The goal of In Situ Resource Utilization (ISRU) is to utilize resources that are available at the site of exploration, pursuing the philosophy of "make what you need where you need it" instead of bringing it all the way from Earth, with the intent of achieving a reduction of mass requirements for exploration missions, a reduction in mission risk and cost, and expanded human presence in space. The purpose of this subtopic is to identify and experimentally validate single and multistep In Situ Resource Processing and Refining processes that have the potential for achieving the goal of ISRU. Such processes may include thermal, chemical, and electrical processing of extracted resources into useful products. In Situ Resource Processing and Refining includes efficient and economical production of propellants, mission critical consumables, life support gases and water, and feedstock (such as silicon, aluminum, iron, and polymers) for use in In Situ Manufacturing (X1.01), from resources that have been extracted and separated using processes defined and developed under In Situ Resource Excavation & Separation (X1.02). To be successfully implemented, In Situ Resource Processing & Refining proposals must minimize the mass which must be brought from the Earth, including the mass of the required power system and Earth-supplied processing consumables, and produce 100s to 1000s of times their own mass of product in their useful lifetimes. In addition, the maintenance, human supervision, crew operation, and crew training required for process operation must be minimal and affordable. Technical areas included in the subtopic are:

- Mineral Processing To Extract Oxygen and Feedstock For In Situ Manufacturing
- Water and Carbon Dioxide Processing To Produce Oxygen and Fuels
- Hydrocarbon, Plastic, and Polymer Production
- In Situ Bio-Support Processing, including agricultural chemical, mineral extraction for fertilizer products, processed regolith for plant soil, food supplements, etc.

Process evaluation metrics include mass of product made per hour, final mass of product per mass of processor, Watts per mass of resource processed per hour, percentage conversion of resources into product in a single pass, and mass of Earth consumables used per mass of in situ product made.
Proposals of interest include:

(1) Developing technologies, processes, and systems for robotic precursor and early human missions to the Moon in the areas of processing of lunar resources into oxygen, propellants, and feedstock for \textit{in situ} manufacturing; and

(2) Developing technologies, processes, and systems for robotic precursor missions or eventual human missions to Mars which produce mission critical consumables, such as oxygen, propellants, life support gases, fuel cell reagents, and \textit{in situ} manufacturing feedstock. Robotic and human missions to Mars that consider initial or evolutionary use of ISRU consumables currently assume the use of liquid oxygen and hydrocarbon fuel (methane, propane, methanol, ethanol, or low freezing point mixtures) propellants for propulsion systems and mobile fuel cell power systems.

For processing concepts that can be used on robotic precursor missions, payload masses (including rovers) are typically below 300 kg. Robotic precursor concepts must demonstrate critical functions and must be scalable to human mission needs. Mars sample return missions that incorporate \textit{in situ} propellant production require 300–2000 kg of propellant depending on the size of the same and whether the mission is a Mars orbit rendezvous or direct Earth return mission. Breathing rates for astronauts are approximately 0.07 kg of oxygen (O\textsubscript{2})/person/hr in habitats and 0.1 kg/person/hr for Extra-Vehicular Activities (EVAs). Early human lunar mission surface durations may vary from 3–45 days and can include from 2–6 crewmembers. Lunar human landers require approximately 5000–8000 kg of propellant for ascent and approximately 15,000–25,000 kg for landing and ascent combined. Mars mission surface durations are 30–90 days for opposition class missions and 450–600 days for conjunction class missions. Mars human ascent vehicles typically require 20,000–30,000 kg of propellant. Fuel cell reagent consumption rates depend on the power required for the application, the reagents, and the fuel cell technology used. EVA suits and small rovers can require 500W to 1 kW of power/hour, unpressurized rovers can require 3–6 kW of power/hour and pressurized rovers can require 10 kW/hour and above.