

A Survey of Radio Frequency Energy Harvesting Techniques: Towards Effective Powering of Mobile Devices

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Abstract

The fundamental goal of energy harvesting systems is to reduce the need for a wired power supply or battery replacements. Radio Frequency (RF) energy harvesting has been established as a viable alternative for powering mobile devices without increasing greenhouse gas (GHG) emission which is a threat to the environment. However, there are challenges facing the effective harvesting of appreciable energy for these devices. Low RF power harvestable from various sources and low radio frequency-direct current (RF-DC) conversion efficiency have made it a very difficult task to harvest sufficient power to drive mobile devices such as smartphones. Lower frequency RF sources could yield appreciable harvestable energy but this comes with the challenge of portable antennas that could match these frequencies. This paper presents various RF energy harvesting techniques in literature and discusses some of the difficulties encountered by researchers while designing RF energy harvesting circuits. The significance of adopting alternative renewable sources to power mobile devices in the face of the looming global energy crisis while avoiding global warming was highlighted. Additionally, suggestions for future work aimed at harvesting enough energy to power smartphones and other mobile devices were presented.

Keywords

RF energy harvesting, conversion efficiency, RF power, greenhouse gas, smartphones, mobile devices.

Biographies

Lukman Salihu holds a B.Eng. degree in Computer Engineering from Bayero University Kano, Nigeria. He is currently working towards his M.Eng. degree in Communications Engineering in the department of Telecommunication Engineering, Federal University of Technology Minna, Nigeria. His research area is Radio Frequency Energy Harvesting.

James Agajo is an Associate Professor and a highly motivated career-driven achiever with over 21 years of lecturing and research experience in the field of Wireless Communication, Computer System design, Spectrum Management, Industrial Automation, Signal Processing Research, and Project Development with over 90 publications in high profile journals. He received a Bachelor of Engineering (B.Eng) Degree in Electrical and Computer Engineering from the Federal University of Technology Minna, and a Master's of Engineering (M.Eng.) Degree in Electronics and Telecommunication Engineering from Nnamdi Azikiwe University, with a (Ph.D.) in Telecommunication and Computer Engineering from Nnamdi Azikiwe University. He is presently an Associate Professor and Head of Department of Computer Engineering at the Federal University of Technology Minna. He is Presently an Examiner at various universities among which are the University of Johannesburg South Africa, Ahmadu Bello University, and more. Presently he is a visiting Lecturer at Federal University of Petroleum Resources Effurun, Nile University Abuja, Kebbi State University of Science and Technology Kebbi, and the University of Pretoria. He is a member of many bodies amongst which are the International Association of Computer Science and Information Technology (IACSIT), HEDON (Clean Energy Group), Partnership for Clean Indoor Air (PCIA), Nigeria Society for Engineers (NSE), International Association of Engineers (IAENG), Society of Satellite Professional International (SSPI). He is also a member Renewable Energy Application Group of Nigeria (MREAGN). He is a fellow of the Institute of Policy Management and Development (IPMD), also an ICT/oil and Gas Consultant. He is happily married with kids.

Bala Alhaji Salihu received the B.Eng. and M.S. degrees in electrical and computer engineering from the Federal University of Technology, Minna, Nigeria, in 2004 and 2011, respectively, and the Ph.D. degree in communication and information systems from Beijing University of Posts and Telecommunications, Beijing, China, in 2015. From 2006 to 2010, he worked as an Assistance Lecturer in the Department of Electrical and Computer Engineering, Federal University of Technology, and later transferred to Telecommunication Engineering Department in 2010. His research interests include wireless communication, network architecture, network management systems, and radio resource management in LTE-Advanced.

Supreme Ayewoh Okoh holds a B.Eng. degree in Telecommunication Engineering from the Federal University of Technology (FUT) Minna, Nigeria with first class honors. He is currently working towards his M.Eng. degree in Communications Engineering at the same university, and an M.Ed. degree in Advanced Teaching at University of the People, Pasadena California, USA. He is a recipient of various awards such as Total Petroleum scholarship award (2014), the best graduating student award from the department of Telecommunication Engineering FUT Minna (2018), the University of the People scholarship award (2021), etc. He is a Cisco Certified Network Associate (CCNA) and a Huawei Certified ICT Associate (HCIA). He is a member of IOEM Society International, Michigan USA, and the Nigeria Society of Engineers (NSE). He is also a member of IWTC research group Abuja Nigeria, and Green Wireless Networking Research Group (GreenWiN) FUT Minna. His research interests include bio-signal processing, machine learning, precision agriculture, spectrum management, network security, optimization algorithms & soft computing, blockchain technology, big data analytics, cloud computing, internet of things, adolescent development, spiritual intelligence, and measurement & evaluation.