Dwindle Carbon Footprint During Mobile Communication

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Abstract-- *The requirement of next mobile telecommunication methods is to deliver the energy consumption minimization and greenhouse gas emissions minimization approach for ICT (information and communications technology) industries and improve the bandwidth utilization as well as data rates. Since from last decade, there has been some improved solutions already proposed, however still their big requirement for a holistic technique and research over the system level innovations. EARTH and Green Touch are two recent projects introduced for energy efficient solutions in wireless access networks. EARTH project proposed to improve the 3G and 4G communication systems with aiming to deliver solutions for energy efficient deployments. Another recent project for energy efficiency based communications in mobile access networks is Green. Green Touch is recently introduced by the tea of Green Touch. These methods having overall goal is to enable wireless access network energy efficiency. The limitations of this approaches is that there is no proof-of-concepts to claim efficiency for energy. In addition to this, there is no extensive analysis for data rates and bandwidth utilization. In this paper we are presenting hybrid approach for energy efficiency as well as data rates efficiency. This hybrid approach is based on advantages of both EARTH and Green Touch methods. The performance analysis is done using NS2 simulation tool for performance metrics such as data rate, energy efficiency etc.*

Keywords-CO2 Emission, Energy Consumption, Data Rate, Earth, Green Touch, Mobile Communications, ICT.

I. INTRODUCTION

Since from the last decade there is tremendous growth in mobile cellular communications in terms of the connected wireless resources, as well as demand for new services and ubiquitous connectivity, this resulted into excessive energy consumption in wireless access networks is significantly increasing. The increasing energy consumption resulted into the big research challenge for mobile operators because of increasing energy cost as well as increasing problem of sustainable development and global warming. Hence, it becomes urgent for mobile operators to support vastly different QoS (quality of service) needs of increasing number of users in an energy efficient manner. To support access to information anywhere, and anytime at a low energy consumption would require a paradigm shift in the network design objective [1].

Since the introduction of GSM in the 1980's, mobile wireless services have experienced a tremendous evolution and become important components of daily life. Today, there are more than 4 billion mobile subscriptions in the world; more than half of the population. In 2008, the number of mobile subscriptions overtook the total number of fixed broadband subscriptions (only about 1.3 billion worldwide) [2] [3]. The driving force behind this rapid growth is the introduction of wireless packet data networks which enabled mobile internet usage in the beginning of 21th century and fundamentally changed the direction of wireless access networks. Mobile operators experienced a major breakthrough in 2007 when for the first time the aggregate amount of data traffic exceeded voice traffic. This resulted in a paradigm shift from low bandwidth services, such as voice and short message, to bandwidth hungry data services.

Forecasts of the telecommunication market indicate a continued rise in the number of mobile subscribers and their monthly data demand—these are the fundamental drivers of traffic growth [4]. According to surveys, global mobile penetration rate will reach 100 percent after 2020 [2]. Moreover, as the internet of things becomes a reality, there will be massive growth in the number of connected devices—which is expected to be around 50 billion devices by 2020; ranging from ultra-low power sensors to machines. Simultaneously, the introduction of data hungry devices such as smartphones and tablets and associated applications are expected to lead to a thousand-fold traffic increase in 2020 in comparison with 2010 result in a monthly data traffic of 200 Exabyte's world-wide [4], [5], [6]. A common belief is that future wireless access networks will need to cope with vastly different challenges and expectations than they do today.

The growing demand for ubiquitous connectivity and new services, however, comes with an undesired consequence

of increasing energy consumption. At present time ICT is having issues of using approximately 3 % of electricity consumption all over the world in which around 10 % electricity consumption done by WANs at 60 billion kWh per year [7]. This consumption corresponds to typical annual electricity consumption of 20 million European households. Annual electricity consumption has risen 16-20 percent every year, corresponding to a twofold increase in every 4-5 years [8].

Such conditions resulting into the problem for mobile operators as increasing energy consumption along with costs of energy directly result into growing OPEX (operational expenditures). In fact, operators' cost figures show that nowadays the energy cost of running a network constitutes almost 50 percent of overall OPEX [9, 10]. It should be noted that this cost is not only due to the direct cost of electricity, but also comes from the operation of off-(electrical) grid base stations (BSs) in the network. In such cases, especially in many emerging markets, delivering fuel to the BS sites accounts for a significant share of the operator's total energy cost [9].

In addition to rising operational expenditures, there is another important consequence of increasing energy consumption: carbon-dioxide (CO2) emissions whose devastating impact on climate change has been highlighted in many recent studies [11], [12]. The reports show that ICT, the fifth largest industry in power consumption, emits 2 percent of the world-wide CO2 representing approximately one fourth of the emissions produced by cars. Despite the fact that these numbers look rather small, they are expected to increase by nearly a factor of 3 due to upward trend in energy consumption [2], [8], [9] and [11]. This issue motivates governments to take political action in order to prevent global warming. In 2008, the European Commissions (EC) decided to lower CO2 emissions by 20 percent by 2020. This also creates another strong driving force for mobile operators. The aforementioned figures regarding energy consumption and its consequences on OPEX and CO2 emissions may be outdated or inaccurate due to the rapidly evolving ICT environment. However, they clearly indicate that sustainability of ICT and mobile radio networks are at risk—unless there are changes to address these issues. Therefore, in order to enable the continuation of the global success of ICT, which is the core of many achievements of today's networked society, it is essential to change the present growth trend of energy consumption. In this paper we are first evaluating the existing current energy efficient solutions such as EARTH and GREEN Touch and then presenting proposed solution which is based on both EARTH and GREEN Touch projects. The goal of this proposed hybrid method is to improve the performance of energy efficiency along with data rate.

In this paper, section II discussing the on current problems in green wireless access networks and current solutions, section III presenting the framework for proposed method with its design and algorithm details. Section IV presenting the current results achieved so far in this research with expected outcomes. In section V, conclusion and future work discussed.

II. RELATED WORK

2.1. Challenges

Due to the reasons described in the previous subsection, one of the biggest challenges for mobile operators is to provide 1000-fold capacity to 50 billion devices, requiring access to information anywhere and anytime to anyone and anything, in an affordable and sustainable way. In this regard, identification of the most promising areas where the largest improvements could take place is highly important. As was noted energy consumption of the mobile terminals constitutes only a small fraction of the total mainly due to the fact that strict battery constraints of the terminals lead to low power consumption solutions resulting in high energy efficiency.

Current mobile radio networks have been optimized for quality of service, coverage, scalability, etc.—energy was not explicitly included as a design objective. This situation introduces some technical drawbacks impairing the realization of green wireless access. These drawbacks can be summarized as follows:

- Equipment Level Challenges: Current hardware for BSs are generally optimized for maximum load scenarios and due to lack of scalability, these components operate at sub-optimal points most of the time. This situation leads to significant energy loss at the equipment level.
- Node Level Challenges: Similar problem occurs at the node level due to the fact that BSs are designed to guarantee a certain level quality of service (QoS) at any time and energy consumption adaptation in accordance with traffic is inadequate. Additionally, strong requirements for high system throughput and low latency set an upper bound for the average resource utilization to lower radio interference levels and wastes energy, especially under medium and low load conditions.
- Network Level Challenges: From a network perspective, the main challenge originates due to the known trade-off between energy consumption and network performance. Therefore, a decision on which entity is more important, e.g., higher performance or lower energy consumption,

and how much performance degradation is allowed for a certain energy saving create a challenge for the operators. Moreover, due to the fact that wireless access networks are often dimensioned for peak hour traffic, energy is wasted primarily for two reasons: 1) Mobile traffic shows significant variation in both spatial and temporal domains; and 2) Power consumption of the BSs are almost load-independent.

Overcoming these challenges creates a vast potential for an improvement in energy efficiency of wireless access networks. However, there is a need for a paradigm shift in network design objectives and a holistic system approach needs to be taken instead of waiting on incremental improvements in BS equipment.

2.2 Current Solutions

As the increasing prices of energy as well as increasing issues of environment, efficiency in energy has become a hot research topic amongst network operators, their equipment suppliers, academia, and the regulatory and standardization bodies like 3GPP (Third Generation Partnership Project), ITU (International Telecommunication Union), ETSI (European Telecommunication Standards Institute). This trend has created an innovative research area called green radio. With financial support from governments, many green projects were initiated by several consortia of industry and academia over the last few years in order to reduce CO2 emissions.

In this respect, they aim to define a unified approach while taking components, node architectures, radio transmission techniques, and network architectures into account.

Among the main projects, Mobile VCE Green Radio [15] aims at developing green radio architectures, focusing mostly on BS design issues such as power amplifiers (PAs), sleep modes, etc. OperaNet (Optimising power efficiency in mobile radio Networks) [16] proposes a holistic approach considering a complete end-to-end system with optimized cooling systems, terminal design, energy recovery in base stations, etc. Greentouch [14] has a ambitious goal of improving the energy efficiency of ICT networks (optical, wireless, etc.) by a factor of 1000 by 2015 when compared to 2010 levels mainly by introducing a fundamentally new network architecture. On the other hand, the EARTH (Energy Aware Radio and network technologies) consortium [10] presents an integrated approach and aims at minimizing the energy consumption of LTE networks with solutions at each of the level from the lowest level up to the system level.

But such initiatives aiming for the selecting enhancements. Generally there are two methods are possible for system wide and rigid solution for energy efficiency such as either clean slate method with totally disruptive redesign of the wireless access networks or holistic processing of potential enhancements can be undertaken depending on present 4G systems. Recently there are two such methods introduced by Alcatel Lucent groups such as EARTH as well as Green Touch as discussed in above section. Both EARTH and Green Touch having advantages and disadvantages. Existing methods EARTH and Green touch introduced to provide solutions for energy efficiency, but there is no proof-of-concepts.

III. PROPOSED METHODOLOGY

3.1. Problem Definition

Now day's use of wireless networks such as wireless sensor networks (WSNs), mobile ad hoc networks (MANET) is growing all over the world for radio communications. Especially WSNs are majorly used in crucial areas and applications. Due to the increasing data communications in such networks, energy consumption is increasing more and more. As wireless networks consume increasing amount of energy, this contribute a growing fraction to the CO2 emissions of global information and communications technology (ICT) industry. The CO2 emissions should be minimized by using energy efficient approaches in wireless networks. Since from last 15 years, there has been a significant interest in energy efficiency in sensor networks as well as multihop mesh network because of limited battery life of the communicating nodes. The Energy Aware Radio and Network Technologies (EARTH) and Green Touch are recent methods for solution to energy efficiency in radio communication networks. However the performance evaluation of both approaches has not yet conducted for their energy efficient solutions.

3.2. Solution

In this paper, to overcome the limitations associated with latest energy efficient projects such as EARTH and Green Touch, we have two objectives (1) to evaluate the performance of EARTH and Green Touch for data rate and energy efficiency. (2) To design and evaluate the proposed hybrid method for energy efficiency and data rate improvement. By considering it, below figure 1 is showing the detailed flowchart for practical work and results analysis. Figure showing that we have evaluated two existing methods against proposed Hybrid method with four important performance metrics for green WANs.

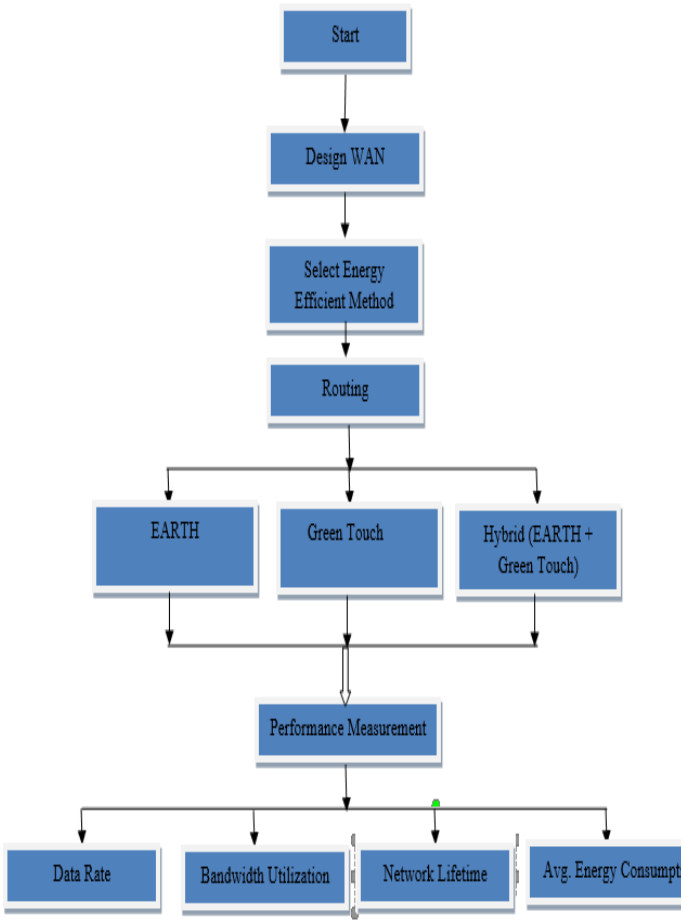

Figure 1: Flowchart of simulation work

A. ***EARTH:*** EARTH stands for Energy Aware Radio andNetwork Technologies, which started in 2010 by 15 researchers from various places such as academia, SMEs (small and medium enterprises) which is also known as EU FP7 in order to find the proper solutions to overcome the challenges of energy efficiency.

- This project is based on unified method in order to target the entire system from perspective of energy efficiency.
- The main focus of EARTH project is on cellular broadband wireless networks with the future wireless systems such as LTE and LTE-advanced.
- The main aim of the EARTH project is to deliver the tangible outputs like energy aware management methods, improved deployment strategies and network architectures, innovating designs of component designs with goal of improved energy efficiency.
- Ambitious goal was set by EARTH project for reducing the overall consumption of energy in mobile broadband wireless networks by the 50 % approximately and hence resulted into significant reduction in CO2 emission as well as energy costs.
- During the less load conditions, most of energy consumption reduction is achieved by ensuring the fact that wireless access networks energy consumption is proportional to traffic load.

B. ***Green Touch:*** After EARTH, Green Touch is another project recently announced project with goal of energy efficiency in wireless access networks.

- This project analysed the basic limits of systems of global communication by studying the principles of computer sciences and information theory.
- This resulted into the fact that basic physical limits allowing to design the system which is having many orders of magnitude. These are more efficient as compared to current systems.
- But the factors like deployed infrastructure, downwards compatibility, current technology performance etc. difficult for realization.
- The Labs of Alcatel-Lucent Bell were initiated process to shift such barriers to the unprecedented energy efficiency and hence formed the consortium of resource manufactures leading academia and network operators.
- Therefore the goal is to totally rethink on communication methods in order analyse the theoretical solutions with aim of addressing the research in electronic devices and information theory.

C. ***Proposed Algorithm:***The proposed method for energy efficiency in Green WANs is based on two existing well know projects EARTH and Green Touch. This protocol is introduced to balance both load in network and energy consumption in order to control the excessive CO2 emission. This hybrid approach is based on advantages of both EARTH and Green Touch methods through our extensive performance analysis and results. Below algorithm is designed to achieve both data rate improvement and energy efficiency.

Algorithm 1: EAGR [EARTH-GREEN TOUCH]

1. Extracting the packet information initially.
2. Defining pointer to routing table.
3. DA localization based on measuring the depth from sink node.
4. FA localization based on extraction of neighbouring nodes information from the sink node.
5. Selecting the shortest route for data communication between source to destination node.
6. Routing table updating frequently.

7. During the communication apply function for energy efficiency monitoring.
8. Before actual data transfer, translate all nodes in sleep mode to save energy consumption except the actual source node.
9. Once shorted path selected, activate all intermediate nodes in FA.
10. Data forwarding done according load balancing approach of EARTH.
11. For energy monitoring applying Green Touch Method.
12. Both EARTH approach for load balancing and Green Touch applied tighter in below subsequent steps:
13. If energy level of any node goes below threshold or load on node goes particular threshold, then finds another alternate path in order to balance load or improved the network lifetime performance
14. If any node detects all its lower depth nodes below current threshold value, then it calculates new threshold and, start sending data on those paths again.
15. Repeat this process still to the simulation ends.
16. End.

IV. EXPERIMENTAL RESULTS

4.1. Network Configurations

The practical analysis and evaluation is done by using NS2. We have implemented and simulated three methods of energy efficiency. We have used the NS2 version ns-allinone-2.32. Below table 1 is showing the network scenarios and configurations.

Table 1: Network scenario configuration

Wireless Access Network Size	25/50/75/100/125/150
Type of Traffic or Data	Constant Bit Rate
Size of Network	1000 x 1000
Total Simulation Period	50s
Rate of Packet Transmission	10 m/s
Pause Time	1.0s
Method	EARTH/Green Touch / EAGR
MAC Protocol	802.22
Channel Data Rate	11 Mbps
Mobility Speed	10 m/

4.2. Simulation Results

Below graphs are indicating performance analysis and results achieved for all three methods such as EARTH, Green Touch and EAGR on green wireless access networks. For energy consumption, energy consumption of EARTH is showing more when network is small size as compared to Green Touch and it's vice versa for large size networks. Proposed method showing less energy consumption for all types of networks as compared to EARTH and Green Touch. Figure 2 and 3 showing the energy efficiency performance analysis.

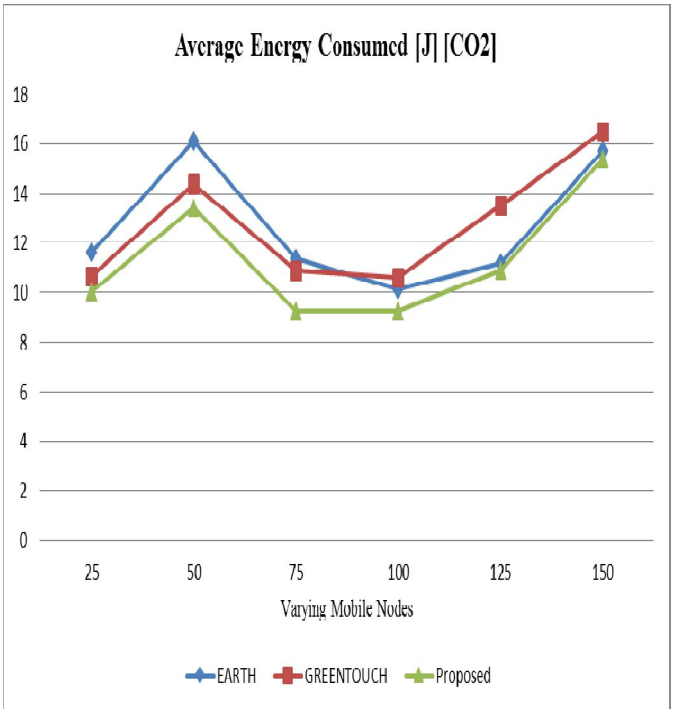

Figure 2: Performance Analysis of Average Energy Consumed.

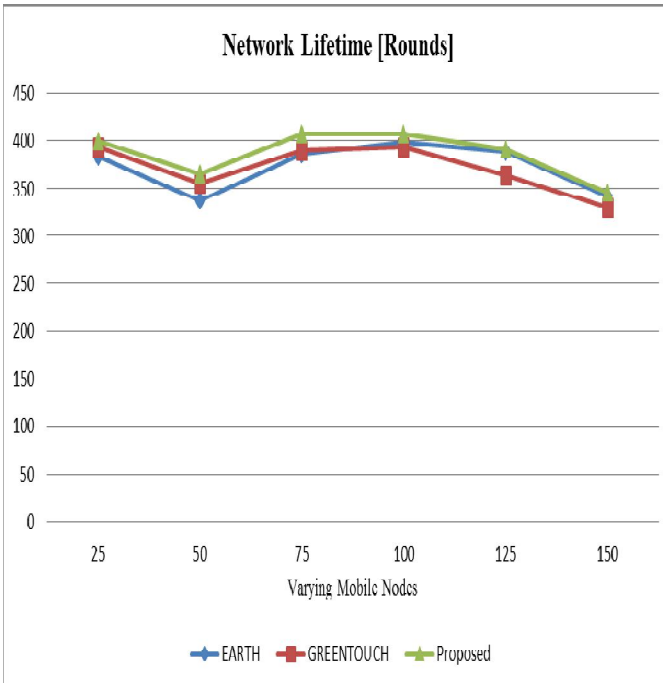

Figure 3: Performance Analysis of Network Lifetime

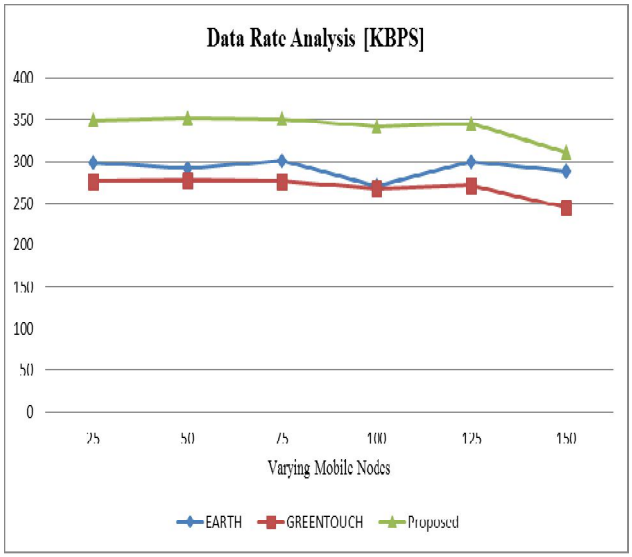

Figure 4: Performance Analysis of Data Rate

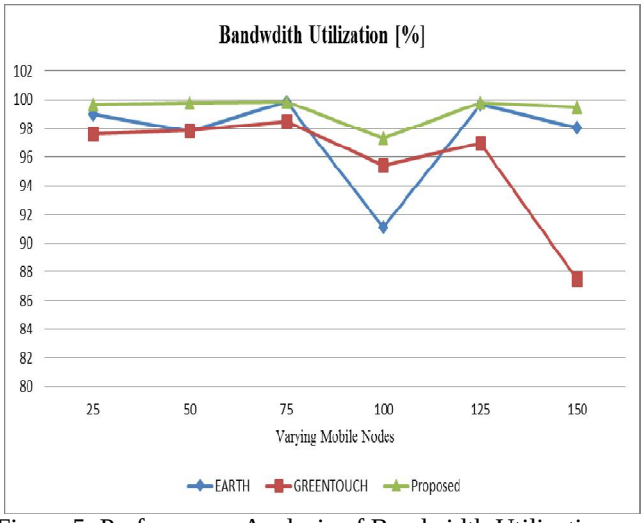

Figure 5: Performance Analysis of Bandwidth Utilization

Figure 4 and 5 showing that along with both data rate and bandwidth performance is improved as compared to both existing methods.

V. CONCLUSION AND FUTURE WORK

In this paper reported the current challenges and issues of green wireless access networks. The energy consumptions from mobile devices in WANs resulted into CO2 emissions, hence to control the CO2 emissions, number of research projects has been going on to improve the energy efficiency performance of WANs. In this we studied and evaluated two recent energy efficient projects such as EARTH and Green Touch. Additionally proposed new hybrid algorithm for improving the performance of both data and energy efficiency as compared to existing methods. From the practical results it is showing that performance of proposed method is improved as compared to existing methods.

REFERENCES

[1] R. Samuelson, "The Moral Challenge of Globalization," Washington Post, May 2008.

[2] A. Fehske, G. Fettweis, J. Malmodin, and G. Biczok, "The global footprint of mobile communications: The ecological and economic perspective," IEEE Communications Magazine, vol. 49, no. 8, pp. 55–62, 2011.

[3] S. Aleksic, M. Deruyck, W. Vereecken, W. Joseph, M. Pickavet, and L. Martens, "Energy efficiency of femtocell deployment in combined wireless optical access networks," Elsevier Computer Networks, vol. 57, no. 5, pp. 1217 – 1233, Apr. 2013.

[4] Cisco Inc., "Cisco visual networking index: Global mobile data traffic forecast update, 2013-2018," February 2014.

[5] A. Osseiran, V. Braun, T. Hidekazu, P. Marsch, H. Schotten, H. Tullberg, M. Uusitalo, and M. Schellman, "The Foundation of the Mobile and Wireless Communications System for 2020 and Beyond: Challenges, Enablers and Technology Solutions," in Proc. of IEEE Vehic. Technol. Conf. (VTC Spring), Dresden, Germany, June 2013.

[6] J. Zander and P. Mahonen, "Riding the data tsunami in the cloud: myths and challenges in future wireless access," IEEE Communications Magazine, vol. 51, no. 3, pp. 145–151, March 2013.

[7] S. Tombaz, A. Västberg, and J. Zander, "Energy and cost efficient ultra high capacity wireless access," IEEE Wireless Communications Magazine, vol. 18, no. 5, pp. 18–24, Oct. 2011.

[8] G. Fettweis, "ICT energy consumption: Trends and challenges," in Proc. Of Wireless Personal Multimedia Communications (WPMC), Lapland, Finland, Sept. 2008.
[9] 3GPP TSG-RAN WG1, "Enhanced network energy efficiency," Valencia, Spain, January 2010.
[10] [D. Zeller, M. Olsson, O. Blume, A. Fehske, D. Ferling, W. Tomaselli, and I. Gódor, "Sustainable Wireless Broadband Access to the Future Internet -The EARTH Project," in The Future Internet. Springer, 2013, vol. 7858, pp. 249–271.
[11] A. Bianzino, C. Chaudet, D. Rossi, and J. Rougier, "A survey of green networking research," Communications Surveys Tutorials, IEEE, vol. 14, no. 1, pp. 3–20, 2012.
[12] P. M. Cox, R. A. Betts, C. D. Jones, S. A. Spall, and I. J. Totterdell, "Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model," Nature, vol. 408, no. 1, pp. 184–187, 2000.
[13] C. Böhringer, T. F. Rutherford, and R. S. Tol, "THE EU 20/20/2020 targets: An overview of the EMF22 assessment," Elsevier Energy Economics, vol. 31, pp. 268–273, 2009.
[14] "AlcaLu Leads New Green Mission", Press Release, Jan 11th, 2010. http://www.lightreading.com/document.asp?doc_id=186549.
[15] C. Han, T. Harrold, S. Armour, I. Krikidis, S. Videv, P. Grant, H. Haas, J. Thompson, I. Ku, C. Wang, T. Le, M. Nakhai, J. Zhang, and L. Hanzo, "Green radio: radio techniques to enable energy-efficient wireless networks," IEEE Communications Magazine, vol. 49, no. 6, pp. 46–54, June 2011.
[16] D. Feng, C. Jiang, G. Lim, J. Cimini, L.J., G. Feng, and G. Li, "A survey of energy-efficient wireless communications," IEEE Communications Surveys Tutorials, vol. 15, no. 1, pp. 167–178, 2013.