Paper ID: 95594
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IAF SPACE SYSTEMS SYMPOSIUM (D1)
Innovative Systems toward Future Architectures (1)

Author: Mr. Adriano V. Autino
Space Renaissance International, Italy

Mr. Werner Grandl
Space Renaissance International, Austria
Dr. Alberto Cavalo
Space Renaissance International, Italy
Mr. Ghanim Alotaibi
Kuwait
Prof. Bernard Foing
ILEWG "EuroMoonMars", The Netherlands
Mr. Stefano Antonetti
D-Orbit SpA, Italy
Dr. Marie-Luise Heuser
Space Renaissance International, Germany
Mr. Gary Pearce Barnhard
Xtraordinary Innovative Space Partnerships, Inc., United States

3XE: ENERGY, ECONOMY, ENVIRONMENT. A SPACE PERSPECTIVE CASE: BIG DATA FARMS IN SPACE

Abstract

Energy is rapidly becoming the primary factor of sustainability. During the industrial era, energy demand was met by traditional sources, chosen for convenience when environmental concerns were limited to pollution. Emerging economies relied heavily on coal for electricity. In recent decades, climate change concerns have driven the "energy transition," phasing out greenhouse gas (GHG)-emitting technologies. However, the rise of the electronic society—electronic money, mass video communication, electric mobility, AI, supercomputers, and big data farms—has led to soaring energy demand, challenging green transition strategies. Despite policies aimed at reducing consumption, global energy demand is rising far beyond expectations. While renewables are growing, fossil fuels are too, and both together still fail to meet increasing demand. As a result, GHG emissions continue to rise despite global reduction efforts. Additionally, the energy market is highly influenced by geopolitics, especially for natural gas, which, as the least GHG-intensive fossil fuel, is in high demand. Gas-fired plants can be built quickly, making them a practical choice amid energy crises. Without innovative solutions, energy costs will skyrocket, leading to severe social consequences, and restricting the benefits of the electronic society and mobility to privileged groups. Nuclear fission, now recognized as a non-GHG-emitting technology, is seeing renewed interest. Small Modular Reactors (SMRs) promise cost reduction, while fourth-generation fast reactors aim to address nuclear waste and reduce uranium mining needs. Civilian Space Development offers solutions to the energy crisis. Big data farms could move from Earth to orbit, the Cislunar region, or the Moon, reducing environmental impact by eliminating terrestrial heat dissipation. In the mid-term, industrial settlements at Earth-Moon Lagrange Points could harness uninterrupted solar power, avoiding atmospheric losses and seasonal limitations. Lunar facilities could utilize small nuclear reactors to maintain energy supply during the 14-day lunar night, shifting the environmental impact away from Earth. This paper explores

the potential for relocating big data farms to Earth orbit, the Moon, and the Cislunar region. Key considerations include: • Stakeholder analysis • Users on Earth and in space • Basic user requirements • Maintainability, availability, readiness • Technologies needed for different locations (Earth orbit, Moon, Lagrange Points) • Architectural design concepts • Power supply in open space and on the Moon • Communication infrastructure for data exchange • Interaction with satellite networks (orbital and Cislunar) These solutions could reshape the future of energy, sustainability, and space industry development.