

**DEVELOPMENT OF ISRU UNIT SYSTEMS ON THE SURFACE OF MOONS OF PLANETS THE EARTH AND THE SATURN.** R. A. Chandrachud<sup>1</sup> <sup>1</sup>Undergraduate student, B.K. Birla College Of Arts, Commerce and Science, Mumbai University(rhushichandrachud@gmail.com).

**Introduction:** It is possible, of course, that exo planets in other star systems could provide a home for humans, but these father systems are merely unreachable on our time scales and any ship which would visit them must function as a self-sustaining settlement in the vacuum of interstellar space for some thousands of human years. While planetary bases will have applications in the exploration and settlement of space, To explore planets in detail there must be self sustainable machinery manufactured on the planet itself. The primary phases for the exploration of the planets would require energy and then comes ISRU Units in primary focus. Hence to provide audience reading this paper idea regarding the challenges and procedures to establish ISRU Units on the planets and moons I propound a ISRU system for Saturn's moon 'Titan'

**ISRU for inner planets and moon systems:** For inner planets it is possible to ship the desired part from the Earth but For Outer planets it is comparatively harder to do so. Thus, everything must be planned in accordance with available options or risk disaster. The most ideal position to establish ISRU in the solar system is our own natural satellite MOON. Inner planets possess more possibilities and could actually can be treated as test ground for ISRU technology due to less distance from the Earth. If this technology popularize to the acceptable extent then it would turn milestone for planetary journeys along with surface exploration.

**ISRU Development for Earth's moon :** About a half century ago, our epistemic knowledge had driven us to the most fascinating moon of our native planet. Viewing current scenarios and advancements in technology whole mankind dreams to settle a permanent lunar base. Thus in the initial stages the structures which could be built over lunar surface would require instant energy. The lunar regolith is enriched with the constituents which would meet large energy and habitational requirements there only. The earth has no need to calculate the launching costs and payloads as the required materials could be transported to desired locations, but on the moon each gram costs much to lift off from the earth. Thus, to make these lunar structures highly earth independent effective ways are being searched by various space organizations.

As NASA and other organizations have undertaken endeavors to develop self sufficient lunar structures, a new frugal and least earth dependant lunar structure (Sustainable Permanent Lunar Modules) are emerging. Totally different from terrestrial colonies these mod-

ules would first introduce humans to the surface of moon and allow humans to perform experiments on the lunar surface. Thus the aspects carefully considered here are ISRUs, Water Processing on the lunar surface, and Refining of the metals and most importantly extraction of Helium-3. It is very important for the In-Situ Resource Utilization units to proliferate on the lunar surface as they will drastically meet all the energy needs of the structures installed on lunar surface. These ISRUs will be powered with solar panels along with fuel cells as back-up plan. Carefully chosen isotopes of Uranium could power these ISRU units. Another type of ISRU units is water processing ISRU units powered by U-233 fission reactor which run a 10MeV S-CO<sub>2</sub> Cycle. The Metal refining units could be installed at Oceanus Procellarum region. For Helium-3 Extraction the power required would be very low compared to the other operations.

In this paper, I describe the advantages of solar panels for ISRU units and detailed analysis of Water processing ISRU units having no solar panels which extends to the details of metals which could be extracted profitably from selected regions with techniques involved. (Here the consequences like catastrophic failures are also considered). Basically this paper propounds use of ISRU units on the lunar surface in a new way along with new extraction work techniques.

**Determination of ISRU units position for outer planets and moon systems:** In forthcoming years if Saturn or Jupiter Exploration gain importance in the changing policies of Space Exploration organizations then ISRU units could be trustworthy options for self sufficient energy supply. In outer planets group Saturn would be the most powerful option to explore due to its moons and possible habitable prospects along with previous operational experiences. Also, Titan could turn promising option in the terms as an alternative for space colonization settlements propose to be built in its orbits.

**Structural fundamentals of ISRU unit on Titan:** The first piece of infrastructure to be sent to the Saturn system as part of exploration would be surely a Titan lander. This lander would contain ISRU plant which would serve as a Unit for Processing Titan's resources of Water, Methane and Nitrogen. It would supply all the life supporting materials for human exploration also. Further ISRU Units for Helium-3 gas extraction could be installed but they would take time to become

operational and thus to bring in revenue from the installation day Life support ISRU must be installed. The next aspect to consider here is larger part of mass of this lander is devoted to payload than fuel due to less gravity of the titan.

**Challenging landing and Successful Operation of the ISRU Unit on the titan:** The greatest challenge of operating a ISRU on Titan is the extreme cold. Titan average nearly -180°C. Only spacecraft landed there is Huygens Probe which frozen to death. Thus to make ISRU lander escape this situation extensive insulation and internal heating is required. Many of the chemical reactions carried out would be exothermic with requirement of ample amount of electrical Power. waste heat generated from a nuclear reactor which powered these processes keep the probe warm. One more prevention to be considered here is destabilization of Titan's methane ice surface due to generated heat. As a measure of prevention the lander bottom is uplifted over the ice on the landing legs. Steel sections brought from Earth are driven through holes in the landing pads and frozen into the ground to guard the lander against wind gusts in thick atmosphere.

**Determining the Site for ISRU unit on the Titan:** With Similar Physics as the Earth Titan has an exception of water ice as rocks due to cold. ISRU plant would be placed near a point on the surface where the crust is thin, allowing water to seep up from Titan's interior. The site ultimately chosen was on the slopes of a cryo volcano near Titan's equator compared to geothermal power plants near volcanoes and geysers to take advantage of the heat seeping up from the Earth's interior. On Titan, a small fleet of protected rovers designed to cut out blocks of water ice from the cryovolcano flows. ISRU lander perform melting, purification, and processing of these blocks. Nitrogen and methane could be harvested from Titan's atmosphere. The only technological needs are those robot rovers and shuttles which would carry export of materials from ISRU Units.

**Future Scope:** The Advanced civilization is meant to be mastered the art of conversion of the energy from available materials. With the more detailed study of particular planet this technique for catering energy supply need could be replicated with exo planets and their moons for further exploration and colonization efforts. The only need is to plan a concrete base with more emphasizing these techniques Now.

**Abstract Link For LEAG2019 ISRU Unit Poster:**  
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