Proceedings of the 2nd International Conference on Management Research and Economic Development
DOI: 10.54254/2754-1169/86/20240951

Research on Measurement of Direct ICT-enabled Social Carbon Reduction

Yonglian Weng[1,a], Tianjian Yang[1,b,*]

[1]*Modern Post College, Beijing University of Post and Telecommunications, Beijing, China*
a. wylldph@bupt.edu.cn, b. frankytj@bupt.edu.cn
**corresponding author*

Abstract: With the introduction of the concept of low-carbon economy, all countries in the world strive to achieve the coordinated development of economy, energy conservation and emission reduction. China has also announced its plan to the world to achieve carbon emission reduction. However, most places in China have not yet reached the stage of coexistence of low-carbon and economic development .and the emergence of information and communication technology has brought hope for the realization of this "win-win" goal. This paper synthesizes the three major international carbon emission reduction measurement standards and quantifies the potential of direct ICT-enabled social carbon reduction in combination with the research on the products of China Telecom Operator A, and forecasts the carbon reduction of Operator A in 2025 and 2030 in combination with its future business development. This study provides a reference for Chinese telecom operators to better realize the market expansion of low-carbon products.

Keywords: ICT, Carbon Reduction, Low Carbon Economy, Quantitative Measurement

1. Introduction

With the introduction of the concept of low-carbon economy, industrial development around the world is emphasizing energy conservation and environmental protection, striving to reduce the negative impact on society while ensuring economic development. China has also announced that it will strive to achieve carbon peak by 2030 and carbon neutrality by 2060, which has set a clear goal for Chinese low-carbon development. There is a complex relationship between economic development and carbon emissions. The increase of per capita output value in society is accompanied by the increase of energy consumption and production waste, which may bring adverse environmental impacts to society [1]. Although scientific and technological progress is alleviating the conflict between economic development and environment, even the developed provinces in eastern and central China have not reached the inflection point of the environmental Kuznets curve at present, and have not really achieved the goal of "win-win" economic development and low-carbon environmental protection [2]. Information and communication technology (ICT), as the representative technology of the new generation of scientific and technological revolution, also plays an important role in promoting Chinese low-carbon development process. In recent years, ICT has been deeply integrated with cloud computing, big data and artificial intelligence, and more ICT products have gradually entered the direct carbon reduction scenario from indirect enabling carbon reduction, promoting the development of society towards a low-carbon economy. Therefore, it is of

DOI: 10.54254/2754-1169/86/20240951

great significance to quantify the carbon reduction of direct ICT-enabled social carbon reduction, which can not only help technology developers understand the low-carbon energy saving potential under different application scenarios, but also provide guidance for the iteration of low-carbon technologies and products, so that low-carbon technologies can be used more widely.

2. Literature Review

At present, telecommunication enterprises in some countries have made some quantitative research on ICT enabled social energy conservation and carbon reduction. AT&T, an American telecommunication company, has announced that it has reduced 17.1 million tons of carbon dioxide emissions by providing information and communication technology products and programs to the society, which is 2.2 times of its own carbon emissions [3]. British Telecom, a British telecommunication company, estimated that by 2030, it could enable the society to achieve more than 60 million tons of carbon emission reduction through the large-scale implementation of the information and communication technology [4]. Deutsche Telekom, a German telecommunication company, has determined through research that in 2021, the company will bring more than 26 million tons of carbon emissions reduction to the society by providing customers with ICT solutions, which is 3.34 times of its own carbon emissions [5]. In the domestic research, Wang Xuan quantitatively calculated that the use of nationwide smart streetlight which supported by ICT could reduce 0.69 million tons carbon dioxide emissions for society [6].

In addition to the measurement of ICT enabled social carbon reduction in some countries, different international organizations have conducted measurement and research on the global ICT carbon reduction potential. GeSI (Global Electronic Sustainable Development Initiative), mentioned in its report “SMATER2020” that the five most potential areas of ICT energy conservation and emission reduction are smart machines, smart logistics, smart buildings, smart agriculture and dematerialization [7], and then it also released the report “SMATER2030”, which predicted that by 2030, the use of ICT in the whole society could reduce global carbon dioxide emissions by 20% [8]. GSMA (Global System for Mobile Association) has also measured that the emission reduction in smart work, life and health, smart cities, and smart transportation accounted for nearly 70% of the ICT enabled social emission reduction [9].

Current quantitative measurement in the field of ICT enabled social energy conservation and carbon reduction is mostly based on the results of foreign case studies, while there are few relevant studies in China, and there is also a lack of carbon emission reduction measurement for the whole business of operators. Therefore, this paper takes telecom operator A as an example to quantitatively measure the scale of direct ICT-enabled social carbon reduction and predicts the carbon reduction prospects in 2025 and 2030 in combination with its business volume development scale.

3. Quantitative Measurement Method

At present, there are many carbon reduction measurement methodologies in international organizations. In order to make the carbon reduction measurement results more reasonable, this paper selects the carbon reduction measurement methodology adopted by GeSI, GSMA and WRI.

3.1. Three International Carbon Emission Reduction Measurement Methodology

GeSI used the measurement method of emission reduction effect based on LCA of product life cycle in its report. This carbon emission reduction measurement method divides the scenarios into BAU (Business as Usual) traditional system without ICT and the scenarios with ICT system. Two effects are considered in the measurement of carbon emissions: enabling effect and rebound effect. Enabling effect refers to the effect of ICT reducing non-ICT system emissions, that is, the reduction of carbon emissions brought by ICT system in this scenario; The rebound effect refers to the increase effect of carbon emissions caused by the increase of ICT system, which generally comes from the carbon emissions generated during the production and operation of ICT system itself. Therefore, carbon emission reduction can be calculated by subtracting rebound effect from enabling effect brought by ICT system.

In its report, GSMA mainly used coefficient theory measurement methodology. The carbon emission reduction calculation of GSMA is most commonly used to calculate the carbon emission reduction of ICT enabled society by way of connected equipment. The data sources in the coefficient theoretical calculation method of GSMA mainly include three dimensions: carbon emission coefficient data, terminal equipment quantity data, and user behavior survey data. In order to ensure the accuracy of the calculation results, the coefficient theory method requires high data accuracy.

The GHG measurement methodology proposed by WRI and WBCSD includes “GHG Protocol for Corporate” and “GHG Protocol for Project” and The low-carbon products investigated in this paper belong to “GHG Protocol for Project”. This inventory method includes the following steps: setting GHG inventory boundary, selecting baseline, determining candidate baseline, estimating baseline carbon emissions, detecting and quantifying GHG emissions reductions, and reporting GHG emissions reductions. “GHG Protocol for Project” is a carbon reduction measurement method that is widely used internationally and highly recognized by the public.

3.2. ICT enabled Social Carbon Reduction Measurement Methodology

As the operators involved in this paper directly enable social carbon reduction products to reduce emissions in a variety of ways and data sources, in order to meet the actual needs of each product, this paper integrates the carbon reduction measurement methodology proposed by GeSI, GSMA and WRI, and quantifies operator A direct ICT-enabled social carbon reduction products. The specific calculation process is shown in Figure 1.

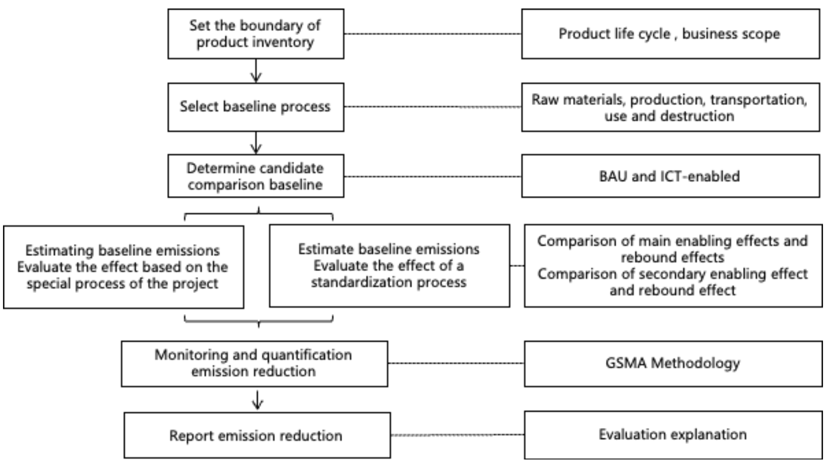

Figure 1: Calculation logic of direct ICT-enabled social carbon reduction.

4. Quantitative measurement process

Step1: ICT product selection. This paper conducted business interviews with the planning department, government and enterprise customer departments, data business departments of operator A, and branches in provinces and cities and subsidiaries of the Group. This paper selects 46 direct enabling social carbon reduction products of operator A for carbon reduction quantitative measurement research. It covers 12 energy-saving and carbon reduction scenarios.

DOI: 10.54254/2754-1169/86/20240951

Step2: Determination of project inventory boundary. The ICT products and solutions selected in this paper compare and analyze the situation under BAU and after enabling ICT products, determine the primary enabling effects and rebound effects.

Step3: Calculation of carbon reduction. In the carbon reduction measurement phase, the calculation is mainly based on the coefficient theory calculation method of GSMA, and the carbon emission sources of ICT system compared with BAU are determined according to the three ways of ICT enabling social carbon reduction: reducing physical use, reducing traffic and improving production efficiency.

5. Calculation example and analysis

5.1. Calculation example: AR Industrial Troubleshooting

AR industrial troubleshooting is an online fault detection product provided by operator A for industrial manufacturing under the background of industrial digitalization and intelligence. AR industrial troubleshooting uses cloud computing, big data and artificial intelligence vision detection technology to automatically identify industrial equipment, and 3D visualization of machine fault parts, so that maintenance experts can remotely implement maintenance guidance and eliminate industrial faults.

Table 1: Calculation table of industrial troubleshooting

Index	Data	Data source
Number of enterprises using AR industrial troubleshooting	223	Operator A enterprise database
Daily average demand of technical support for remote troubleshooting of each enterprise (times)	12	
Daily average demand for local troubleshooting technical support of each enterprise (times)	12	
Average number of days of after-sales service for troubleshooting per enterprise per year (days)	104	
Proportion of aircraft travel in remote troubleshooting	10%	Operator A customer research
Proportion of high-speed rail travel in remote troubleshooting	90%	
Proportion of car travel in local troubleshooting	50%	
proportion of bus travel in local troubleshooting	50%	
Average travel distance of each local troubleshooting (km)	20	
Average travel distance of each remote troubleshooting (km)	1000	
carbon emission coefficient of aircraft (kg/person * km)	0.088	CAEP[10]
Carbon emission coefficient of high-speed railway (kg/person * km)	0.026	
Carbon emission coefficient of car (g/person * km)	43	
Carbon emission coefficient of bus (g/person * km)	9.5	

From the data in Table 2, it can be calculated that the application of AR industrial troubleshooting can reduce 155.07 tons of carbon dioxide emissions for industrial enterprises every year.

5.2. Analysis of ICT Direct Enabling Carbon Reduction Products

In addition to AR industrial troubleshooting, this paper also calculates the amount of energy and carbon reduction of other 45 direct ICT-enabled social carbon reduction products and programs. At the same time, this paper classifies 46 business scenarios of products or solutions into 12 scenarios,

DOI: 10.54254/2754-1169/86/20240951

and calculates the total amount of direct ICT-enabled social carbon reduction in each scenario. As shown in Table 2:

Table 2: Calculation results of direct ICT-enabled social carbon reduction scenarios

ICT scenario	Carbon reduction (ton)	Proportion
Dematerialization	704464.39	1.311%
Smart work	10554050.05	19.648%
Smart home	2438.30	0.005%
Smart building	28052.82	0.052%
Smart transportation	17826434.67	33.187%
Smart education	1507.01	0.003%
Smart energy	14973718.61	27.876%
Smart agriculture	1670449.46	3.110%
Smart life	2094850.30	3.900%
Smart medicine	148060.97	0.276%
Smart government	163511.79	0.304%
Smart manufacturing	5547610.05	10.328%
Total	53715148.43	100%

From the table above, it can be seen that the scenarios with the largest amount of carbon reduction in all scenarios of direct ICT-enabled social carbon reduction products of operator A are: smart transportation, smart energy, smart work, and smart manufacturing. The carbon reduction of these four scenarios accounts for more than 91% of the carbon reduction of all energy saving and carbon reduction products directly enabling the society. In the previous research, the biggest field of ICT indirect enabling carbon reduction through providing network connectivity is smart life [11].

In order to calculate the rebound effect brought by the deployment of ICT system by Operator A, this paper estimates the carbon dioxide emissions of 15.77 million tons of enterprises released by Operator A in the 2022 Corporate Social Responsibility Report [12]. After deducting the rebound effect of ICT deployment, the net social carbon reduction brought by the direct ICT-enabled social carbon reduction products of Operator A in 2022 will be 37.94 million tons.

At the same time, this paper also estimates the carbon reduction data in 2025 and 2030 under different scenarios according to the business volume demand of the investigated products in the next few years, as shown in Figure 2:

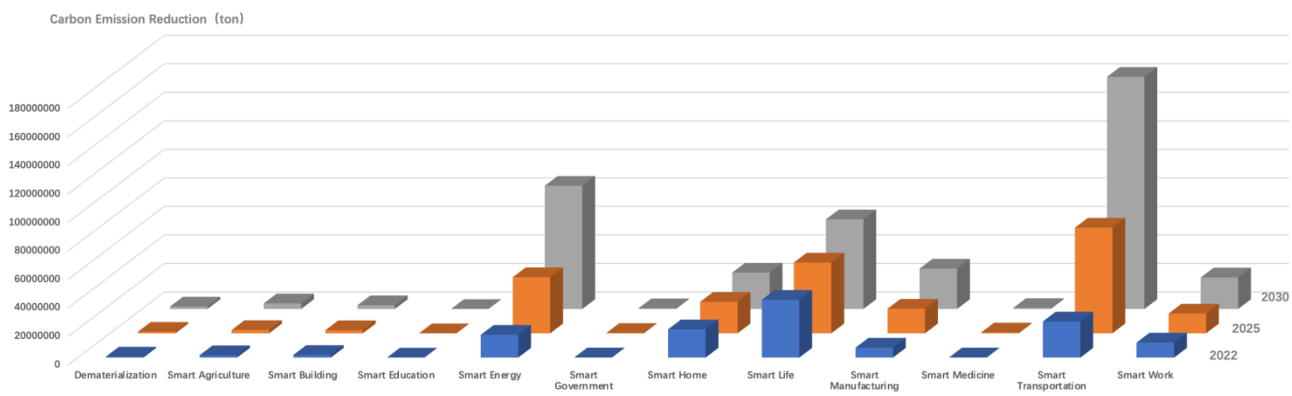

Figure 2: Predicted scale of direct ICT-enabled social carbon reduction

According to the calculation, Operator A is expected to achieve 137 million tons and 239 million tons of carbon dioxide emission reductions in 2025 and 2030 by direct ICT-enabled social carbon reduction product. Among them, transportation, energy, work and manufacturing, which are estimated to have the largest amount of carbon reduction in 2022, will maintain a high potential for enabling carbon reduction in 2025 and 2030. With the further maturity of ICT technology and the large-scale implementation of its application, these direct ICT-enabled social carbon reduction products will have higher potential in the development of social low-carbon economy in the future.

6. Conclusion

This paper conducts classified statistics based on the scenarios of different products and programs, and concludes that transportation, energy, manufacturing, and industry have shown relatively obvious carbon reduction scale at present, and the carbon reduction scale of these scenarios will also maintain a trend of rapid growth in the next few years. Combining the calculation results of operator A and the calculation precedents of international organizations, it can be found that in the early stage of ICT development, with the increase of the number of individual users and household users connected, ICT has developed rapidly through the indirect enabling and carbon reduction capability by providing network connection services. However, as the growth of network connectivity slows down, the customized products developed by ICT for business and government users have become a new growth point for operators and enterprises to enable social carbon reduction in the future, which is an important direction for operators and enterprises in the process of building their low-carbon image and promoting sustainable development.

References

[1] *Wang Linhui, Wang Hui, Dong Zhiqing. (2020) Policy conditions for compatibility of economic growth and environmental quality -- test of policy bias effect from the perspective of environmental technology progress direction. Management World, 36 (03): 39-60.*
[2] *Xu Guangyue, Song Deyong. (2010) Empirical study on China's carbon emission environmental Kuznets curve -- based on provincial panel data. China Industrial Economy, 2010, (05): 37-47.*
[3] *AT&T. (2019) Gigaton Goal. Retrieved from https://about.att.com/csr/home/environment/reducing-emissions.html*
[4] *British Telecom. (2022) Technology must accelerate our journey to net zero emissions and a circular world. Retrieved from https://www.bt.com/about/digital-impact-and-sustainability/tackling-climate-change#suppliers*
[5] *Deutsche Telekom. (2022) CORPORATE RESPONSIBILITY REPORT. Retrieved from https://www.cr-report.telekom.com/2022/management-facts/environment/enablement-factor#atn-19721-19722,atn-19721-19723*
[6] *Wang Xuan, Yang Tianjian, Shu Huaying. (2010) Research on the contribution of ICT to carbon emission reduction. China Soft Science Research Association Proceedings of the 6th International Symposium on Soft Science. Institute of Service Science, Beijing University of Posts and Telecommunications, 2010: 5*
[7] *GeSI SMART 2020 team. (2012) SMARTer 2020: The Role of ICT in Driving a Sustainable Future. Retrieved from https://gesi.org/research/gesi-smarter2020-the-role-of-ict-in-driving-a-sustainable-future.*
[8] *GeSI SMARTer2030 team. (2015) SMARTer2030: ICT Solutions for 21st Century Challenges. Retrieved from https://gesi.org/research/smarter2030-ict-solutions-for-21st-century-challenges.*
[9] *GSMA. (2019) The Enablement Effect: The impact of mobile communications technologies on carbon emission reductions. Retrieved from https://www.gsma.com/convening-for-good/enablement-effect.*
[10] *CAEP. (2022) The Environmental Planning Institute of the Ministry of Ecology and Environment officially released the greenhouse gas emission coefficient set for the whole life cycle of Chinese products. Retrieved from https://www.caep.org.cn/sy/tdftzhyjzx/zxdt/202201/t20220105_966202.shtml*
[11] *Shi, Y., Weng, Y., Feng, J., & Yang, T. (2023) Analysis on indirect ICT-enabled carbon emission reduction estimate and future potential in China.2023:5-6.*
[12] *China Telecom. (2022) Report on Social Responsibility of 2022. Retrieved from https://www.chinatelecom-h.com/sc/cg/csr2022.php.*