Measures to Promote CO_2 Emission Reduction by Heat Pump Air-conditioners
− Analysis based on Questionnaire Survey −

Background

The actual level of market penetration of cost-effective, energy-efficient technologies is often below their optimal level of market penetration; the gap between the actual and optimal levels of market penetration is known as the "energy efficiency gap," and it arises due to various hindering factors known as "energy efficiency (EE) barriers." This is particularly true for heat-pump room air-conditioners (RACs), which are an alternative to boilers for use as space-heating appliances. Although several scenarios proposed for the development of a low-carbon society have led to the recognition of the potential of RACs, there have not been many discussions on policies to improve the diffusion of these appliances.

Objectives

The purpose of this study is to conduct a case study on RACs in Japan to determine if EE barriers exist, identify the barriers if they exist, and discuss appropriate measures for the removal of these barriers.

Principal Results

1. Possession and use of space-heating appliances

The current status of possession and use of space-heating appliances was surveyed by an internet questionnaire survey of approximately 2,500 consumers.

(1) Main space-heating appliances in living rooms show an almost even split between combustion and electric types, with a share of approximately 30% using RAC as the main space-heating appliance (Fig.1). The changes in main space-heating appliances indicate that the share of RACs increased, whereas kerosene heating lost its share from about 50% five years ago.

(2) This trend is expected to continue driven by consumers' growing awareness about safety and amenity, improving insulation properties, high oil prices, etc. However, many consumers still have a negative impression about its energy-cost-saving potential, implying the possibility of slow penetration. Therefore, it is vital for policy makers to discuss measures to accelerate CO_2 emission reductions.

2. Barriers to energy efficiency and measures to remove barriers

We examined the impact of each of six EE barriers—imperfect information, split incentives, access to capital, bounded rationality, hidden costs, and risks—in discouraging consumers from using RACs; these barriers have been identified on the basis of theoretical investigations by previous studies (Table). In addition, CO_2 emission reduction potential curves, which show the relationship between the reduction amount and the marginal cost of reduction, are drawn using the questionnaire data and taking the EE barriers into account.

(1) Approximately 60% of the CO_2 emissions resulting from space heating and space cooling can be reduced if all households use currently available RACs (="technical potential"). Even after taking cost-effectiveness into consideration, approximately 50% of the emissions can be reduced (Fig.2).

(2) However, two-thirds of the cost-effective potential (="economic potential") may be neglected due to the influence of various EE barriers (="economic potential" – "market potential"). Among the EE barriers, "imperfect information" on energy costs and appliance efficiency is estimated to have the largest impact on the economic potential (Fig.3).

3. Policy implications for climate change policy

As can been seen in the case study of RACs, even apparently cost-effective technologies may be confronted with many barriers. In order to accelerate CO_2 mitigation, there is a need for research on methods to remove the EE barriers.

Future Developments

Further research is needed on measures to remove barriers through case studies.

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Reference

K. Nishio and Y. Iwafune, 2009, "Measures to Promote CO_2 Emission Reduction by Heat Pump Air-conditioners – Questionnaire Survey and Analysis on Energy Efficiency Barriers –", CRIEPI Report Y08026 (in Japanese)

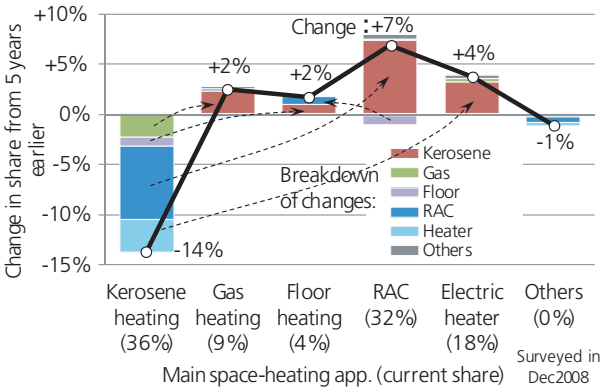

Fig.1 Changes in share of main space heating appliances over past 5 years

The questionnaire survey reveals that the percentage of RACs steadily increased to 32% as of the survey, mainly due to the shift from kerosene heating, decreasing to 36%.

Table 1 Energy efficiency barriers to be analyzed

Energy efficiency barriers	Examples in case study of room air-conditioners in residential sector
Imperfect information	Failure to understand which appliance is energy efficient - Incorrect estimation of energy costs
Split incentives	Inappropriate incentives to promote EE - Appliances preinstalled by others - Not accountable for energy bills
Bounded rationality	Limited time, attention, and ability to process information - Interested in EE, but not proactive
Access to capital	Difficult financial conditions - Budget constraints on initial cost
Hidden costs	Costs other than initial and running costs - Loss of benefits etc.
Risks	Little information on future prospects - High discount rate (short pay-back time).

We examine the impact of each of the six EE barriers in discouraging consumers from using RACs. A theoretical framework for classifying EE barriers is incorporated into the analysis of the results of the questionnaire survey: the percentage of households under the influence of barriers, and the impact of barriers to CO_2 emission reduction potential.

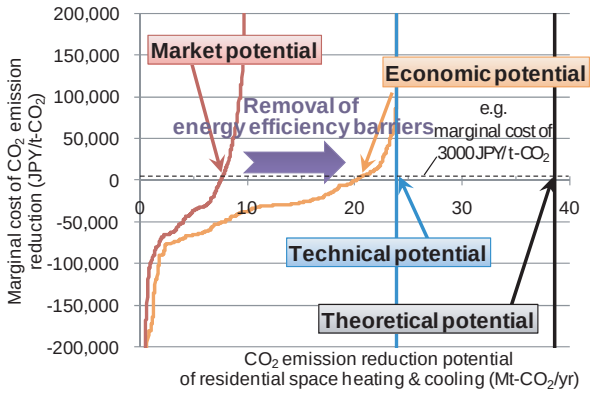

Fig.2 CO_2 emission reduction curves of RACs

The "market potential" up to 3,000 JPY/t-CO_2 (approx. 30 USD/t-CO_2) is limited to 20% of current emissions (="theoretical potential"). Two-thirds of the "economic potential", which can be economically achieved, would be possibly lost in cases wherein EE barriers are not removed.

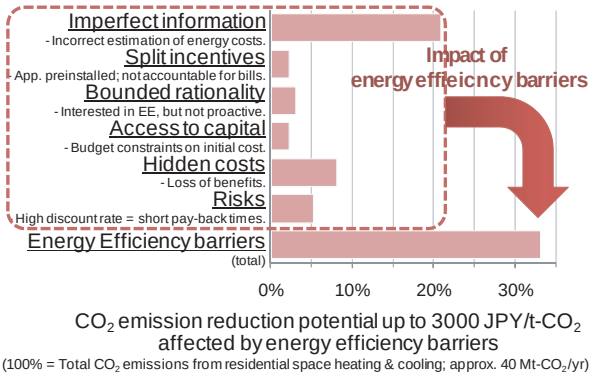

Fig.3 Impact of energy efficiency barriers

"Imperfect information" is estimated to have the highest impact; by this barrier, there would be a decrease of 21% in the theoretical reduction potential, or the current amount of emissions. The study also discusses policy implications for removing each barrier in order to promote energy-efficient space-heating appliances.