# Compact Ultra Light Nuclear Electric Power Systems for Future Moon Bases and Colonies

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Future bases and colonies on the Moon will require large amounts of electric power for life support, processing in-situ resources, recycling scarce materials, transport fuels and energy, and many other uses. Current US per capita energy usage is approximately 10 kilowatts, counting all energy inputs, including coal, oil, natural gas, nuclear, hydro, solar, biomass, etc. Per capita demand on the Moon will be much higher, at least 100 kilowatts per person. The corresponding electric power for a lunar base of 100 persons would then be at least 10 megawatts(e), and 100 megawatts for a lunar colony of 1000 persons. The electric power would be used to extract oxygen and nitrogen from Moon rocks; together with aluminum, iron and other metals and non-metals; to recycle and reconstruct scarce materials like water and hydrocarbons; and to provide heat and light for life support and agriculture.

Nuclear electric power systems are attractive because in contrast to solar photo voltaics, they are not affected by variations in solar illumination during the lunar cycle, and not sensitive to micro meteorite bombardment and accumulations of lunar dust. The SUSEE (Space Nuclear Steam Electric Energy) system is a near term, compact, lightweight, space, nuclear electric system that is based on highly, reliable commercial water/steam reactor technology that has operated for many years. The SUSEE reactor uses a cermet fuel form similar to that presently used in DOD reactors, in which micro size fully enriched $UO_2$ particles are held in a metal matrix (e.g., zirconium or stainless steel). Very high burnups and long lifetimes are achieved using cermet fuel with virtually zero fission product release. Using standard steam conditions (e.g., 1000 psi and 1000 F) and conventional steam turbines, a thermal electric efficiency of 25% is achieved with a single stage expansion. The condenser pressure in SUSEE is high (e.g., ~2 atm, compared to ~0.1 atm in conventional power plants) so as to enable a high radiator temperature (~400 K) for efficient thermal rejection to space. The SUSEE radiator is constructed using lightweight flexible aluminum strips with internal grooved channels in which the exhaust steam condenses to water, for return to the reactor. A complete 10 megawatt(e) system (reactor, turbo-generator, piping, pumps and radiator) would weigh about 20 tons, a factor 10 lighter than high temperature gas cooled space nuclear electric systems. The radiator can be rolled up in a compact bundle to be deployed on the lunar surface – the total radiator for a 10 megawatt(e) system would occupy a 150 meter x 150 meter area.

The SUSEE nuclear electric system is described in detail, including its construction, installation, and operation on the lunar surface. Potential lunar applications that would use large amounts of electric power are described, including aluminum/oxygen propellant, fuel cells for surface rovers, smelting of ores for recovery of oxygen and metals, etc. The SUSEE system requires only modest development and can be quickly ready for implementation at lunar bases and colonies.