

C02 Reduction Potential of Consumer Durables : A Case Study of Air Conditioners in Japan

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(日本の家庭用エアコンをケーススタディとした耐久消費財のCO₂排出削減ポテンシャルの推計)

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論 文 内 容 の 要 旨

In 2015, at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), the Paris Agreement was adopted as a new international framework for tackling the global warming, taking the place of the Kyoto Protocol. The agreement demonstrated a clear resolve by the whole of the international community to seriously tackle global warming. It is a clear statement that reducing emissions of Greenhouse gases (GHG), the cause of global warming, is becoming increasingly urgent, and that measures to combat the problem must now be rapidly worked out. Climate policies can be approached from a wide variety of viewpoints, but the lifestyles and behavior patterns of consumers are considered an important factor in terms of global warming impact. According to the world CO₂ emissions by sector in 2014 published by International Energy Association (IEA), the total CO₂ emissions caused by residential sector accounts for 17% of the world CO₂ emissions and residential sector is one of the key sector for reducing CO₂ emissions. Even in Japan, residential sector is also one of the main CO₂ emitters. Residential sector is the fourth largest sector of CO₂ emissions in Japan as to 2014 and it is an important point that CO₂ emissions from residential sector entirely tend to increase since 1990, while those from the other sectors entirely tend to decrease or be stable during the same period. It indicates that the importance of reducing CO₂ emissions from residential sector increases. In particular, since durable goods such as automobiles and home appliances are so essential to our lifestyles, the CO₂ emitted by their manufacture and use makes a large contribution to global warming. Motivated by this background, this doctoral thesis focuses on CO₂ emissions induced by air conditioner in Japan as a case study, and estimated reduction potential of change in product lifetime and energy efficiency. The thesis consists of five chapters.

Chapter 1 provides the research background and shows the importance of residential sector on world greenhouse gas emissions based on the research report published by International Panel of Climate Change (IPCC) Working group III and sectoral CO₂ emission data in the world reported by International Energy Association (IEA). This chapter also shows recent trends in the CO₂ emissions in Japan reported by Ministry of the Environment of Japan and mentions that CO₂ emissions from residential sector have been increasing and the residential sector has an important role in reducing CO₂ emissions in Japan. With this background, chapter 1 explains why this thesis focuses on air conditioners in this thesis.

Chapter 2 conducts a comprehensive literature review of relevant previous studies, explains the contributions and shortcomings of those previous studies and clarifies the significance and novelty of this doctoral thesis

Chapter 3 statistically modelled the product lifetime and trend of energy efficiency in use of air conditioners in Japan. Using those models, this chapter estimated the number of stock and replacement of air conditioners and CO₂ emissions induced by air conditioners. I conducted scenario analyses about changing both product lifetime and energy efficiency in use of air conditioners. The results show the effects of changes in product lifetime and energy efficiency on CO₂ emissions. Finally, this chapter revealed a target value of improvement rate of energy efficiency of air conditioners in shortening the product lifetime through a demand policy such as vehicle scrappage scheme.

Chapter 4 applied the statistical models of product lifetime and energy efficiency estimated in chapter 3 into the environmental input-output framework and developed a comprehensive analytical framework for life-cycle CO₂ emissions induced by final demand of air conditioners in Japan between 1990 and 2005. Using the framework, this chapter further proposed a structural decomposition analysis to identify specific industrial sectors that have indirectly contributed to increasing life-cycle CO₂ emission from air conditioners during the study period: 1990 to 2005. This chapter also evaluated combined scenarios of changing both product lifetime and energy efficiency of air conditioners and analyzed the energy efficiency improvement necessary for holding CO₂ emissions from air conditioners in 2005 at 1990 level. Finally, based on the results, this chapter comprehensively discussed how we should reduce CO₂ emissions from air conditioners from point of view of industrial technologies surrounding air conditioners, product lifetime, and energy efficiency in use.

Chapter 5 summarizes the main results obtained from Chapters 3 and 4, and shows the contribution of this thesis to environmental and energy policies for reducing CO₂ emission from durable goods.