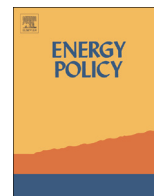




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# Individual Heating systems vs. District Heating systems: What will consumers pay for convenience?



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## HIGHLIGHTS

- District Heating (DH) and Individual Heating (IH) systems differ in user convenience.
- Difference of convenience is evaluated by a double-bounded dichotomous choice method.
- Consumers are willing to pay a 4.03–12.52% higher rate to use DH rather than IH.
- Consumers with high living standards prefer DH to IH, and show high consumer loyalty.
- Strategies to foster DH systems should stress DH convenience over its lower cost.

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## ABSTRACT

For Korea's two most popular apartment heating systems – Individual Heating (IH) and District Heating (DH), – user convenience rests heavily on location of the boiler, availability of hot water, administration of the system, and user control of indoor temperature. A double-bounded dichotomous choice method estimates consumer value for convenience, in a hypothetical market. Higher-income more-educated consumers in more expensive apartments prefer DH. Cost-conscious consumers, who use more electrical heating appliances and more actively adjust separate room temperatures, prefer IH.

With willingness-to-pay (WTP) defined as the price ratio between IH and DH, 800 survey respondents indicate a WTP of 4.0% for DH over IH. IH users unfamiliar with DH expect little greater convenience (0.1% WTP), whereas the WTP for DH users runs to 7.9%, demonstrating consumer loyalty. Quantified estimates of consumer preference and convenience can inform design of a full-cost-plus pricing system with a price cap. Results here indirectly predict the effect of abolishing regulations that exclusively establish district heating zones. Strategies to foster the many external benefits of DH systems should stress not their lower cost, but convenience, comfort, and safety. Higher installation costs still hamper DH expansion, so policy-makers could set policies to lower cost barriers to entry.

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## 1. Introduction

In Korea, two different types of heating systems dominate the heating market for apartment housing.<sup>2</sup> Individual Heating (IH) systems use a small gas boiler for each housing unit, and heat intermittently. District Heating (DH) systems provide continuous heating through pipes from heat generators which are located away

from individual apartment units. Over the last few decades, these two heating systems have been fiercely competing to expand and maintain market share in Korea. IH and DH have been thrusting and parrying over the validity of DH supply cost, i.e., DH's economic feasibility vis-à-vis IH. DH systems were introduced in Korea to promote energy efficiency at an affordable cost, since they produce most heat on a large scale, through a Combined Heat and Power plant (CHP), and through recycling some of the remaining heat from waste incineration and power generation.<sup>3</sup> However, taking into

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<sup>2</sup> From the 2010 census, around 60% of total housing in Korea is apartments, with over 80% of apartment heating provided by Individual Heating (IH) systems (63.4%) and District Heating (DH) systems (21.4%).

<sup>3</sup> In 2013, 2238 thousand households and 3503 buildings were provided the heat equivalent of 10,398 TJ via DH. Facilities such as Combined Heat and Power plants (CHP) and Peak Load Boilers (PLB) provide 63.9% of heating, and the remaining 36.1% was brought from exterior sources, such as waste heat to power and waste incineration heat.

account steam bleeding, pipe damage, and facility investment cost, it often has been argued that DH's real costs can be higher than costs for IH (Park and Kim, 2008).

IH and DH differ in how they produce, manage, and supply hot water for heating and bathing. As a result, each provides different conveniences for their customers. For example, DH usually circulates hot water throughout an apartment unit, so DH users can use hot water from the tap instantly. IH users may find it inconvenient to operate a boiling system on their own, having to wait for water to heat to the temperature they want. Consumers may not consider Samsung's 'Galaxy' and Apple's 'iPhone' to be the same, while their calling, internet surfing, and photography functions are little different from one another. The value that consumers feel when using these different products soon converts to the pricing of products in the smartphone market. IH and DH can also be interpreted as an analogous case in that they both provide heating and hot water for homes. However, the two heating systems differ in convenience when actually used at home, in usability, safety, supply stability, and environmental effects. They differ in value as a result. Nonetheless, unlike smartphones, it may not be practical for each home to freely choose a heating system. Heating systems are usually chosen across an entire apartment block, and governments often make infrastructure decisions in the urban planning stage. Thus, the distinct values that consumers experience when using IH and DH, in terms of ease or convenience, are often not quite represented through market pricing.

A certain heating system may be dominant for its efficiency and cost, but it does not necessarily follow that consumers favor one system over another for these attributes alone. Surely product price is one of the major factors influencing consumer preference. However, if products provide different levels of convenience, preferences may not be determined by price alone. Moreover, heating costs for homes are not as strongly influenced by the heating system used as by the indoor heating environment, including indoor temperature, insulation, and ventilation (Lee et al., 2004; Park et al., 2005). Korean consumers may not have much interest in the long and exhausting debate about supply economics between two heat delivery industries.

This paper evaluates and compares the economic value that consumers place on different types of convenience between IH and DH. Because the Korean heating market has limits on the precise range of values for distinct convenience each heating system offers, consumers in our survey are presented a hypothetical market situation. They are then asked about their willingness to pay (WTP) for the use of either heating system in a given circumstance.

The existing heating market in Korea largely has been managed by the government, through controls on heating fees and the choice of heating systems for large-scale residential land developed in large blocks. However, recently there are a growing number of heating companies who offer services and charge fees beyond government control that a resident may choose to pay, and for the purpose of expanding private competition the Korean government recently has granted permission to install gas heat pumps within a DH exclusive supply area. As the apartment market is nearly saturated, one may expect IH and DH heating systems to compete more openly and fiercely with one another in smaller housing development areas, and in re-development areas. These days, with rising incomes, more efficient markets, and higher-level consumer service, more private sector and customer-based heating markets are emerging. So now is the time to re-investigate formerly government-dominated heating policies, and to apply core information relevant to consumer preferences in the development of new heating policies.

This paper aims to derive and compare consumer WTP for convenience associated with the use of IH or DH. The next chapter summarizes distinct convenience of use between IH and DH, and

then the survey design used for evaluation, including the survey method goal and questionnaire, is introduced. The third chapter reports estimates of consumer WTPs from survey data, and the derived WTP numbers are broken out by individual survey group. Finally in chapter four, issues relevant to Korean heating policies are discussed in light of these research results.

## 2. Methods

### 2.1. Classification of convenience

In this paper, convenience of use of IH and DH are largely distinguished by the following four aspects: 1) location of the boiler (or heating generator facilities); 2) use of hot water; 3) administration of the heating system; and 4) control of indoor temperature.

#### 2.1.1. Location of the boiler

DH by definition has a centralized heat generating facility located away from any single apartment, whether it is a CHP, Peak Load Boiler (PLB), or a waste incinerator. On the contrary, IH has an individual boiler on an enclosed porch or in a multi-use room, for every unit in a larger apartment building. The first convenience afforded by the location of the boiler is that IH users must consider the risk of an accident, from a gas eruption or leak. According to Cho's (2000) survey of 917 household gas users, 35% of respondents answer that there is a possibility of gas accidents in their own apartments. Eight out of 10 respondents agree to pay an extra 1000 won<sup>4</sup> or more for safety insurance; thus, most gas users are well aware of the risk of personally administering gas. Excluding the safety issue, DH has other strengths: more useable space and better visuals in the apartment building. With DH there is no need to occupy space with a boiler, or a passage around it, or to install ventilation or fire equipment within or adjacent to each apartment. Another relative ease of use of DH is that customers can avoid the noise, vibration, and any burning gas smell when the boiler starts, since it is not located inside the living space.

#### 2.1.2. Use of hot water

DH companies keep high temperature water (above 90°; all temperatures here are in Celsius) at all times, and this hot water sends heat to heat exchangers for hot water use, then is close-looped back to the heating company. Through this continuous process of transferring heat, apartment buildings get hot water circulated at 45–50° – just the right temperature for use. So homes using DH systems always have immediate access to hot water right from their taps. On the contrary, IH users have to start the boiler every time they need hot water, an inconvenience. And in order to achieve the right temperature, it also takes a certain amount of time, which actually varies with conditions. Because there is a limit to how much hot water each boiler can generate in an hour, there may be cases that consumers do not get the temperature of hot water they want.

#### 2.1.3. Administration of the heating system

IH systems allow each household to maintain its own heating facility, including the boiler, passage, and ventilation. In contrast, DH companies maintain their heat supply facilities, including generation, transport, and administration, and heating facilities within apartment complexes are under the control of the apartment office. So DH users are free from the burden of doing their

<sup>4</sup> The basic unit of money in Korea, the 'won', is mentioned here for the two surveys: Cho (2000) conducted in 1999, and our survey in 2014. The exchange rate for a U.S. dollar to the Korean won was 1.138 won/\$ in 1999 and 1.099 won/\$ in 2014.

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