



# Consumer Behavior Towards e-Waste and Carbon Neutrality

Jiazhe Li<sup>1</sup>(✉) and Boren Xiao<sup>2</sup>

<sup>1</sup> School of Economics and Management, Beihang University, Beijing 100083, China  
21377007@buaa.edu.cn

<sup>2</sup> Wuhan Haidian Foreign Language Shiyuan School, Wuhan 430299, China

**Abstract.** With the rapid development of science and technology, electronic products have been produced much more than before, and they are used more and more widely. In addition, a great number of characteristics that electronic products have, such as large quantity, fast production, complex composition and structure, and difficult treatment will make more and more e-waste generated. At the same time, more and more greenhouse gases, such as carbon dioxide are produced all around the world. This terrible situation makes the life system be faced with a serious threat. As a result, climate change has become a global problem for humans. Therefore, the concept of carbon neutralization was proposed. In the process of achieving carbon neutrality and reducing the generation of e-waste, consumer behavior plays a crucial role, especially when consumers need to pay an average premium for sustainable products. Based on the research on consumer behavior in the new era, this paper summarizes the impact of consumer behavior on e-waste and carbon neutralization. After that, we will continue to propose relevant measures to reduce the production of e-waste and greenhouse gas by influencing consumer behavior.

**Keywords:** consumer behavior · e-waste · carbon neutralization

## 1 Introduction

With the development of global science and technology, Greenhouse gas emissions have soared, which will cause global warming. It is thought that GHG emission will increase by 50% by 2050, mainly because of the expected 70% increase in energy-related CO<sub>2</sub> emissions [1, 2]. In order to solve those problems, measures are taken by governments. For example, The Paris Agreement of 2015 marked a major milestone in the effort to make global carbon emissions reduced and create a carbon-neutral world. It is the largest international agreement in history, with 197 countries and the European Union signing on. Its goal is to make global warming limited to a maximum of 2 °C above pre-industrial levels. This agreement is a major step forward in combating climate change, as well as promoting sustainable development and economic growth. All signatories are committed to taking action to reduce emissions and increase the use of renewable energy sources [3]. In the background of accelerating decarbonization, the value of metals keeps

increasing. However, the amount of e-waste is increasing, which makes a great number of metal resources wasted. With the development of electronic waste pollution control, the United States formulated mandatory regulations on the disposal of waste household appliances in the 1990s, and it firstly defined toxic waste such as waste computers in legislation and prohibited non-standard disposal methods [4]. Consumers are becoming more interested in climate changes. Therefore, consumer behavior has been studied by researchers. Existing research shows that more than 70% of consumers are even willing to pay higher prices for sustainable products. It will help reduce the production of e-waste and greenhouse gases.

Researches on the impact of e-waste and carbon neutralization on consumer behavior has increased significantly in recent years. However, there is not any research about the combined effect of carbon neutralization and e-waste on consumer behavior. There are two purposes of writing this paper. First of all, we will study the effect that e-waste and carbon neutrality make on consumer behavior. Then we will talk about how to use related theories to affect the production of e-waste and carbon dioxide emissions by changing consumer behavior.

## 2 Literature Review

### 2.1 Related Study of Carbon Neutrality

“Carbon neutrality” was defined that countries, enterprises, products, activities or individuals directly or indirectly produced by the total amount of carbon dioxide emissions or greenhouse gases offset the greenhouse gases produced by carbon dioxide emissions or obtain a positive and negative compensation by themselves through afforestation, energy saving and emission reduction over a period of time, and achieve relatively “zero emissions”. Carbon dioxide emissions are considered to be the main driver of global climate change. It is widely believed that it is crucial for the world to reduce emissions so as to prevent the serious impacts of climate change [5]. Greenhouse gases are gases absorbing and releasing radiant energy in the thermal infrared range, and therefore causing greenhouse effect [6]. The main greenhouse gases in Earth’s atmosphere come from water vapor, carbon dioxide, methane, nitrous oxide and ozone [7].

Greenhouse gases such as carbon dioxide are dispersed uniformly in the atmosphere, meaning global concentrations of greenhouse gases are about the same. Therefore, when it comes to global greenhouse gas concentrations and the greenhouse effect, it does not matter where emissions are produced or avoided. Thus, emissions that cannot be avoided locally can be offset by carbon offset projects elsewhere. This can be done, for example, through forest protection, reforestation or the expansion of renewable energy.

The analysis of the results revealed that while revenues and globalization are associated with increased CO<sub>2</sub> emissions, renewable energy production and consumption are effective strategies for achieving the carbon neutrality target. This suggests that while revenues and globalization may have a positive effect on the economy, they are not conducive to achieving carbon neutrality targets. However, renewable energy production and consumption are highly effective in achieving these targets. Thus, it is essential that businesses focus on increasing renewable energy production and consumption in order to effectively reduce emissions and meet carbon neutrality goals. The international effort

to become carbon neutral could be the biggest international agreement in human history. The Paris Agreement of 2015 marked a major milestone in the effort to reduce global carbon emissions and create a carbon-neutral world. It is the largest international agreement in history, with 197 countries and the European Union signing on. Its goal is to limit global warming to a maximum of 2 °C above pre-industrial levels. This agreement is a major step forward in combating climate change, as well as promoting sustainable development and economic growth. All signatories are committed to taking action to reduce emissions and increase the use of renewable energy sources [3]. The Paris Agreement provides a framework for countries to develop their own national climate action plans, and offers financial support to help countries meet their commitments [8]. If we are successful in achieving the goals of the Paris Agreement, it could be the biggest international agreement in human history, which is a hopeful sign of the growth of the international community. However, it can also be considered as an act of despair to protect itself from self-inflicted damage. Since the first consensus was reached in the first assessment report of the Intergovernmental Panel on Climate Change in 1992, we have wasted a great deal of time in recognizing the seriousness of global warming and taking the necessary actions to deal with it [9].

## 2.2 Related Study of e-Waste

e-Waste, also known as electrical waste, is the percentage of the world's Internet users and the numbers of world mobile, individual Internet, fixed broadband subscriptions, and Internet-connected devices according to the European e-waste definition recommended by the International Telecommunication Union [10]. With the rapid development of science and technology, more and more e-waste is produced in the world, which has become an essential problem for protecting the environment because of the use and discard of electronic products. A new report released by the United Nations showed that more than 53.6 million metric tons of e-waste was produced all around the world in 2019, 7.3 kg on average per person, and only 20% of these e-waste were recycled [11]. These scrapped e-waste has a lot of bad effects, such as, worsening the environment, having a bad effect on human health and not making full use of resources. However, most of e-waste is recyclable and retrievable, and this waste could become a sustainable source for precious metals, such as, silver, gold [3]. As the concept of carbon neutrality was proposed at the United Nations General Assembly by the environmentalists, the value of metal improves greatly. IMF pointed out that the demand of precious metal, such as, copper, nickel, cobalt and lithium may surge in the next two decades because of their importance for clean energy technologies. A related report showed that the attitude of consumers plays a significant role in e-waste recycling process [8]. Therefore, it is of great significance to make research on consumers behavior towards e-waste.

## 3 Consumer Behavior Under the New Era Background

However, under the New Era Background, consumer behavior has changed. In this section, we will continue to explore the status of e-waste and carbon neutrality, and analyze consumer behavior towards them separately.

### 3.1 Consumer Behavior Towards Carbon Neutrality

From the perspective of consumption, residents' transportation and other behaviors will bring direct carbon emissions. In contrast, their electricity consumption and commodity consumption will produce indirect emissions, and the products of industrial electricity consumption, transportation, and other production activities are also ultimately designed to meet the needs of consumers. Therefore, the behavioral response of consumers to the carbon neutralization, as well as the willingness to pay for carbon reduction, are likely to be decisive factors in achieving the carbon neutral target. The residents, as the main body of life energy consumption and the terminal consumer of energy-consuming industrial products, are possible to make a great difference on energy-saving and emission reduction in their lifestyles [12]. What's more, personal energy consumption is influenced by consumers' daily behaviors. For example, their behavior of energy-consuming end uses and end-use usage behavior, which is more heterogeneous and difficult to regulate than of other sectors, can all influence carbon neutralization [9]. From the perspective of consumption, residents' transportation and other behaviors will bring direct carbon emissions, while their electricity consumption and commodity consumption will produce indirect emissions, and the products of industrial electricity consumption, transportation, and other production activities are also ultimately designed to meet the needs of consumers. Generally speaking, with economic development and the improvement of living standards, carbon emissions from personal consumption will gradually increase. To promote consumers' better participation in carbon emission reduction, it is necessary to improve consumers' cognitive ability of carbon emission reduction and strengthen low-carbon awareness education and low-carbon lifestyle publicity. Carbon neutrality is different from previous carbon reduction targets, and the successful realization of carbon neutrality requires the participation of consumers. Consumers' carbon cognition ability is the basis for consumers to actively participate in carbon emission reduction and shift to a low-carbon lifestyle.

### 3.2 Consumer Behavior Towards e-Waste

The large amount of e-waste as well as its low recycling rate have been a serious concern for the governments. And e-waste has been an important factor that influence consumer behavior. However, consumers' psychology and behavior were studied by researchers last decade [13]. Besides, some constructs such as convenience and economic benefits were also studied. And the result showed that whether consumers are willing to take part in recycling e-waste depends on convenience as well as some economic benefits. Further, the theory of planned behavior, which is thought to be one of the most often used methods to study consumers' pro-environmental behavior, were put forward to study consumer behavior towards recycling e-waste [14]. After that, the theory of behavioral reasoning, which is known as BRT, was used to understood the behavior of e-waste recycling. The theory pointed out that consumers' willingness for recycling is decided by five factors. They are self-image (SI), perceived negative effects (PNE), salvage value, inconvenience (INC), lack of support system (LSS) and emotional attachment (EA) [15]. All of these made it difficult for the government to improve the low recycling rate.

Measures have been taken by governments to solve the serious e-waste problem. For instance, the Waste Electrical and Electronic Equipment, also named WEEE, sets related targets. It asks all of EU member states to collect e-wastes separately and recover resource from e-waste efficiently [16]. “In 2020, the government in China have pointed out that more standardized recycling and disposal system for waste household appliances should be built to further improve the industry standards [17]. However, these collective measures have not produce satisfying results. And these years, the concept of circular economy is considered to be more and more relevant in addressing the problem of e-waste [18]. A CE is defined as an “industrial system that is restorative or regenerative by intention and design” [19]. And consumers play a significant role in this process. Consumers of electronic products are straightly involved in the three important stages of a product lifecycle: purchase, use, as well as EoL management. Their behavior of the three stages can directly influence not only the process of reusing and repairing, but also the process of recycling at the product EoL [18]. Human activities are the roots of e-waste. Therefore, we can to try to change consumer behavior to improve the situation through influencing the CE.

## 4 The Combined Effect of Carbon Neutralization and e-Waste on Consumer Behavior

According to data from 2013 to 2019, we made related figures.

According to the Fig. 1 and Fig. 2, both global CO<sub>2</sub> emissions and output of e-waste increase from 2013 to 2019. In this paper, we analyse the combined effect of carbon neutralization and electronic products on consumer behaviour from those aspects.

### 4.1 The Influence of the Government

December 1997, so as to protect human being from the threat of climate changing, the Third Conference of the Parties to the United Nations Framework Convention on Climate

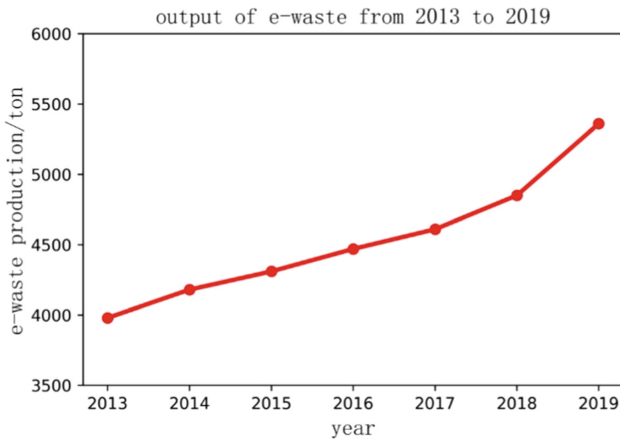
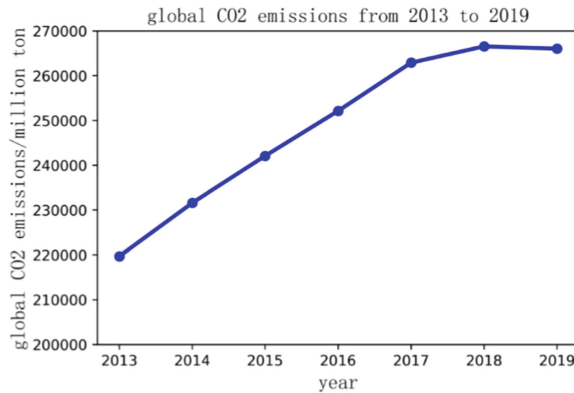


Fig. 1. Output of e-waste from 2013 to 20



**Fig. 2.** Global CO<sub>2</sub> emissions from 2013 to 2019

Change was held in Kyoto, Japan [20]. Representatives of 149 countries and regions adopted the Kyoto Protocol aimed at limiting greenhouse gas emissions of developed countries to control the process of global warming. However, the Kyoto Protocol entry into force actually in February 16, 2005 [21]. With the implementation of this law, the consumers awareness of controlling carbon emissions may increase.

#### **4.2 People's Awareness of Environmental Protection**

With the improvement of consumers' awareness of environmental protection, people are more inclined to repair old electronic products rather than discard them. And more people go out with "Green" Traffic, such as, cycling, waling. Besides, clean energy is used more often than before. Therefore, people's awareness of environmental protection may have a great influence on these results.

### **5 Measures that Influence Consumer Behavior**

#### **5.1 The Call of the Government**

The government should formulate related laws and regulations can influence consumer behaviour greatly. Government publicity and supervision should be strengthened. It will be useful to update the public awareness of consumers on their carbon emission reduction capacity at the consumer end. Improving public awareness and consumers' understanding of carbon neutrality are the basis for consumers to change their lifestyle and effectively engage in the process of carbon emission reduction. Besides, the government's emission reduction policy play an important role in consumer behaviour. We should select strategies and ways with emission reduction efficiency, operability and acceptability at proper time. As a consequence of improving public awareness, the governments should effectively and regularly guide residents' low-carbon consumption and identify the carbon capacity barriers of non low-carbon consumption behaviors. And making consumers to form low-carbon expectations throughout policy design can also

help reduce carbon emissions [22]. What is more, the government should establish the quality insurance mechanism and compensation mechanism of electronic products as soon as possible. To provide consumers with product safety testing information anytime and anywhere, the manufacturer need to ensure detailed records of the supply chain in the process of electronic products' supply. To make producers disclose to production information in the process of production and circulation, the manufacturer should take a series of actions, such as achieving information sharing, information exchange, information exchange.

## 5.2 Create a Positive Social Morality Environment

It provides a social-psychological framework for investigating normative variables that promote sustainable attitudes and behaviors, and it connects personality traits, views about human-environment linkages, and a sense of moral duty to proenvironmental activities [4]. According to a University of Bristol research, environmental initiatives can profit more by appealing to people's 'positive self-concept' rather than their 'economic' or 'economic'-interest. According to Dr. Richard Branson, head scientist of the British Lung Foundation, people generally respect environmental quality and recognize their obligation to care for it.

## 6 Conclusion

In this paper, consumer behavior towards e-waste and carbon neutrality were analyzed in detail by reviewing papers in international peer - reviewed journals. We can see the potential connections between them. Carbon emissions are positively correlated with the amount of e-waste generated. And consumer behavior plays an important role in it. It can be influenced by awareness of environmental protection, the decisions governments made. So, we think we can change these situations by influencing consumer behavior.

## References

1. Rabaey, Korneel, and Arthur J. Ragauskas. (2014) "Editorial overview: energy biotechnology." *Current Opinion in Biotechnology* 27: V-VI.
2. Hoang, Nguyen Tien, and Keiichiro Kanemoto. (2021) "Mapping the deforestation footprint of nations reveals growing threat to tropical forests." *Nature Ecology & Evolution* 5.6: 845-853.
3. Hong, Y. , et al. (2020) "Precious metal recovery from electronic waste by a porous porphyrin polymer." *National Academy of Sciences* 28.
4. Zafeiriou, Eleni , et al. (2022) "Environmental Kuznets curve for deforestation in Eastern Europe: a panel cointegration analysis." *Environment, Development and Sustainability*:1-21.
5. "United States : (2017) Shaheen Statement on President Trumps Short-sighted Action to Roll Back Efforts to Address Climate Change." *MENA Report*, Albawaba (London) Ltd, p. n/a.
6. *Greenhouse Gases: Names, Sources and Global Warming - BYJUS*. <https://byjus.com/neet/what-are-greenhouse-gases/>
7. *What are Greenhouse Gases?* | US Department of Transportation. <https://www.transportation.gov/sustainability/climate/what-are-greenhouse-gases>

8. Kumar, A. (2019) “Exploring young adults’ e-waste recycling behaviour using an extended theory of planned behaviour model: A cross-cultural study.” *Resources Conservation and Recycling* 141.2:378-389.
9. Yang, Ruiliang, et al. (2018) “Different effects of main influence factors on household energy consumption in three typical rural villages of China.” *Energy Reports* 4: 603-618.
10. Jones, R. W. (1997) “The International Telecommunication Union.” *IEEE Antennas & Propagation Society International Symposium IEEE*.
11. Kuehr, Ruediger. (2020) “Global E-waste Monitor 2020.”
12. Xu, Li, et al. (2021) “Distribution and evolutionary in household energy-related CO<sub>2</sub> emissions (HCEs) based on Chinese north–south demarcation.” *Energy Reports* 7: 6973-6982.
13. Dhir, A., Malodia, S., Awan, U., Sakashita, M., Kaur, P., (2021) Extended valence theory perspective on consumers’ e-waste recycling intentions in Japan. *J. Clean. Prod.* 312, 127443.
14. Dixit, S., Badgaiyan, A.J., (2016) Towards improved understanding of reverse logistics–Examining mediating role of return intention. *Resour. Conserv. Recycl.* 107, 115-128.
15. Envelope, Ryap, D. Envelope, and S. Envelope. “Understanding the individuals’ motivators and barriers of e-waste recycling: A mixed-method approach.” *Journal of Environmental Management* 324.
16. Union legislation, E. (2003) “DIRECTIVE 2003/108/EC Amendment to Directive 2002/96/EC on waste electrical and electronic equipment (WEEE).”
17. Anonymous (2020) “Implementation Plan on Improving the Recycling and Disposal System of Waste Household Appliances to Promote the Renewal and Consumption of Household Appliances.” *Resource Regeneration*
18. Parajuly, K., et al. (2020) “Behavioral change for the circular economy: A review with focus on electronic waste management in the EU.” *Resources Conservation & Recycling X* 6:100035.
19. Studies, C., and E. M. Foundation. (2013) “Case Studies - Ellen MacArthur Foundation.”
20. Sands, Philippe. (1992) “United Nations Framework Convention on Climate Change.” *Review of European Community & International Environmental Law* 1.3:270-277.
21. Fletcher, S. R. (2005) “Global Climate Change: The Kyoto Protocol [Updated February 16, 2005].” *Congressional Research Service, Library of Congress*.
22. Liao, Q., and F. Gong. (2014) “Analysis of Carbon Footprint and Carbon Capacity of Xiamen.” *Fujian Architecture & Construction*.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter’s Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter’s Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

