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Stellar Energy Harnessing Satellites: A Proposal for Continuous Wireless Power Transmission

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INTERNATIONAL ACADEMIC RESEARCH COMPETITION

Stellar Energy Harnessing Satellites: A Proposal for Continuous Wireless Power Transmission

1. Abstract :

The global demand for energy is increasing rapidly as energy is required in almost all fields of our modern age. To keep up with the increasing demand, our reliance on fossil fuels has risen, posing a significant risk to the environment and contributing to climate change and environmental pollution.

Traditional renewable energy-generating methods, such as solar panels and wind turbines on Earth, face several limitations due to weather changes, day-night cycles, and location-based issues. Affordability is also questionable, as these methods aren't feasible for mass energy production, so individual investments are necessary in most cases to be able to generate and use renewable energy.

This proposal introduces the concept of Stellar Energy Harnessing Satellites (SEHS), which will be placed in geostationary orbit. Their main task will be to capture sunlight continuously and transmit the collected energy back to Earth at a constant pace via microwave beams. Unlike traditional renewable energy sources, SEHS can operate around the clock, offering a stable energy supply that could potentially reshape the global energy market in a positive manner.

This research will aim to study the technical feasibility, efficiency, safety, practicality, environmental impact, and societal implications of SEHS. Considering the fact that energy shortages and climate concerns are great challenges to humanity, this research could provide a roadmap towards achieving a sustainable and abundant, if not unlimited, power source for the future. A central SEHS project on a huge scale could potentially provide power to any and every location on Earth if we set geopolitical conflict possibilities aside and use a central power supply authority model that is free of any political affairs.

2. Research Question :

Will Stellar Energy Harnessing Satellites (SEHS) be able to safely and efficiently provide us with continuous wireless power to Earth and ensure a practical and socially beneficial solution to the global energy crisis, environmental pollution, and climate change?

3. Research Aims :

This research will aim to provide a proper comprehension of the following points:

- Evaluation of the technical feasibility of SEHS in geostationary orbit.
- Analysis of the efficiency and safety of microwave power transmission.
- The environmental benefits, along with the reduction of greenhouse gas emissions.
- Involvement of societal, political, and ethical aspects of a global-scale SEHS deployment.
- Insight into the economic feasibility and potential funding models.
- Exploration of real-life implementation possibilities and methods.
- Maximum risk reduction methods to ensure safety and environmental welfare.

4. Introduction :

4.1 *Research Background*

Humanity faces a number of great challenges, and among those, two of them are: the rising global demand for energy and the harmful environmental effects caused by the usage of fossil fuels. Studies show that by 2050, energy needs are expected to double, but carbon emissions have to be reduced in order to avoid severe environmental damage and climate consequences **[1]**. Even though the usage of solar and wind energy has grown, they are intermittent and dependent on location, which makes them insufficient as a primary and convenient energy source.

4.2 *Consequences of Inaction*

If we fail to develop or discover a reliable and clean energy source globally, we will face severe consequences such as climate-related disasters, economic instability, and the global energy crisis. Regions on Earth without dependable renewable energy sources will continue using fossil fuels, increasing pollution and the emission of greenhouse gases that will make us bear unavoidable consequences.

4.3 *Importance of the Research*

Stellar Energy Harnessing Satellites (SEHS) could offer a transformative and revolutionary solution to all the problems listed above, granting us a continuous, abundant, and clean energy source straight from space. This approach could ensure carbon emission reduction, improvement of energy security, lower energy costs, and minimization of conflicts over fossil fuels.

5. Literature Review :

5.1 *Concept of SBSP and Wireless Power Transfer*

Peter Glaser first proposed the concept of space-based solar power (SBSP) in 1968 **[2]**. NASA, JAXA, and the European Space Agency (ESA) have dove deep into wireless power transfer from orbit since then **[3]** **[4]**. As advancements have been achieved in lightweight materials, energy storage, and orbital deployment technology, the interest and feasibility of SBSP have been renewed **[5]**.

5.2 *Inspiration Behind Stellar Energy Harnessing Satellites (SEHS)*

Recent research has highlighted the history and engineering of microwave power transmission greatly **[7]** and evaluated environmental impacts in the long run **[8]**. Mankins conducted discussions to evaluate the potential for large-scale SBSP deployment in 2011 [6]. Moreover, recent studies shift their focus to efficiency, safety, and public acceptance of wireless energy transmission **[9]**.

5.3 *Gaps in Past Studies on SBSP and the Idea of SEHS*

Although the technical feasibility of SBSP is well-studied, there are quite a few gaps that exist in assessing societal benefits, regulatory frameworks, and scalable implementation. Past studies mostly focused on technical problems and frameworks, but societal impacts were rarely mentioned. Research done on SBSP lacks the understanding of public acceptance, energy equity, and how global energy markets would adapt to continuous space-based power, which is a major problem if we think of real-life scenarios. Risk management and implementation strategies are yet to be studied in detail, which is not ideal for a project as huge as SEHS.

5.4 *Bridging the Gaps in Current Knowledge*

This proposal greatly seeks to address those gaps by connecting technical feasibility with environmental and social aspects. This research will also aim to highlight potential countermeasures for the risk involved in the project, look into unexplored solutions to technical aspects, explore real-life implementation possibilities and methods, link microwave conversion technology with aerospace methods to maximize convenience, and connect the gaps that were left behind from studies conducted in the past.

6. Research Methodology :

This research will follow the methodology stated below:

6.1 *Qualitative Phase*

Understanding stakeholder perspectives, societal and ethical concerns, policy constraints, and geopolitical implications will be the main intention in this phase.

⋄ **Stakeholder Analysis Module:** Interviews with experts in aerospace, renewable energy, and policy will be arranged in order to understand real-time conditions and circumstances. This research will explore political, ethical, and societal considerations, while also looking into potential risks and benefits for the stakeholders. This will make sure that a proper comprehension of current scenarios is achieved.

6.2 *Quantitative Phase*

In this phase, this research will test the technical feasibility, efficiency, and safety of SEHS.

⋄ **Theoretical Modeling Module:** Orbital and solar capture models will be created (**7–10** deterministic models & **500–1,000** Monte-Carlo runs per key scenario for sensitivity and uncertainty analysis) to estimate the potential of energy collection (Average solar constant at geostationary orbit ≈ **1,366 W/m²**) **[3][6]**, giving a proper theoretical framework and roadmap. Detecting errors and solving them will be accessible through the creation of a proper model.

⋄ **Power Transmission Simulation Module:** Computer simulations will be used to study microwave beam propagation (**2.45 GHz** and **5.8 GHz**), energy efficiency, and atmospheric losses (Estimated to be around **70%**) **[7][9]**. This would ensure that no room for error is left behind, as simulations (**3–5** atmospheric conditions) provide us with immense convenience while also maintaining practicality.

6.3 *Data Analysis Stage*

This stage will focus on integrating qualitative and quantitative findings to form a complete picture of a world where SEHS has solved a handful of the greatest challenges of mankind. In this stage, all the data gathered in the qualitative and quantitative phases will be put together, and a thorough analysis will be done. Once all the data is confirmed to be correct, the pieces of the puzzle will be put together to form a practical project model.

6.4 *Ethical Considerations and Project Feasibility Approach*

In the last phase, we will discuss and ensure the safety of humans and wildlife with officials, so that microwave power transmission from SEHS does not harm humans, animals, or ecosystems. Proper consideration of fair access to SEHS-generated energy across countries will be ensured. Public transparency and environmental responsibilities will also be confirmed. Methods to prevent military abuse will also be looked at. The points noted below will also be decided in this phase:

- Timeline for each research stage (Theoretical, prototype, and testing).
- Resource planning (Software, collaborations, and budget).
- Risk assessment (Technical, environmental, political, and economic).

7. Potential Roadblocks and Limitations

High costs of Stellar Energy Harnessing Satellites (SEHS) construction, launch, and maintenance might be a major roadblock that can be solved with proper financing and partnerships. Possible effects of microwave beams on wildlife, humans, and aviation also pose a risk that can be solved via proper planning. Geopolitical conflicts might arise, and to solve that, the world leaders need to come to an agreement. Initial investments may limit access for developing countries, which might result in discrimination.

8. Conclusion

This research and the idea of SEHS present a groundbreaking and revolutionary solution to the global energy crisis, environmental pollution, and climate change. If the roadblocks are countered properly, then this research could ignite a flame that will illuminate for centuries, reflecting the glory of mankind and science.

9. Post-Research Plan

The post-research plan will be to expand research through international partnerships with space agencies and renewable energy-oriented organizations. Policy and regulation proposals will be published for global and space energy governance. The gap between theory and practical application will be bridged, and public awareness campaigns will be run.

10. References :

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[9] H. Li and Y. Wang, “Wireless Power Transmission for Space Applications: Efficiency and Safety Studies,” Journal of Aerospace Engineering, vol. 34, no. 2, pp. 1–10, 2021, Q2. DOI: 10.1061/(ASCE)AS.1943-5525.0001256

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