EUROPEAN SPACE NUCLEAR POWER SYSTEMS: ENABLING TECHNOLOGY FOR FUTURE COLLABORATIVE EXPLORATION MISSIONS

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Introduction: Space nuclear power systems have been under development as part of a European Space Agency (ESA) programme, which has focused on proof of concept technologies and advancing the technology readiness level of radioisotope based systems based on ^{241}Am. As a science driven technology programme, this initiative has brought the space and nuclear industries together to create new technologies that benefit space exploration.

Radioisotope Power Systems Development in Europe: The ESA programme is based on developing radioisotope based power systems in the 10 W to 100 W range using ^{241}Am, which would complement higher power density radioisotope systems. Providing greater flexibility in the scale of available power system solutions translates into a greater variation in mission design and science data return.

Summerer and Stephenson [1] concisely summarise some of the findings of the European Working Group on Nuclear Power Sources for Space, established in 2004 to assess future European requirements:

1. Establish a European safety framework.
2. Produce a space nuclear power roadmap.
3. Start research programmes and studies on nuclear power sources and their use in Europe.
4. Establish in a timely fashion binding international safety standards and implement these in Europe.
5. Establish a communication strategy and policy for engaging with the public.
6. Establish infrastructure in Europe to deal with all through-life aspects of nuclear power systems i.e. development, manufacturing, handling, testing, integration, launch by making as much use of existing infrastructure as possible.
7. Consider reactors and nuclear propulsion systems as a longer-term objective.

The ESA programme has focused on technology development based future science requirements. The Working Group recognised space nuclear power sources an enabler for European ambitions in space by also considering future science community demands.

Science Drivers & The Ice Giants: Science communities around the globe continue to propose innovative mission concepts that rely on nuclear power.

Scientific interest is increasing in the outer planets of the solar system and their satellites. This is particularly true of Uranus and Neptune and also due to the fact that little is known about these bodies given that Voyager was the last probe to provide any data. Missions to these bodies are not possible without nuclear power and would be ideal targets for collaborative international scientific and technology programmes.

The icy and gas giants have played a significant role in driving the current conditions in the solar system particularly given that most of the mass is the solar system resides in these large bodies. The idea of using our own solar system to understand the formation of extra solar planets is supported by the fact that Neptune and Uranus-like extra solar planets are common [2] and presents an additional compelling argument in favour of future missions to the icy giants. There are many unanswered questions related to their interiors, oblique rotation, magnetic fields, composition and ring systems. Arridge et al. [3,4] and Masters et al. [5] have provided detailed scientific cases for European led missions to explore the Uranus and Neptune systems respectively citing the need for a European flight ready space nuclear power source by the end of the 2020s.

System Architectures: A number of radioisotope power system architectures are under development exploiting thermoelectric generators and dynamic conversion systems.

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