# Chapter 7: Conclusion and Future Scope

## 7.1. Conclusions

High power wireless transmission for large distance via microwave is the key issue for the feasibility of satellite solar power station (SSPS), and many techniques have been developed. Besides others, research should focus on the reduction of space segment's components dimension and space vehicle dispatch cost.

- As SSPS total system cost reduction is desirable, and therefore an economic model of the system is proposed where it has interrelated parameters those are optimized for the high efficiency and cost-effective performance. Then, a cost minimization method is derived, and results are investigated for economically efficient SSPS prototype design. The Derived economic model can be utilized for any microwave-based wireless power transfer system because of generalized mathematical Expressions used. The effect of transmitting antenna size is investigated for the desired power density on the receiving ground antenna, and it is found that its size reduction is possible which reduces total system cost.
- The Levelized cost of energy (LCOE) is also calculated for the SSPS, and it is found comparable with conventional energy resources which motivate future research scope in SSPS.
- Also in this thesis, various cost effective and reduced size rectennas are proposed. An improved CP rectenna with reduced size using CMRC is proposed. Rectenna

size can be further reduced by eliminating CMRC or any BPF, and a CP rectenna without BPF is proposed. The proposed rectenna is fabricated and tested and results are found satisfactory. Therefore, this low profile rectenna strategy is suitable for cost-effective highly efficient and onboard rectenna.

- At lower RF input rectenna efficiency is poor and to solve this problem DSFR technique is also proposed which is found improved than the convention SSFR.
- CP rectenna is suitable for SSPS or WPT application, because it reduces the polarization loss. In contrast a LP antenna array with differential feed technique is proposed which provides low-level cross polarization in both E-plane and H-plane due to differential feed peak gain is improved. The proposed antenna array with differential feed is connected to rectifier and its efficiency is highly improved in comparison with single fed antenna array.
- Rectenna efficiency is highly dependent on the connected load, and for a specific resistance it provides maximum power. Unfortunately, the energy storage units like a rechargeable battery or supercapacitor do not have voltage/ current characteristics of a resistor. To solve this problem a power management circuitry is proposed utilizing resistance emulation technique.
- Harmonic harvester scheme integrated power management circuitry is also developed. Dual input buck-boost topology is used and interfacing switches operate in complementary pulsed mode to realize respective matching load resistances. An open loop simple control management is used for the two rectifier sources those are sharing load, fundamental rectifier feeding power in DCM for $(1-k)T_{LF}$ and harmonic harvester rectifier feeding power in DCM for $kT_{LF}$. Harmonic harvester Rectenna experimental results are presented for multiple

input power levels. The proposed technique provides a simple solution for low power energy harvesting with maximal power transfer.

## 7.2. Future scope

In SSPS operating frequencies of 2.45 GHz and 5.8 GHz are found suitable. The challenges in higher frequency SSPS operation should be explored. SSPS real model is not available so far. Thus a pilot demonstration is desirable for practical measurements. SSPS utilizes microwave beamforming technique for transmitting power wirelessly, and 10 dB tapered Gaussian beam is found suitable which implies that ground rectenna receives power density that is a bell-shaped curve. There are high chances of unbalanced rectenna array. Thus the design of balanced rectenna array considering Gaussian tapered beam should be investigated. Moreover, SSPS is considered to feed utility grid, but most of the research so far is using resistive load. Rectenna with resistive load converts RF-DC efficiently. In contrast, resistive load should be replaced with energy storage element such that stored DC power can be further processed into alternating current (AC) power, and SSPS can be utilized to feed grid with significant amount of power.