in the Executive Order. This basic infrastructure (Communications, PNT, Power, construction robots, precision landing beacons) reduces risk by providing ready services and enables commercial and international partner augmentation for added capability and experimentation.

INTRODUCTION

On December 18, 2025, the White House signed Executive Order 14369 “Ensuring American Space Superiority” (White House 2025) which calls upon the United States of America (USA) to “pursue a space policy that will extend the reach of human discovery, secure the Nation’s vital economic and security interests, unleash commercial development, and lay the foundation for a new space age”. The Executive Order (EO) shares and reemphasizes many of the same overarching goals presented in previous US policy and strategy documents (White House 2017; 2020a; 2020b; 2021; 2022; U.S. Congress 2015) including:

- Establishing a sustainable/enduring presence in space
- Lunar surface utilization and development
- Establishing a commercial space economy
- Industry and international partner collaboration

More importantly, the new EO provides a much-needed sense of urgency and sets clearly defined policy objectives and timelines. To this end the EO specifies a series of priorities including:

- Returning humans to the moon by 2028
- Laying the foundations for lunar economic development
- Fostering economic growth by attracting at least $50 billion of additional investments in American space markets by 2028
- Establishing initial elements of a permanent lunar outpost by 2030

NASA is currently amid executing the early phases of its Moon to Mars (M2M) plan to return humans to the Moon as part of the Artemis campaign while simultaneously charting a future for sustainable lunar exploration and sending humans on to Mars. This NASA M2M effort follows a "blueprint" for sustained human presence and exploration in space, summarized in the NASA Moon to Mars Strategy and Objectives Development document (NASA 2023). This strategy document includes a high-level value proposition that is supported by three pillars: Science, Inspiration, and National Posture, each with numerous stakeholder benefits (see Figure 1 taken from NASA 2023) and is well aligned with many of the EO goals. To date, NASA has put significant effort into pursuing its near-term science and exploration goals, contributing to two of the three pillars. *However, limited work has been done to develop a strategy to kick-start a commercial space economy as described in the M2M Objectives and directed in EO 14369.*

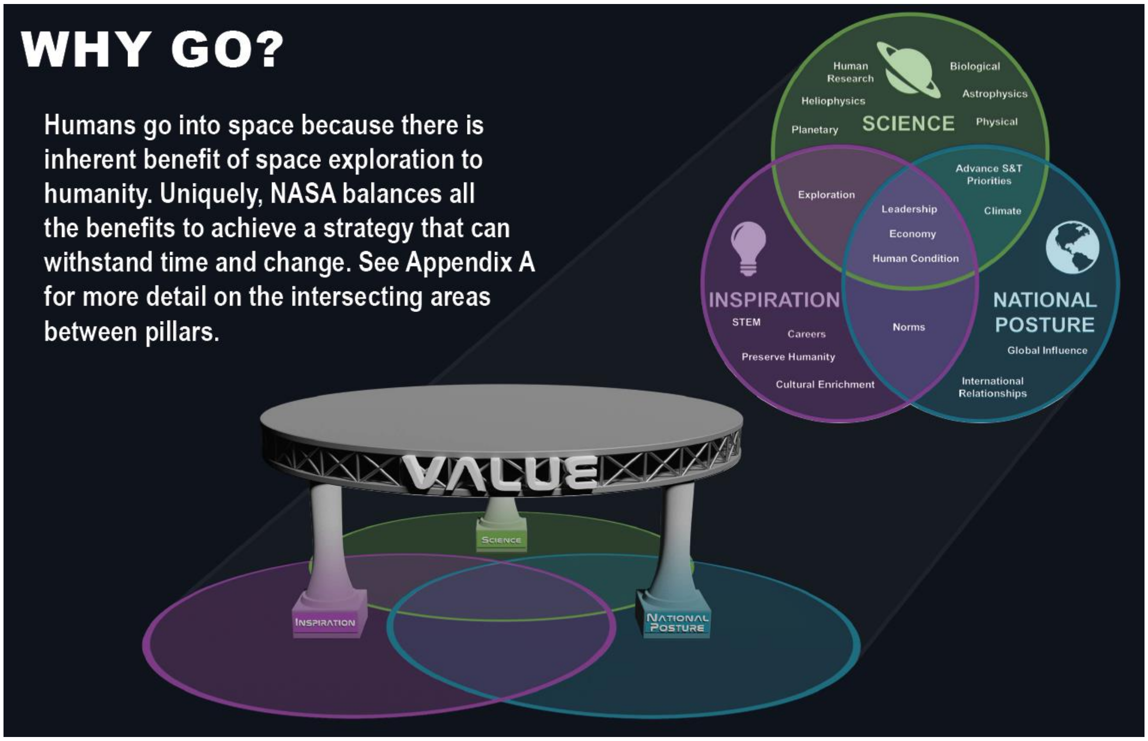

Figure 1. NASA's Moon to Mars value proposition.

This emerging space economy will be based on off-world resources, technologies, and services and is estimated by some to be worth up to $10T annually (Goswami et al. 2020). The

EO is also a clear response to the fact that other space-capable nations are beginning to rapidly establish themselves in cislunar space and compete for space resources and territory. These nations are pursuing space with the expectation that these activities will lead to significant economic benefit and have the potential to tip the balance of power in their favor (Goswami et al. 2020; Olson et al. 2022; USAF 2019; DIA 2022).

The US space industry and venture capitalists are also investing significant time and resources to develop technologies, systems, and define architectures towards the creation of a space resource-based economy (Carrio et al. 2024; Ximenes et al. 2024; Frank 2025; DARPA 2025; Metzger et al. 2013). In some instances, companies are pursuing their own privately funded lunar demonstrations and forming consortiums to accelerate the development of technologies and infrastructure to support their business aspirations. Many of these early commercial concepts aim to produce and sell lunar ISRU-based commodities such as cryogenic propellant, water, oxygen, Helium-3, and construction and manufacturing feedstocks. Other companies aim to provide services in support of a cislunar space ecosystem including power, communications, PNT, and mobility and logistics. A common theme across most if not all commercial concepts is the need for basic integrated lunar surface infrastructure. These basic infrastructure needs include:

- Power generation, storage, and distribution
- Communications, Position Navigation & Timing (PNT)
- Landing/Launch pads, roads and paths (routine access and surface mobility)
- Protective shelters and equipment storage facilities
- Surface logistics (payload offloading and manipulation)

Recognizing this growing demand for lunar surface infrastructure and its alignment with future Artemis objectives, a small multidisciplinary team of NASA technologists and subject matter experts has developed the Lunar Innovation Park concept that establishes the minimum viable infrastructure to kickstart sustained lunar surface operations and commercial activities.

The Park is a permanent surface infrastructure at a location of strategic importance on the Moon. Once established, it is readily reproducible at any location of strategic importance. It is designed to provide users with power, local and direct to Earth communications, prepared landing zones for routine safe access to the Park, and a protective shelter for surface assets. The Park also includes autonomous robotic systems for regolith manipulation, structural assembly, outfitting, limited logistics, and payload transportation.

The Park can be constructed over a series of five medium-scale (625 kg) CLPS missions to incrementally build up infrastructure and services. The Park uses existing and emerging NASA and industry technologies to make the Park feasible in the near term, perhaps as soon as two years from project start. Park construction and operations are accomplished using autonomous and tele-operated robotic systems and requires limited remote human intervention and supervision. The Park is enabling to the national goal of sustained human presence, but on-site human presence is not required. The Park can accommodate customers as soon as the first mission is completed. It is designed to support augmentation and expansion of capabilities and services to accommodate future growth for commercial-scale surface operations and human occupancy. It is envisioned that NASA, and the US government would leverage public-private-partnership models to establish the Park. The infrastructure and surface assets would be privately owned and operated, and NASA would serve as an anchor customer of Park services (Miller et al. 2015).

The Park provides NASA and industry with the core infrastructure and services needed to conduct continuous lunar surface operations; encourage and support technology development; build confidence in lunar surface infrastructure technologies and capabilities; and provide an ecosystem for collaboration and investment. In addition, the Park concept provides a valuable opportunity to accelerate the demonstration of infrastructure systems and surface operations for future Artemis Moon and Mars missions; establish interoperability standards and norms of operation; and reduce the cost and risk of future lunar science and technology demonstration missions and surface operations by providing customers access to proven resources and services. Finally, the Park can play a significant role in addressing the urgent EO call to "lay the foundation for lunar economic development", and "establish lunar infrastructure and standards that enable implementation of space priorities and a robust space industrial base". The Park can be built in the timeframe specified in the EO at relatively low cost with existing technology.

Early iterations of the Park concept were presented to NASA's Space Technology Mission Directorate leadership in February of 2025 which led to follow-on work to mature the Park concept presented herein. The Park concept has also served as the foundation for the NASA Lunar Surface Innovation Consortium (LSIC) Lunar Infrastructure Technology (LIT) campaign study (JHU-APL 2025). Conversations with numerous US space industry contacts and policy experts indicate strong interest and endorsement of the Park concept.

The remainder of this paper provides an overview of the Park concept starting with a summary of the design objectives, design approach, Park layout, and services. Then a Park build-up sequence is presented and each of the construction missions are described. Most results presented herein are derived from a Lunar Innovation Park architecture study conducted by the Compass study team at NASA Glenn Research Center (NASA 2026). Details related to site selection, infrastructure design and analysis, concepts of operations, and mission design and system studies, etc. are documented in accompanying Park publications (Gelino et al. 2026a; 2026b; 2026c) and will be referenced herein where appropriate.

LUNAR INNOVATION PARK OVERVIEW

Design objectives. The Park concept was designed to meet the following overall objectives:

1. Provide scalable power, communications and PNT to support the construction and operation of the Park and to support a limited number of science missions and/or commercial users
2. Provide power for lunar night survival for all landed assets and users

3. Enable extreme proximity landing (~20 m) near established Park surface assets to reduce complexity of Park construction, reduce electrical power cable mass and deployment distance, minimize Park footprint, and simplify logistics and access
4. Provide logistics services to deliver and manipulate small payloads, and support infrastructure assembly and outfitting
5. Construct an unpressurized shelter to provide radiation, thermal, meteorite protection to surface assets (e.g., rovers, computers, sensitive payloads)
6. Enable routine and repeated access to the Park
7. Use the Park construction and operations to demonstrate and mature foundational technologies needed for commercial-scale operations and future Artemis missions
8. Establish near-term momentum towards National objectives and commercial operations

Design approach. Once the Park objectives were defined, a series of Park layouts and construction missions were designed**.** The preliminary Park layouts were represented with simple sketches to workout infrastructure ideas, overall layout, and construction concepts of operations (ConOps). Then a series of medium-scale CLPS missions were defined, assuming 625-kg payload capacity available for the delivery of Park systems and construction equipment (e.g., vertical solar arrays and batteries, communications and PNT systems, robots for site preparation and infrastructure assembly, etc.). Basic Park systems and construction equipment mass and power requirements were included in this preliminary design process, based on existing and emerging technologies (i.e., technologies at TRL 4 - 9). Several design iterations were completed, taking inspiration from past work (Spudis et al. 2010; Sanders et al. 2024), and incorporated technical inputs from NASA technologist and SMEs to refine the concept before arriving at a preliminary Park concept. Once the preliminary Park concept was defined, a more rigorous mission design and feasibility analysis of the Park concept was completed in collaboration with the "Compass Lab" multi-disciplinary systems engineering team at NASA's Glenn Research Center. This Compass study compared different Park construction ConOps and sequences as a function of several metrics including landed mass, cost, efficiency, complexity, and risk. The study also traded Park layout versus individual Park elements and construction activities. For example, a major trade that influenced the overall Park layout was associated with landing pad and berm construction to enable close-proximity landing and positioning of power generation and storage assets. This was traded with the use of long high-voltage power cables for power grid construction and power distribution when landing assets with 1 km separation (a common assumption). The Compass study results included recommended Park layout, construction sequence and mission design, landed mass, mission duration, cost, and potential science and Artemis mission opportunities. These results will be provided in a future report (NASA 2026).

Lunar Innovation Park concept. A completed Park site layout derived from the Compass study is shown in Figure 2 with a soccer field to provide a sense of scale. One critical design feature is the use of close-proximity landing (~20 m) of Park surface assets to reduce complexity of Park construction, reduce electrical power cable mass and deployment distance for power grid construction, and simplify logistics and access. In addition, close-proximity landing of assets can minimize the surface area (footprint) of the Park in the highly constrained terrain of the lunar south pole region. The south polar region is dominated by steep slopes and shadowed craters, making relatively flat areas with high average solar illumination and Earth visibility extremely scarce and therefore valuable. The Park is constructed over a series of five medium-scale CLPS missions. The concept includes the following key infrastructure elements and assets:

- Two 5 kWe deployable and retractable Vertical Solar Array Technology (VSAT) with seven 125W inductive chargers
- 41 kWhr batteries to supply lunar night keep-alive power to all Park assets and additional Park customers
- Third Generation Partnership Project (3GPP) 5G communications, WiFi6 and dual band Direct to Earth (DTE) communications
- Two prepared single-use landing sites for medium-scale commercial and/or science landers (in addition to the sites prepared for Park construction landers)
- One reusable Landing and Launch Pad (LLP) for medium to large scale landers
- One unpressurized protective shelter for surface assets (6.2 m^3 internal volume). Includes power and communications
- Two NASA In Situ Resource Utilization (ISRU) Pilot Excavator (IPEx) systems for site survey, preparation, regolith manipulation, and surface system inspections via on-board cameras and sensors
- One multi-purpose robot, notionally called Construction Pilot Excavator (CPEx), for advanced site prep, construction and logistics support, and surface system inspections

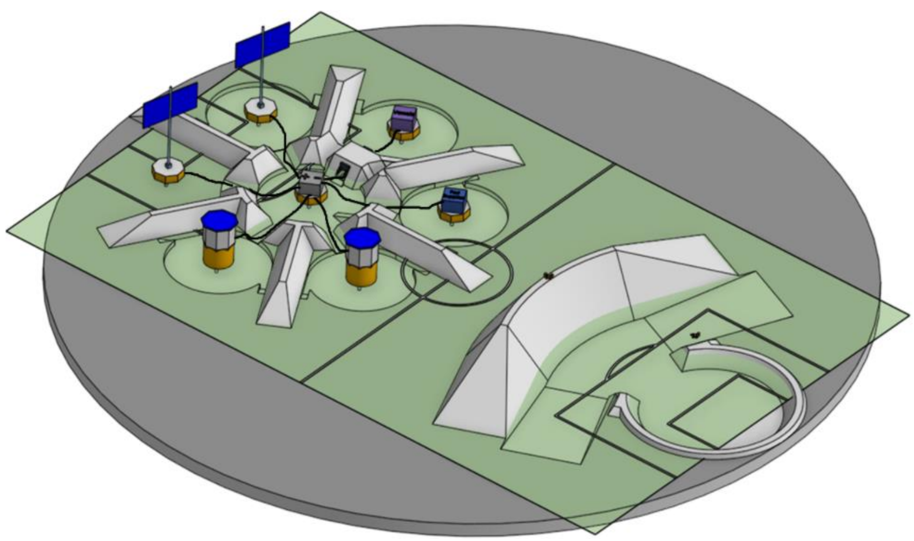

Figure 2. The Park after completion of five construction missions and two customer missions. A standard sized soccer field is included for scale.

LUNAR INNOVATION PARK MISSION SEQUENCE

Mission 1 – Establish a foothold with power, communications, and PNT. The objective of the first Lunar Innovation Park mission is to establish an initial foothold in a location of strategic importance on the lunar surface (see Figure 3). This first mission will provide permanent lunar infrastructure for power generation, storage, and distribution and include a 5-kWe VSAT system, a 10-kWhr battery, and three 125-W inductive wireless chargers to recharge surface rovers. This power system was sized to support continuous daytime operations of the lander-based systems along with three 40-kg-class rovers (e.g., IPEx or similarly sized science rovers and tech demos).

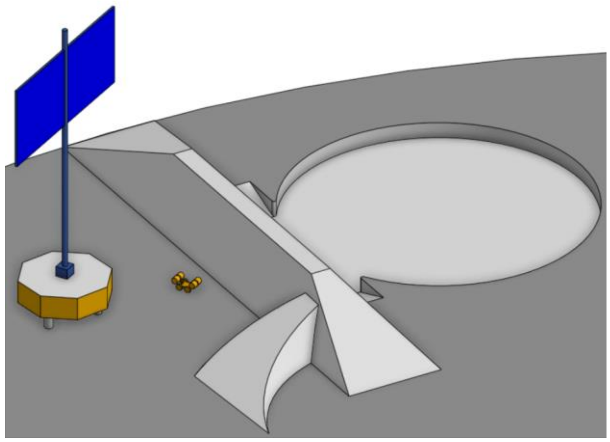

Figure 3. Mission 1 end state: 5-kWe VSAT power generation, 3GPP 5G/WiFi6 communications and PNT, and regolith berm and prepared landing area.

Power is sized for the lander systems and IPEx to survive the maximum period of continuous darkness at the location (e.g., nighttime). In addition, a dust tolerant power interface is included for future incorporation of the VSAT into a power grid (see Mission 3). The communications system includes 3GPP 5G 60-Mbps relay up to 10 km distance, WiFi6 short distance (<1 km) communications, S/Ka band for direct to Earth or Lunar Communications Relay and Navigation System (LCRNs) relay link. The lander will include a beacon that provides range, rate and bearing information to enable close-proximity landing of future landers – including precision capable landers by commercial firms, or by our international partners (for example, Japan, India, and Korea are all pursuing precision landing capability). The VSAT tower will also include lights and cameras for situational awareness. Mission 1 will deploy an ISRU Pilot Excavator (IPEx) system (Schuler et al. 2024) to perform hi-resolution topographical mapping and construct a landing area with bulk regolith berm in preparation for the next lander mission. The berm is designed to protect the first lander (with the VSAT retracted) from lander rocket engine plume surface impingement (PSI) ejecta from the second lander and enable close-proximity landing. Mission 1 operations and site construction will include many first-of-its-kind demonstrations including VSAT deployment and retraction, supervised autonomous site inspection, landing site preparation and regolith berm building operations, wireless charging, and verify the performance and lunar night survival of numerous critical infrastructure technologies. IPEx will exceed all off-world wheeled robotic mobility rate and distance records. It will move orders of magnitude more regolith than ever before on a scale commensurate with Earth-based civil engineered structures. In addition, IPEx operations will provide an important opportunity to gather data on regolith geotechnical properties such as bulk density and angle of repose, regolith interaction with IPEx wheels and excavation implements, dust loading, effects of repeated trafficking, and enable IPEx model validation and design enhancements.

Mission 2 – Provide system redundancy and power augmentation. The objectives of the second mission are to provide system redundancy and power augmentation. The lander manifest is identical to the first and includes a 5-kWe VSAT system, a 10-kWhr battery, and three additional 125-W inductive wireless chargers; redundant Earth communication links and a 60-Mbps 5G surface relay; and a second IPEx. Mission 2 is the first time that extreme proximity landing is attempted on the Moon. It will also be the first demonstration of bulk regolith berms as PSI mitigation. New PSI data will be obtained by imaging the landing event from cameras on the surface and witnessing berm erosion from ejecta impacts and plume impingement. Specifically, IPEx and VSAT mounted cameras will be in protected positions that allow video surveillance of lander 2's ejecta field. IPEx cameras can also be used to perform post landing visual inspections of the berm and landing area. Once landing and post-landing operations are complete, the two IPEx systems will work together to expand the Park footprint to include an extended regolith berm structure and prepared regolith landing site for the third lander (see Figure 4), demonstrating multi agent coordinated autonomous robotic operations.

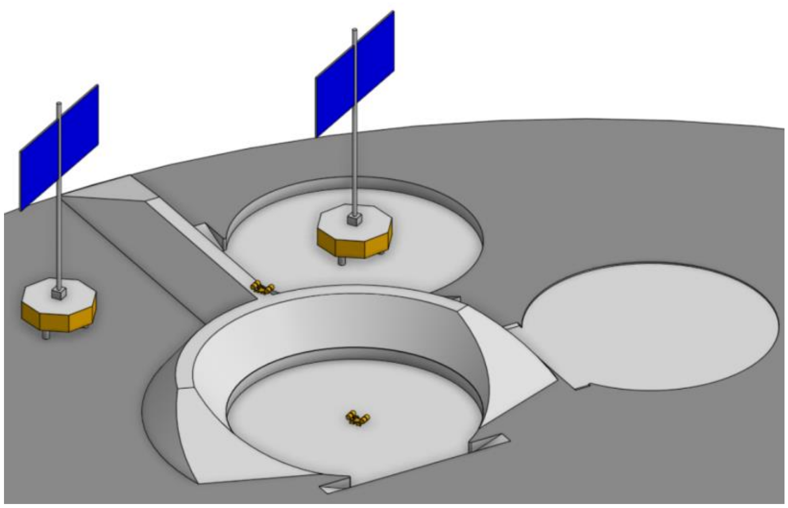

Figure 4. Mission 2 end state: 5-kWe VSAT power augmentation, redundant 3GPP/WiFi/DTE comms., PNT, and additional regolith berm and landing area.

Mission 3 – Expand power storage and commission the first lunar power grid. The objectives of the third mission are to increase energy storage with the addition of 21 kWh of batteries; deploy CPEx to assist in construction and logistics operations; commission the first lunar power grid; and expand the Park footprint to include additional landing sites for two more landers (see Figure 5). The lunar power grid will be established by connecting the two VSATs, batteries on board the three landers, and the Power Management and Distribution (PMAD) systems resulting in a grid with 10-kWe solar power generation, 41-kW$_e$h storage, and seven

125-W inductive charging stations. Power grid connections will be made using the logistics capability of CPEx to deploy cabling between the landers and mate dust tolerant umbilical interfaces. Commissioning of the power grid will mark the final step in establishing minimum viable power infrastructure. Upon completion of Mission 3, the Park will have the ability to support daytime operations and night survival for the Park infrastructure systems and up to four customers (e.g., four IPEx-sized systems). CPEx can provide customers with services such as regolith excavation and delivery; limited hardware transportation, manipulation and inspection; assist in structural assembly and outfitting tasks; and be outfitted with sensor packages to gather critical data for the science community and inform future lunar infrastructure construction requirements. At this point in the Park buildup, significant surface operations experience has accumulated. It is expected that the regolith manipulation and geotechnical data from of IPEx and CPEx will lead to a better understanding of regolith mechanics, construction system performance and durability, and provide opportunities to refine future infrastructure and construction system designs.

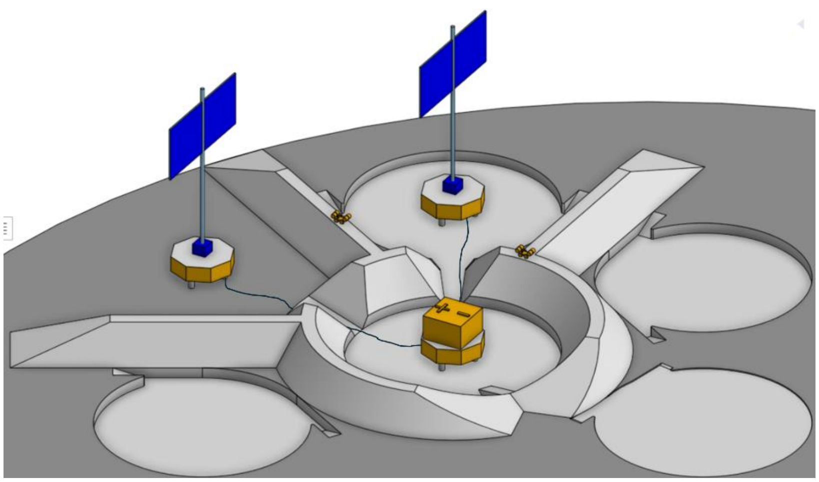

Figure 5. Mission 3 end state: 21-kWh battery delivered and power grid established. Additional regolith berms and prepared landing areas built for Mission 4 and a customer lander

Mission 4 – Build an unpressurized shelter. The objectives of the fourth mission are to land and offload structural elements and assembly robots for the construction of an unpressurized protective shelter; prepare a regolith foundation for the shelter; assemble, outfit and bury the shelter; and expand the Park footprint with additional landing sites for Mission 5 and a second customer lander (Figure 6). The shelter assembly and outfitting can be accomplished by using the Automated Reconfigurable Mission Adaptive Digital Assembly Systems (ARMADAS) (Gregg et al. 2024) developed for the autonomous robotic assembly and outfitting of modular structures. The ARMADAS system utilizes prefabricated structural voxels and multiple robotic agents to assemble the structures. The shelter construction activity includes several key demonstration milestones including the coordination of up to six autonomous robots to complete the task (CPEx for foundation preparation, and three ARMADAS robots for shelter assembly and outfitting, two

IPEx's for depositing regolith overburden); being the first assembled structure on the lunar surface; and demonstrating the use of bulk regolith for radiation attenuation, thermal stability, and meteorite protection. The shelter will include sensors to monitor internal temperature, radiation and vibrations from meteorite impacts and seismicity.

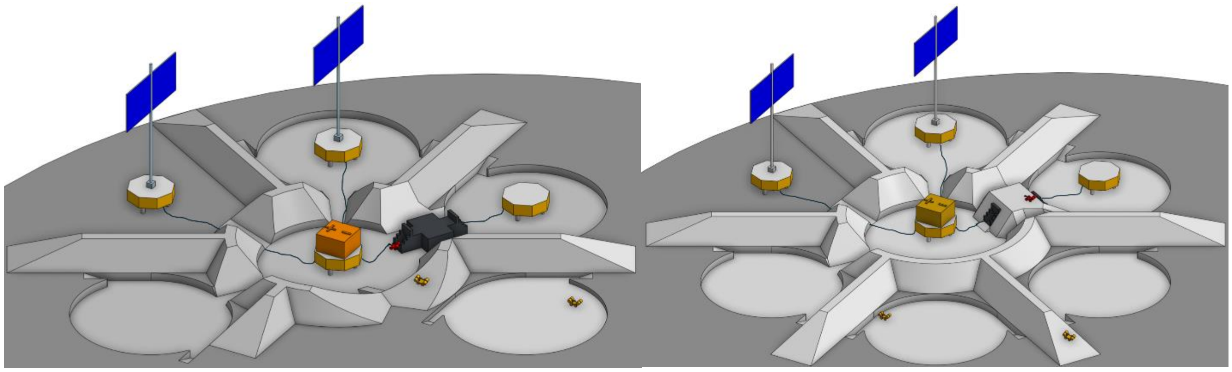

Figure 6. Mission 4: Shelter construction lander landed and connected to power grid; shelter assembled and outfitted (left), regolith overburden positioned atop the shelter and additional regolith berms and landing areas are added for Mission 5 and a second customer lander (right).

Mission 5 – Build a reusable landing/launch pad. The objectives of the fifth mission are to land and offload structural elements and systems for the construction and inspection of a reusable Landing/Launch Pad (LLP); prepare the LLP site and regolith berm structures; and construct a permanent LLP surface (Figure. 7). The site preparation and berm construction will use existing IPEx and CPEx systems for regolith manipulation. The LLP can be constructed using a variety of methods including deployable/assembled high-temperature surface on a smooth compacted regolith foundation or emerging in-situ regolith construction methods such as microwave sintering, laser or inductive melting, or polymer/regolith extrusion.

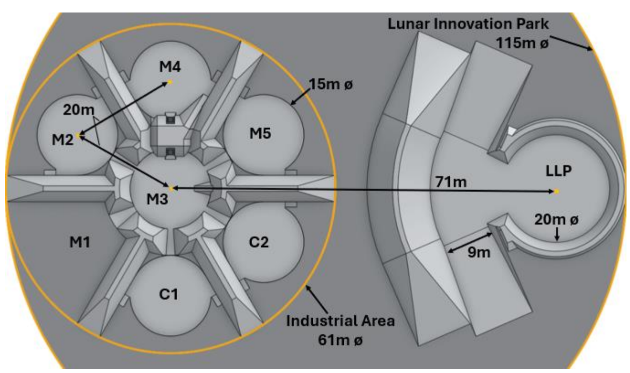

Figure 7. Park layout at the completion of Mission 5.

At the end of Mission 5, the first phase of Park build-up will be complete and will provide the minimum viable infrastructure and services including power and communications to support continuous daytime operations and lunar night survival, shelter for surface asset protection, and a permanent reusable LLP to provide close-proximity routine safe access to the Park. The IPEx, CPEx, and ARMADAS systems will remain available for future users for as long as they are in working condition. It is envisioned that Park expansion and upgrades/augmentation will occur as demand for the infrastructure increase and new services capabilities are required, including by commercial partners, and international partners who can take advantage of the existing infrastructure to defray cost and risk. Early augmentations to the Park would likely include adding FSP systems to support nighttime operations and large-scale ISRU commodities production, large-scale logistics capabilities to off-load, transport and manipulate large payloads, and a lander relocation capability to remove landers for the LLP.

KEY PARK BENEFITS

Science. The Compass study of the Park concept primarily focused on identifying the minimum viable infrastructure to support commercial activities but also studied the benefits of infrastructure for science missions as well (NASA 2026). The study considered a 40-kg class (IPEx scale) rover with a 1-kg science payload, developed in a previous Compass study. The science rover was designed around a concept of operations that assumed nine days of sunlit operations (e.g., traverses between the Park and the science location of interest), four days of dark traverse in a permanently shadowed region (PSR) (a likely candidate location for a science mission), and fourteen days of hibernation during the lunar night with stay alive power; power available at the Park. The study determined that upon the completion of Park Mission 3, establishing the power grid (described above), the Park could, for example, *enable 8-12x more science assuming four, 3-year life rovers that utilize the Park for the same cost of six, 2-week life rovers (disposable systems that don't use the Park) OR could support the same amount of science at approximately 50% of the cost*. It is expected that this level of cost savings would significantly accelerate scientific discovery by offering increased mission opportunity on the lunar surface.

Artemis risk reduction. The steady incremental build up and operation of the Park provides valuable risk reduction demonstrations of technologies for subsequent human exploration. The core infrastructure technologies used in the Park concept are also baselined for the Foundational Exploration segment of the Artemis campaign including power generation and distribution systems, 3GPP communications, and PNT. Other benefits to Artemis include the following:

Fission surface power risk reduction. Buildup of the Park surface power grid will provide an early demonstration of power generation, storage, and distribution, and can be augmented to include Fission Surface Power (FSP) systems once they become available. Additionally, lessons learned from grid construction and operations would be extensible to any future power grid. Surface construction operations such as berm building and surface preparations for landing areas and LLPs are directly applicable to the construction of stable FSP site preparations and regolith berms for radiation attenuation. Regolith based construction has the potential to reduce FSP radiation shielding requirements and thus reduce mass of the landed system. Radiation attenuation from a regolith berm would also reduce the required standoff distance of 1 km that is currently baselined in the NASA FSP requirements, thus reducing the mass of power distribution cables and the complexity of distributing cable over long distances.

Sustained human presence risk reduction. The construction concepts utilized by the Park are expected to have extensibility to many different types of infrastructure needed to support the "Sustained Lunar Evolution" and "Humans to Mars" segments of the Artemis campaign including the construction of landing facilities, tall towers for large-scale solar power generation (>100 kWe) and science applications, protective shelters for surface assets and crew during long-duration stays, and storage containers for crew consumables. Human landing could occur at a location that already has pre-positioned assets including landing beacon, communications, landing pad, power, and pre-positioned pressurized habitat with stored supplies.

Early ISRU demonstrations and commodity production. National goals and commercial ambitions assume the creation large-scale ISRU with a diversity of industrial processes transforming the lunar regolith into useful commodities and products. NASA has yet to articulate a step-wise strategy to prove benefaction and production of the large number of lunar elements, and to use commercial partnerships to scale their production. However, it is known that among the most important and basic products are the use of bulk regolith for horizontal and vertical construction and the production of O_2, H_2, and H_2O.

The Park is capable of supporting ISRU technology demonstrations and early small-scale production of commodities such as O_2, H_2, and H_2O defined in Table 1 of Sanders et al. 2024. Specific examples include long-duration (6 – 12 months) ISRU Pilot Plant demos to produce 1000 kg of O_2 and 125 kg of H_2 and the production of up to 2000 kg of O_2 per year for ascent vehicle refueling. These early ISRU demos are critical for maturing technologies and operations and providing confidence to future users and commercial producers of these types of commodities. Furthermore, the Park provides an opportunity for NASA and industry to conduct efficient lower cost long-duration system development and demonstration activities and will accelerate commercial-scale ISRU capabilities needed to support a space resource based cislunar economy. Once basic production is proven, commercial partners can make use of existing Park infrastructure to scale production, or to use existing production as inputs for derivative products.

CONCLUDING REMARKS

This paper introduced the Lunar Innovation Park - a concept for establishing the minimum viable infrastructure needed to kickstart lunar surface operations and commercial economic development. The Park is permanent infrastructure at a location of strategic importance on the Moon built up over a series of five CLPS medium scale missions and uses existing and emerging NASA and industry technologies to make the Park feasible by 2030. One critical design feature is the use of close-proximity landings (~20 m) to reduce complexity of Park construction, reduce electrical power cable mass and deployment distance, minimize footprint, and simplify logistics and access. An early Park concept was presented to NASA's Space Technology Mission Directorate (STMD) leadership in February of 2025 and led to follow-on work including a detailed systems study to mature the Park concept presented herein.

The Park will reduce costs and risks for subsequent technology development missions and commercial operations by providing pathfinder services such as: power, local and direct to

Earth communications, PNT, robotic regolith manipulation, logistics, and perhaps most importantly, the ability to land spacecraft in extreme proximity in the Park. This infrastructure reduces the operational risk of missions that leverage the Park and simultaneously offers the possibility to reduce the size weight and power (SWAP) and therefore the cost of any such mission. In addition, the Park will provide an opportunity for technology demonstration, maturation and risk reduction that will enable future Artemis “Foundational Exploration” and “Sustained Lunar Evolution” segments and long-duration science missions at lower cost. One specific study result indicated up to 50 % reduction in cost for a series of missions by using a small number of 3-year life rovers that utilize the Park versus many 2-week life rovers (disposable rovers that don’t use Park). By providing minimum viable infrastructure, the Park is a powerful investment multiplier for broad effective scientific and resource exploration, commercial development, and know-how that will launch the era of space-resource based commerce.

Finally, the Park can play a significant role in addressing the Executive Order mandate to “lay the foundation for lunar economic development”, and “establish lunar infrastructure and standards that enable implementation of space priorities and a robust space industrial base”. The Park can be established in the time frame specified in the Executive Order.

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