



SOLAR POWER SATELLITE AND MICROWAVE TRANSMISSION FROM SPACE TO EARTH FOR GENERATING ELECTRICAL POWER

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Abstract

A solar power satellite (SPS) is a renewable energy system that converts the sun's energy into electricity in space and transmits it to Earth using microwaves. One of the most challenging technologies for the SPS is microwave power transmission from the geostationary orbit to the ground. The technologies for microwave power transmission have been studied for more than 40 years since the initial demonstrations in the 1960s; however, for SPS application, considerable research, especially on high-efficiency power conversion between direct current (dc) and radio frequency (RF) and on high-accuracy microwave beam control over a long range, is still needed. This paper introduces the concept of SPS and presents the technologies and issues associated with microwave power transmission from space to ground to generate electrical power.

Keywords: Solar Power; Solar Power Satellite; Microwaves; Rectenna; Wireless Power Transmission.

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1. Introduction

What is Solar Power Satellite?

The new millennium has introduced increased pressure for finding new renewable energy sources. The exponential increase in population has led to the global crises such as global warming, environmental pollution and change and rapid decrease of fossil reservoirs. Also the demand of electric power increases at a much higher pace than other energy demands as the world is industrialized and computerized [1]. Under in these circumstances, research has been carried out to look into the possibility of building a power station in space to transmit electricity to Earth by way of Radio waves the Solar Power Satellites.

What is Microwave Transmission?

The concept of solar power satellites for generating electricity in space was first proposed by Peter Glaser in 1968. The power generated in space can be transmitted to earth as microwave signals which can be collected with the help of an antenna called Rectenna and then converted into electric power. Individuals have discussed the use of space solar power systems (SPS) as a prominent means of supplying energy to the earth to replace and conserve non-renewable sources of energy [2]. The significance of greenhouse effect resulting from burning fossil fuels and escalating prices of fossil fuels have again brought to the public's attention the possibility of utilizing renewable energy sources. The time is certainly appropriate to reexamine the SPS project for making use of the abandon solar energy for generating electricity [1].

Necessity:

- 1) The necessity of the solar power satellite is, compare to earth based solar panels they receives only a part of the solar energy [3].
- 2) It will be affected by the day and night effect and other factors such as clouds.
- 3) So it is desirable to place the solar panel in the space itself, where, the solar energy is collected and converted into electricity which is then converted to a highly directed microwave beam for transmission.
- 4) This microwave beam, which can be directed to any desired location on earth surface, can be collected and then converted back to electricity.

2. Problem Defination

Space-based solar power (SBSP)

SBSP is the concept of collecting solar power in space (using an "SPS", that is, a "solar-power satellite" or a "satellite power system") for use on Earth. It has been in research since the early 1970s.

SBSP would differ from current solar collection methods in that the means used to collect energy would reside on an orbiting satellite instead of on Earth's surface. Some projected benefits of such a system are a higher collection rate and a longer collection period due to the lack of a diffusing atmosphere and night time in space.

Part of the solar energy (55–60%) is lost on its way through the atmosphere by the effects of reflection and absorption. Space-based solar power systems convert sunlight to microwaves outside the atmosphere, avoiding these losses, and the downtime (and cosine losses, for fixed flat-plate collectors) due to the Earth's rotation.

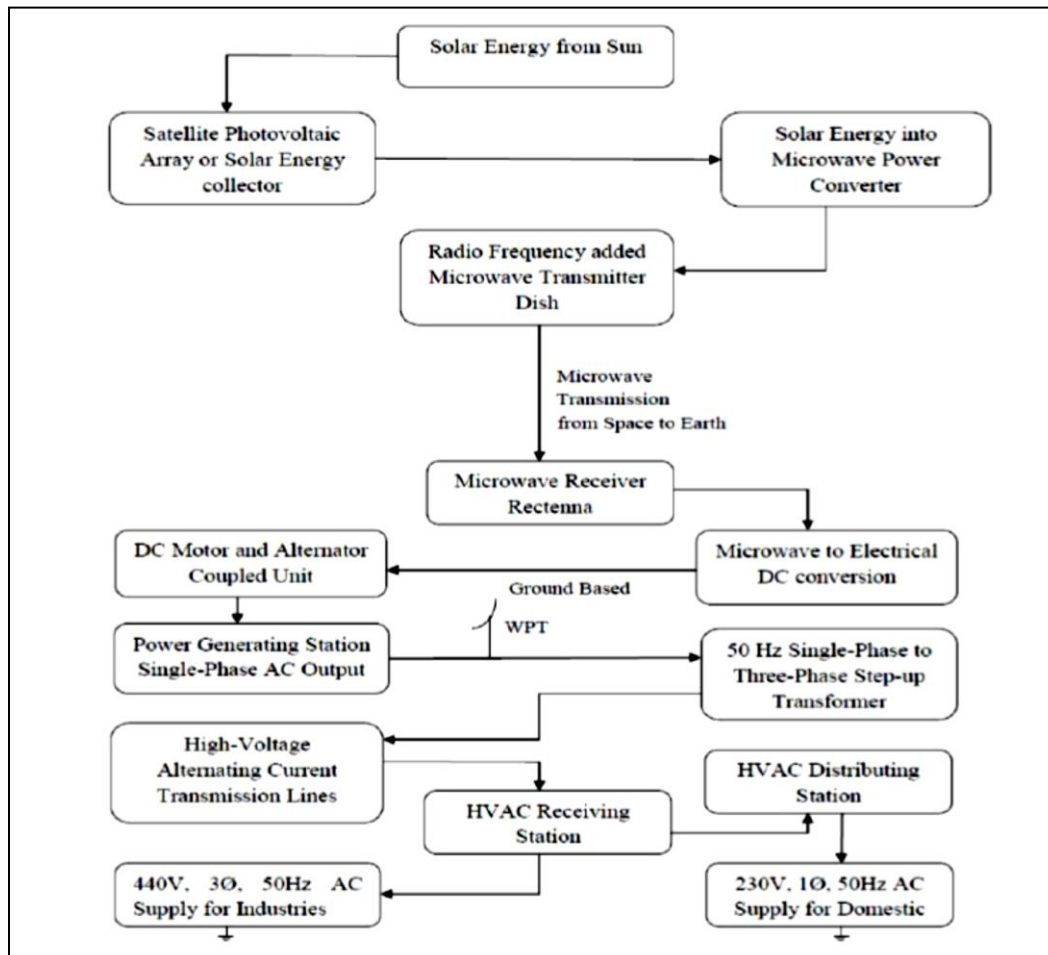
Besides the cost of implementing such a system, SBSP also introduces several new hurdles, primarily the problem of transmitting energy from orbit to Earth's surface for use. Since wires extending from Earth's surface to an orbiting satellite are neither practical nor feasible with current technology, SBSP designs generally include the use of some manner of wireless power transmission [4]. The collecting satellite would convert solar energy into electrical energy on board, powering a microwave transmitter or laser emitter, and focus its beam toward a collector (rectenna) on Earth's surface. Radiation and micrometeoroid damage could also become concerns for SBSP.

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SBSP is considered a form of sustainable or green energy, renewable energy, and is occasionally considered among climate engineering proposals. It is attractive to those seeking large-scale solutions to anthropogenic climate change or fossil fuel depletion (such as peak oil).

The concept of wireless power transmission at microwave frequencies has recently generated much excitement for the development of new battery charging techniques, stations for wireless power distribution, and other consumer products that operate by means of remote energy transfer. Not only has this excitement generated a new paradigm of research and development for engineers and scientists, but more importantly, improved the general awareness of the public regarding the practicality and feasibility of green energy technologies. One popular example includes the charging of mobile devices, laptops, and other portable electronic equipment by the recycling of parasitic electromagnetic energy from the local environment. Additional applications of this approach to green technologies can include the control and system operation of low-power medical devices, environmental monitors for security and surveillance, and other sensors for home automation. Concepts can also be applied to more directive and high-power systems for space applications and the related telecommunications, as well as the powering and control of remote robots for disaster control and electric cars for terrestrial transportation.

3. Materials and Methods



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According to the block diagram, research has been carried out to look in to the possibility of building a power station in space. The new millennium has introduced increased pressure for finding new renewable energy sources. Non pollutant Naturally available sun power which is applicable for many purposes hence, it is also utilized for Solar Power Satellite also, in this research a SPS which is absorbs amount of solar power through photovoltaic cells are mounted on the satellite, it takes Solar power as a input and converts in to the DC form of electrical power and result of generated DC electrical power stored in to the Nickel Cadmium battery and from this the satellite will takes power for its operation. SPS main objective is collecting amount solar power and converts in to the Microwave Power and Transmission towards earth side. Solar Power Satellite mainly consists of Microwave generator it take input power from the battery and essentially generates Microwave pulses in the range of 2.45GHz and it should be transmitted towards rectenna element which is mounted on the earth surface.

Microwave transmitted from space and received by the rectenna which is combination of Receiver antenna and Rectifier element hence, it rolled as a advance instrument in the electrical technology.

Numbers of Rectenna instruments are used on the earth surface they are working on the similar ratings according the satellite rating configuration. Rectenna main function is receives transmitted microwave power from space and converts it in to DC form of Electrical power. So the whole technology introduce new version of Electrical power generating station. Generated DC will be inverted in to AC by means of coupling of DC Motor- Generator set then Generator-Alternator set in the power generating station. Finally AC power will generate and then it will step-up in to higher ratings and ratings should be suitable for long distance transmission lines.

Objectives of Solar Power Satellite

The new millennium has introduced increased pressure for finding new renewable energy sources. The exponential increase in population has led to the global crises such as global warming, environmental pollution and change and rapid decrease of fossil reservoirs. Also the demand of electric power increases at a much higher pace than other energy demands as the world is industrialized and computerized. Under in these circumstances, research has been carried out to look into the possibility of building a power station in space to transmit electricity to Earth by way of Radio waves the Solar Power Satellites.

Objectives of Microwave Transmission

The power generated in space can be transmitted to earth as microwave signals which can be collected with the help of an antenna called Rectenna and then converted into electric power. Individuals have discussed the use of space solar power systems (SPS) as a prominent means of supplying energy to the earth to replace and conserve non-renewable sources of energy. The significance of greenhouse effect resulting from burning fossil fuels and escalating prices of fossil fuels have again brought to the public's attention the possibility of utilizing renewable energy sources. The time is certainly appropriate to reexamine the SPS project for making use of the abandon solar energy for generating electricity.

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Advantages

The idea collecting solar energy in space and returning it to earth using microwave beam has many attractions,

- 1) The full solar irradiation would be available at all times except when the sun is eclipsed by the earth. Thus about five times energy could be collected, compared with the best terrestrial sites.
- 2) The power could be directed to any point on the earth's surface.
- 3) The zero gravity and high vacuum condition in space would allow much lighter, low maintenance structures and collectors.
- 4) The power density would be uninterrupted by darkness, clouds, or precipitation, which are the problems encountered with earth based solar arrays.
- 5) The realization of the SPS concept holds great promises for solving energy crisis.
- 6) No moving parts.
- 7) No Fuel Required.
- 8) No Waste Product.

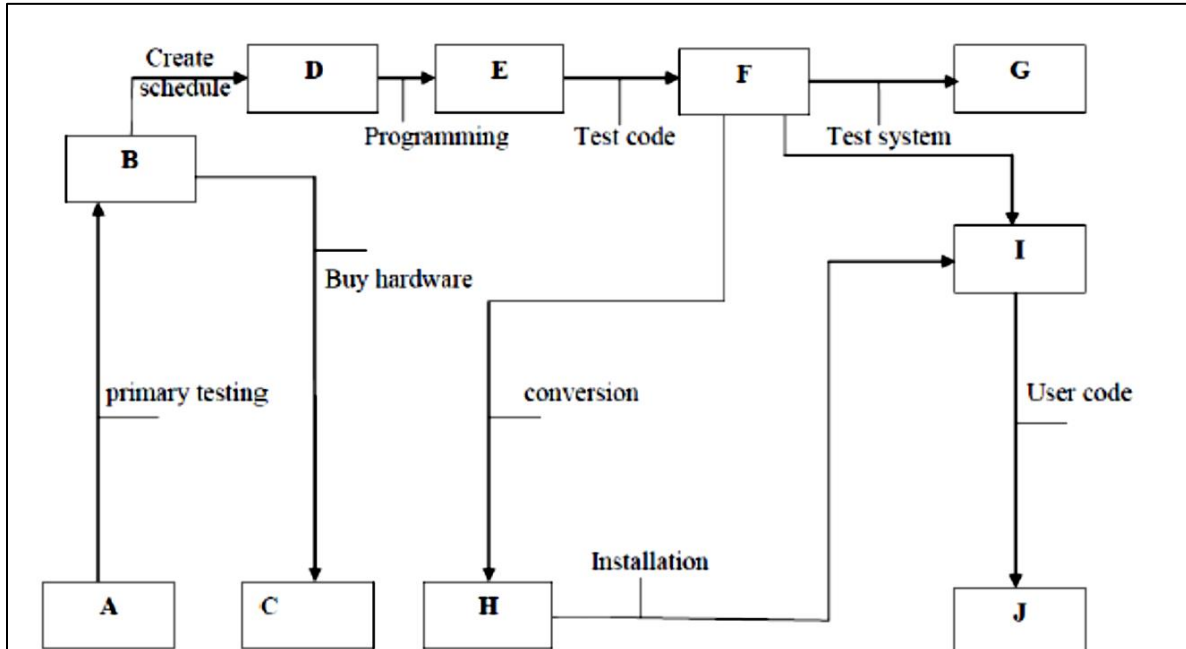
Disadvantages

- 1) The main drawback of solar energy transfer from orbit is the storage of electricity during off peak demand hours.
- 2) The frequency of beamed radiation is planned to be at 2.45 GHz and this frequency is used by communication satellites also.
- 3) The entire structure is massive.
- 4) High cost and requires much time for construction.
- 5) Radiation hazards associated with the system.
- 6) Risks involved with malfunction.
- 7) High power microwave source and high gain antenna can be used to deliver an intense burst of energy to a target and thus used as a weapon.

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4. Methods and Program Evaluation Review Technique [PERT] Chart

Solar Power Satellite and Microwave Transmission from Space to Earth



Where,

A= Geosynchronous Satellite Launch Vehicle

B= Solar Power Satellite

C= Set of Timer

D= Satellite Photo Voltaic Arrays

E= DC filters

F= Nickel Cadmium Battery

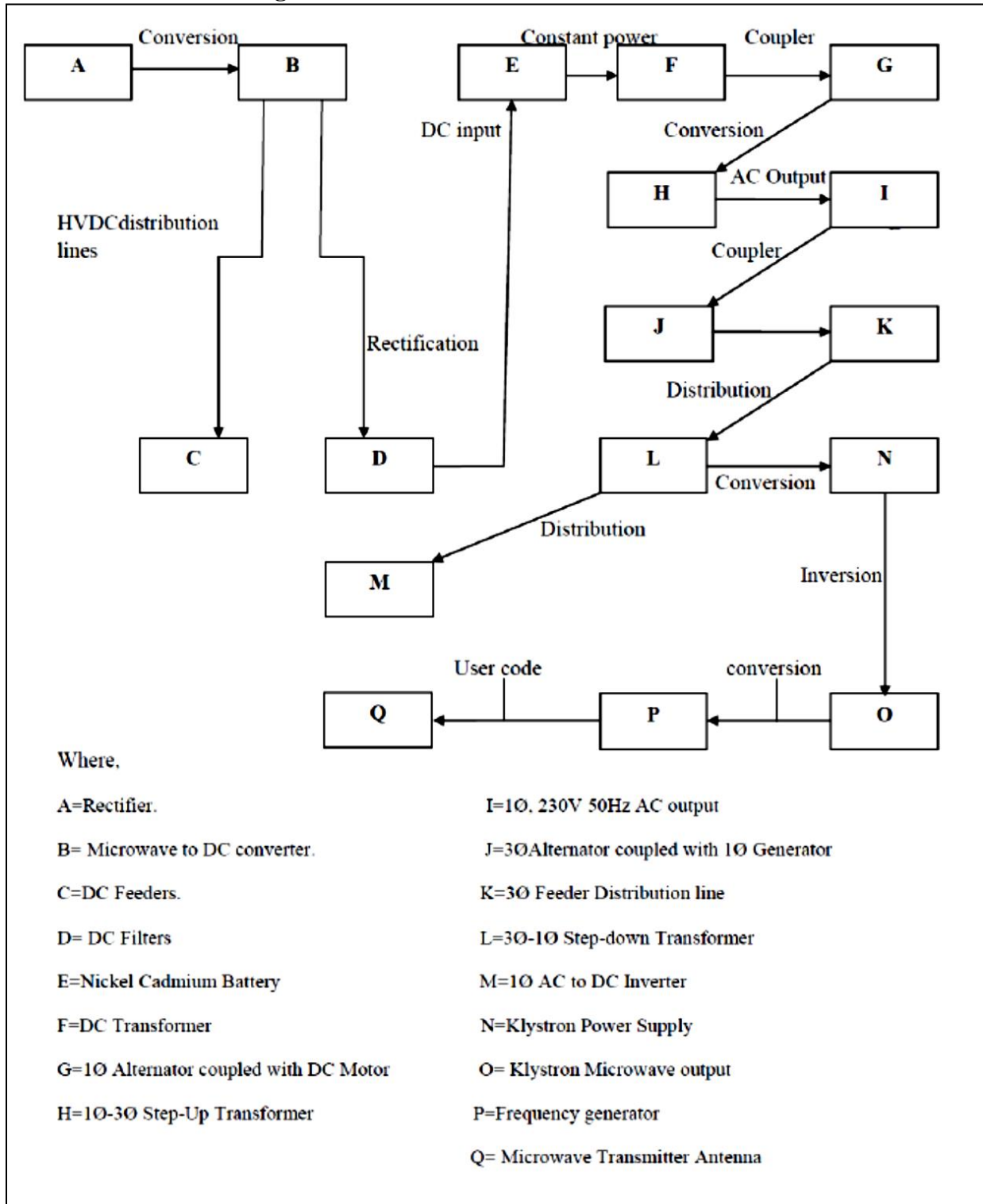
G= Satellite Operation

H= Microwave Converter

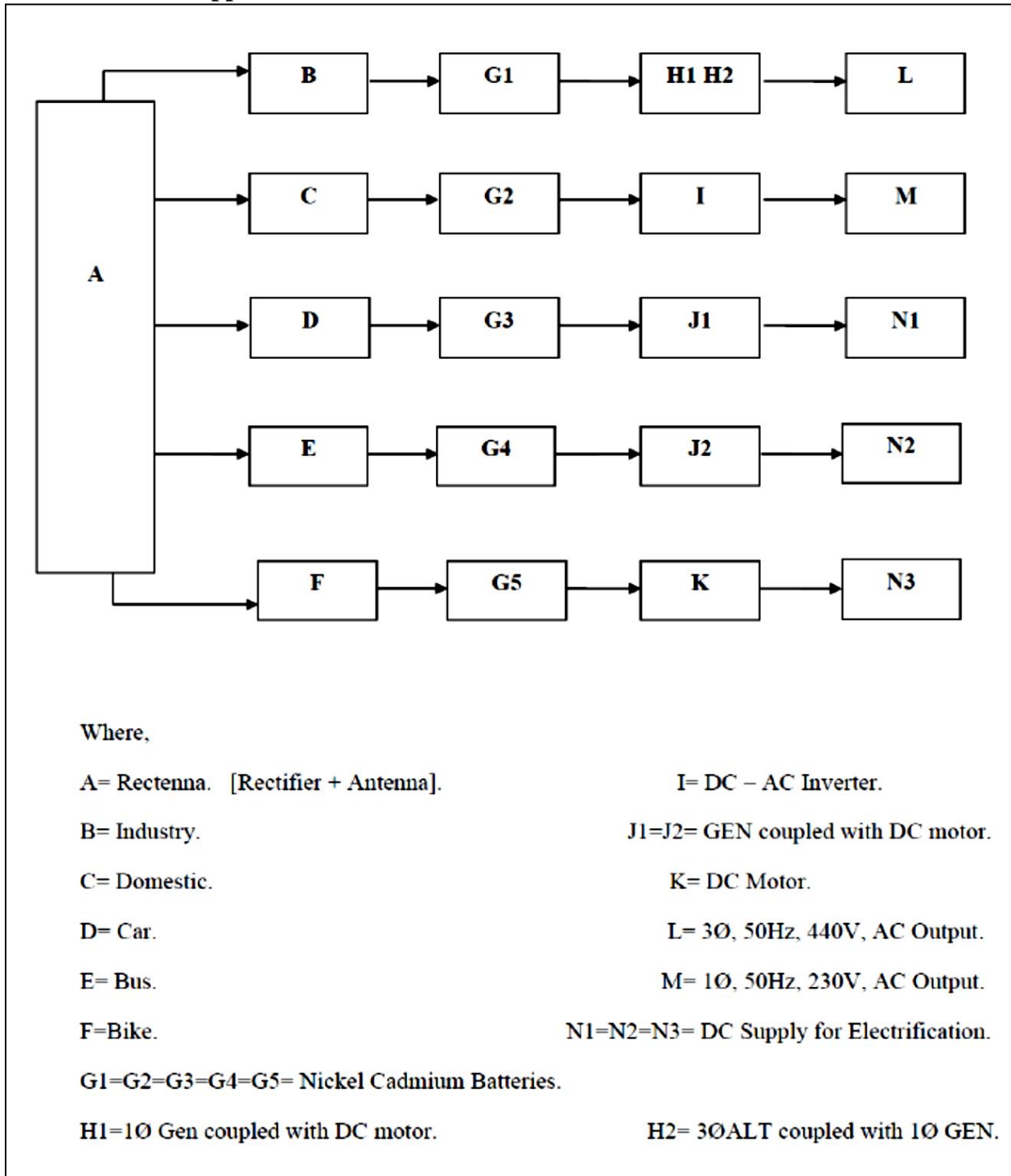
I= Frequency Generator

J= Microwave Transmitter Antenna

Ground Based Generating Station and Wireless Power Transmission



Rectenna and its Applications



5. Conclusions & Recommendations

The SPS will be a central attraction of space and energy technology in coming decades. However, large scale retro directive power transmission has not yet been proven and needs

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further development. Another important area of technological development will be the reduction of the size and weight of individual elements in the space section of SPS. Large-scale transportation and robotics for the construction of large-scale structures in space include the other major fields of technologies requiring further developments. The electromagnetic energy is a tool to improve the quality of life for mankind. It is not a pollutant but more aptly, a man made extension of the naturally generated electromagnetic spectrum that provides heat and light for our sustenance. From this view point, the SPS is merely a down frequency converter from the visible spectrum to microwaves.

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