Biomass district heating in rural villages in Japan – Case study for Nishiawakura, Okayama Prefecture –

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1. INTRODUCTION

As expansion of renewable energy progresses globally, its introduction has become active not only in the electricity sector but also in the heating sector. The main renewable energy source for heating is wood biomass, and there are two approaches to utilize them: Individual Heating (IH) or District Heating (DH). Although DH is acquiring more and more attention particularly in European countries, the number of DH installation is still very limited in Japan. As the comparison between IH and DH has not been fully examined and the feasibility of them is also still largely unknown in Japan, quantitative analysis for these is considered to be an urgent need. Taking such situation into account, I conducted a simulation study at a rural village, based on the assumption that wood biomass is primarily a local resource that is available only in rural communities.

2. MATERIALS AND METHODS

(1) Research site and the scenario settings

Nishiawakura village in Okayama prefecture is selected as the research site, where abundant wood fuels are available. IH scenario and DH scenario, both of which supplies heat for the same consumers, are established for comparison. To examine how the feasibility changes depending on the number and the types of target consumers, each scenario is further divided into 3 cases; less consumer case, reference case and surplus consumer case.

(2) System design and cost calculation

System design and cost comparison methodology follows Aaron et al. (2016), except for those that can not be used due to lack of data in Japan. After calculating the heat demand in hourly resolution for each scenario and case, the size of boiler, storage tank and the length of distribution pipe are identified. The cost calculation is made based on the identified capacity of each equipment and the average capital costs per unit. The calculated costs are narrowed down to annual costs and then transformed into break-even price by dividing by annual heat demand. These break-even prices are then compared for each scenario and case. The average price of heating oil in Japan is also compared, aiming to see the competitiveness with conventional heating systems.

3. RESULTS AND DISCUSSION

As a result of cost comparison, IH has a cheaper break-even price in the case of less consumer case and reference case, but it was reversed in the case of surplus consumer. No case in any scenarios became competitive with the oil price with the parameters set for this study. However, the result and the additional simulation conducted with the new parameters bring two important findings.

Firstly, effective indicators for judging the superiority of DH and IH are identified. The simulations show that DH can be a more viable option than IH when the effect of leveling out of heat demand – which happens when the different heat demand patterns are aggregated – is large, and when the number of consumers to be replaced by biomass is big.

Secondly, some potential solutions for improving the feasibility are extracted out of the simulations. The results show that one of the most important criteria that needs to be secured for biomass heating is to choose the buildings that has stable heat demand as consumers. Other potential solutions include policy support for reducing the capital cost e.g. R&D investment.

CITATION

Aaron M. Hendricks, John E. Wagner, Timothy A. Volk, David H. Newman, Tristan R. Brown. 2016. A cost-effective evaluation of biomass district heating in rural communities. Applied Energy, 162, 561-569.