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Survey on the Utilization of Fire-Wood Boiler using Woody Biomass in Gangwon Province

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ABSTRACT : This survey was carried out to investigate the utilization situation of fire-wood boiler by the questionnaire and personal interview on rural and mountain households of Gangwon province from 1998 to 2005. The questionnaire include 7 questions on installation, 7 questions on fuel, 3 questions on use, and 3 questions on improvement. Each question was analyzed by percentage to investigate the use situation. This survey indicated that the general problems in use of fire-wood boiler are fuel purchase, collection and transportation, that the development of the household heating boiler using wood-based forming fuel which is cheap, small volume, easy handling, convenient purchase and high heat efficiency could be an alternative to improve the problems and that the continuous expansion of the supply of fire-wood boiler can prevent the devastation of forest through the regulation of imprudent fuel supply. Although the financial aid plan on the installation of fire-wood boiler is in active, many petty households in rural and mountain areas lose a chance to install the fire-wood boiler due to the unsatisfactory information. Thus, it will be desirable for municipal government to prepare the information plan to offer the equal chance and condition to all households in rural and mountain areas and to increase the financial aid for the continuous supply of fire-wood boiler.

Keywords : Forest biomass energy, Fire-wood boiler, Questionnaire, Personal interview

INTRODUCTION

In recent days, the global-scale environmental issue such as global warming is frequently raised and in facing high oil price, the utilization of forest biomass as a renewable energy source is seriously considered. Korean government has a plan that increases the supply of substitution energy up to 5% to cope with "UN Framework Convention on Climate Change" and exhaustion of fossil energy until 2011 (Cha, 2006a). Nowadays, the "sustainable life-cycle society" is fixed as a social paradigm in 21st century the environmentalism and sociality with economic development are emphasized (Cha *et al*., 2004; Oh, 2003; Lee and Lee, 2005). Therefore, biomass, a general term of biomaterials, as a sustainable renewable energy source becomes a popular issue. Biomass is a much useful energy source that can substitute with fossil fuels such as oil and coal in Korea where most of the land is mountains (Cha *et al*., 2006b,c,d).

The reasons why forest biomass gets attention in Korea are abundant resources, economic activation of mountain areas through the utilization as energy of forest biomass and contribution on the public function of forest. Thus, as a part of the utilization as energy of forest biomass, Gangwon province gives financial aid on the installation of fire-wood boiler for the first time in Korea.

This survey was carried out to investigate the utilization situation of fire-wood boiler by the questionnaire and personal interview on rural households of Gangwon province from 1998 to 2005.

MATERIAL AND METHODS

This survey was investigated by the questionnaire and personal interview on 590 households that are using fire-wood boiler in 18 cities of Gangwon province from 1998

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to 2005. The questionnaire include 7 questions on installation, 7 questions on fuel, 3 questions on use, and 3 questions on improvement. Each question was analyzed by percentage to investigate the use situation.

RESULTS AND DISCUSSION

1. Questionnaire on installation

1) Where have you heard the information about a fire-wood boiler?

37% of 590 households answered the above question was from the neighbor who is using a fire-wood boiler, 25% was from the municipal authorities that is in charge of the installation of fire-wood boiler and exceptionally, the information from mass media was only 10% (Fig. 1).

2) What kind of boiler have you used before the installation of fire-wood boiler?

Generally, the households using fire-wood boiler were the independent households in rural and mountain areas. Oil boiler was most as 83%, oil/briquette combination boiler was 7% and briquette boiler was 8% (Fig. 2). The use of oil/briquette combination boiler is increased due to the increase of oil price, though oil boiler has been previously used in most of rural and mountain areas.

3) How much was the installation cost of fire-wood boiler?

$2500~3000 of the installation cost was 35% and $1,500~2,000 was 18%. 16% was $500~1000 due to the installation in the early 1990's (Fig. 3). Recently, the installation cost of fire-wood boiler is increased because of the combination of oil.

4) What is the heating area by fire-wood boiler?

1,296~2,916 m^2 of the heating area was most as 49%, 2,916~5,184 m^2 was 26% and less than 81 m^2 was 13% (Fig. 4).

5) How much was the financial aid for the installation of fire-wood boiler?

Gangwon province gave $1,000 of financial aid for the installation of fire-wood boiler in 2005 and $600 in 2004. $600~800 of financial aid was 33%, $400~600 was 4%

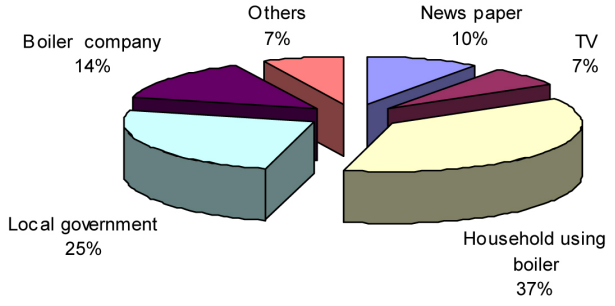

Fig. 1. Information sources on fire-wood boiler.

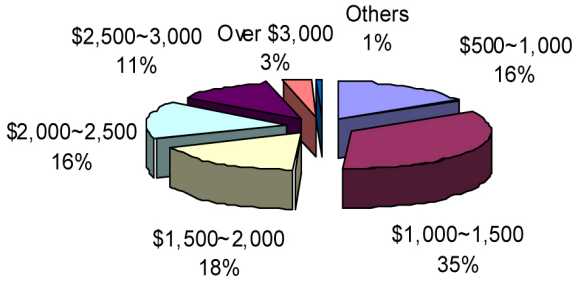

Fig. 3. Installation cost of fire-wood boiler.

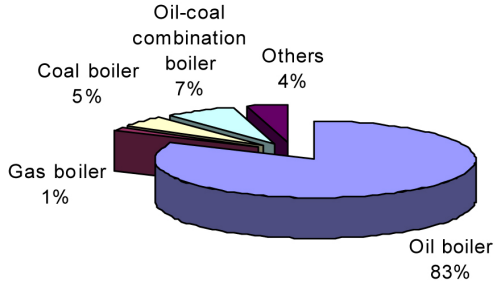

Fig. 2. Types of former used boiler.

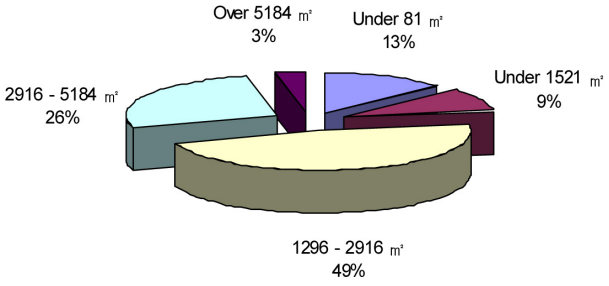

Fig. 4. Heating area by fire-wood boiler.

and more than $800 was 3% (Fig. 5). Thus, these answers indicate that most of households installed their fire-wood boilers prior to 2004.

6) What is the type of present fire-wood boiler?

Fire-wood was 49% and fire-wood/oil combination was 48% (Fig. 6). However, the households also that have been previously equipped a fire-wood boiler preferred to install combination boiler due to the fuel supply and ignition trouble.

7) How do you handle the operation trouble of fire-wood boiler?

Boiler manufacturing company solved the problems without the charge for 2~3 years in the case of the operation trouble of fire-wood boiler (42%) or the households treated the troubles by themselves (27%). However, no trouble was 27% indicating the recent installation (Fig. 7).

2. Questionnaire on fuel

1) What is the fuel of fire-wood boiler?

As the fuel of fire-wood boiler, fire-wood was most frequently used as 81%, inflammable waste material was 8% and oil was 6% (Fig. 8).

2) Where do you prepare the wood fuel of fire-wood boiler?

47% of the households answered that the fuel woods were collected from around forest, 32% from the waste wood and 11% from their own forest (Fig. 9). In particular, 79% of the households prepared the fuel wood without the cost, indicating that there might be a reproach on the preparation of the wood fuel hereafter.

3) When is the main season using fire-wood boiler?

75% of the households operated the boiler in winter, 14% in fall and 9% in spring (Fig. 10).

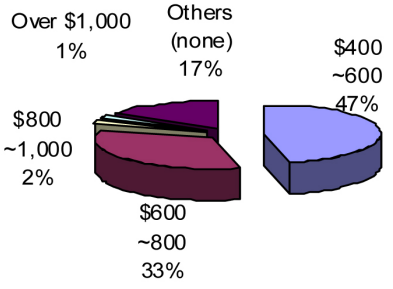

Fig. 5. Financial aids on installation of fire-wood boiler.

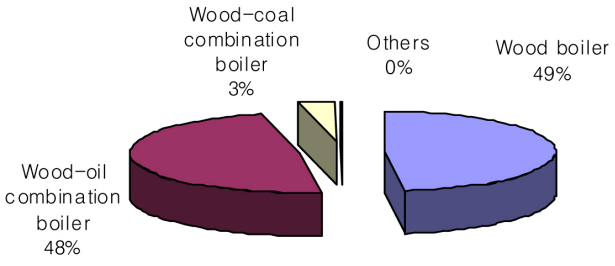

Fig. 6. Types of fuel for fire-wood boiler.

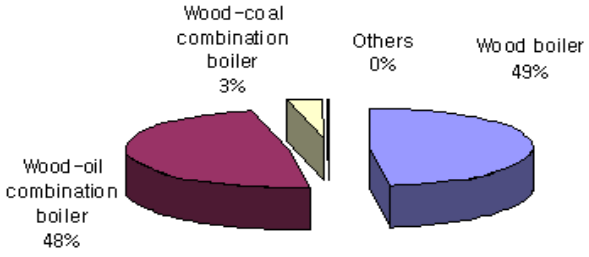

Fig. 7. Service (A/S) on boiler trouble.

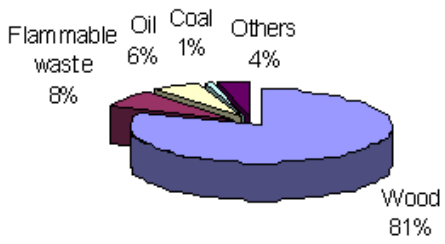

Fig. 8. Fuels of fire-wood boiler.

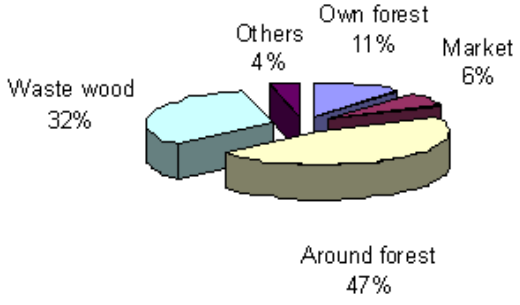

Fig. 9. Patterns of fuel purchase for fire-wood boiler.

4) What is the annual consumption of fuel wood for fire-wood boiler?

50% of the households annually consumed more than 5 tons of fuel wood, 17% was 4 tons and 26% was 2~3 tons. Therefore, most of the households annually consumed more than 2 tons of fuel wood (Fig. 11).

5) What is the monthly consumption of fuel wood for fire-wood boiler in winter?

25% of the households answered the monthly consumption of 3 tons for heating in winter, 17% was 2 tons, 15% was 1.5 tons, 12% was 1 ton and 13% was 0.5 ton (Fig. 12). These results, compare with the annual consumption of fuel wood, indicate that the fuel wood for fire-wood boiler is mainly consumed in winter.

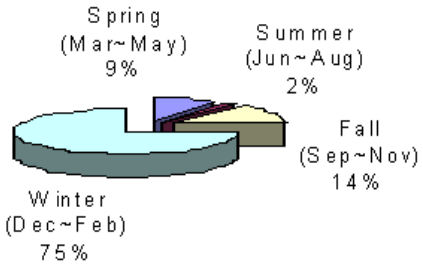

Fig. 10. Seasons using fire-wood boiler.

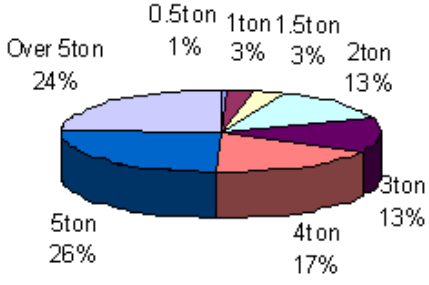

Fig. 11. Amounts of annual fuel consumption for fire-wood boiler.

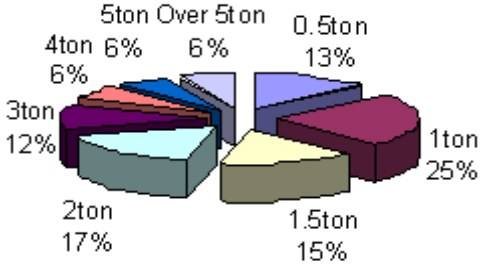

Fig. 12. Amounts of monthly fuel consumption for fire-wood boiler during winter.

6) What is the operation ratio in wood/oil combination boiler?

In the wood/oil combination boiler, the dual operation was 43% (wood/oil: 80/20) and the wood operation was 37%. According to the personal interview, the dual operation was used to substitute the burned-out wood with oil in the cold dawn of winter.

7) Are you willing to install the boiler using the other wood-based forming fuel which is easy to handle and has similar good heat efficiency to oil, if the supply of fuel wood is to be difficult?

This question was to supply the wood-based forming fuels such as wood chip and pallet as the substitutes with the wood fuel previously used for fire-wood boiler. 40% of the households was willing to install such a boiler and 36% was not. However, 22% was no idea, indicating the supply of the boiler using wood-based forming fuel has to be carefully decided through the consideration of the factors such as boiler price, fuel price and financial aid policy (Fig. 14).

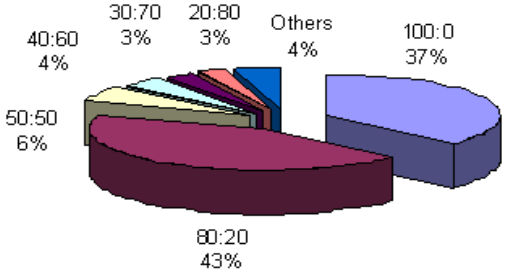

Fig. 13. Answers on operation ratio of wood/oil combination boiler.

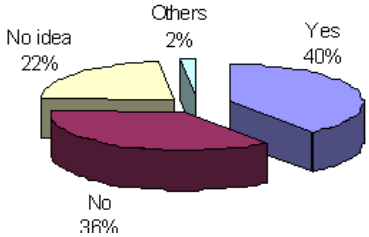

Fig. 14. Answers on installation of chip or pallet boiler.

However, 59% of the households was not willing to purchase the fuel and only 37% was still willing to, if the priceof wood-based forming fuel is expensive compare to that of previous wood fuel (Fig. 15).

Furthermore, 65% of the households did not want to install the boiler and only 33% did, if the price of the boiler using wood-based forming fuel is higher than that of previous fire-wood boiler (Fig. 16).

These facts suggest that it is desirable to decrease the price of the boiler, fuel and to increase the financial aid to supply the new boiler, though the price of the new boiler using wood-based forming fuel is expensive compare to those of the previous fire-wood boiler and fuel.

3. Questionnaire on use

1) What is the use of fire-wood boiler?

The use of fire-wood boiler was for household heating (95%) and another was for horticultural facility heating (2%) (Fig. 17).

This fact indicates that the use of fire-wood boiler is for small-scale heating, otherwise the boiler using the fuel with high heat efficiency such as wood chip and pallet has to be used for medium- and large-scale heating.

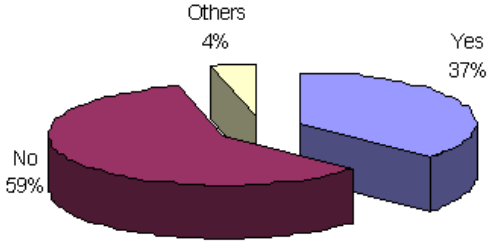

Fig. 15. Opinions on purchase of wood-based forming fuel.

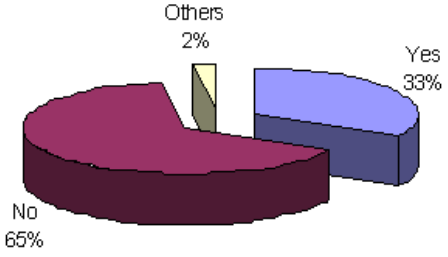

Fig. 16. Answers on purchase of boiler using wood-based forming fuel.

2) How many times do you supply the wood fuel a day to the fire-wood boiler in winter?

Three times were the most frequent as 42% and 3~7 times were 18%. Thus, the fuel supply to household boiler could be an annoying job to user (Fig. 18).

3) How do you treat the ashes from the burning of wood fuel?

65% of the household answered to utilize the ashes from the burning for the other purpose and 35% answered to dump it out. Most of the ashes were utilized as a fertilizer (Fig. 19).

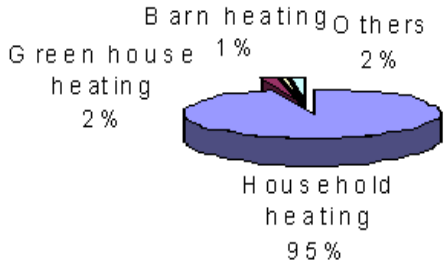

Fig. 17. Purposes of fire-wood boiler.

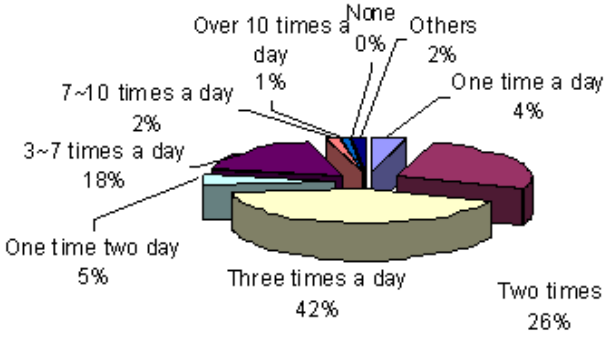

Fig. 18. Times of fuel supply per day to fire-wood boiler in winter.

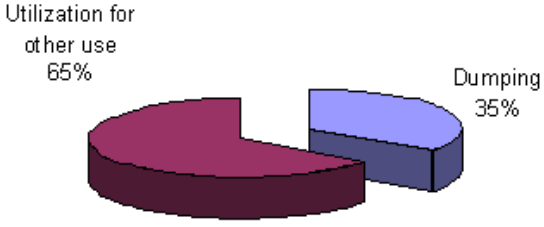

Fig. 19. Treatments of ash from wood fuel burn.

4. Questionnaire on improvement

1) Do you satisfy to use the fire-wood boiler?

The survey of the satisfaction index on the use of fire-wood boiler indicates that satisfaction was 69% and very satisfaction was 20%, suggesting most of the households satisfy to use the boiler (Fig. 20).

One of the reasons of satisfaction was on the fuel: low fuel cost was 36% good heat efficiency was 17%; convenient fuel purchase was 16%. The financial aid on the installation of boiler was also one reason (14%). Thus, the installation of fire-wood boiler may be gradually expanded if increased the financial aid (Fig. 21).

However, there are also several reasons of dissatisfaction: inconvenient fuel purchase was 32%; frequent fuel supply was 31%; much smoke on use was 16%; complicate operation was 7%; uneasy ash treatment was 5% (Fig. 22).

2) Do you satisfy the financial aid on the installation of fire-wood boiler?

The questionnaire about the financial aid on the installation of fire-wood boiler indicated that less was 62% and satisfaction was 38%, suggesting many households want to increase the financial aid (Fig. 23).

30% of the households wanted 80~90% financial aid of the installation cost, 24% wanted 50~60% financial aid, 18% wanted 70~80% and 12% wanted 60~70% (Fig. 24).

Thus, 60% financial aid of the installation cost might be expanded the supply of fire-wood boiler because the present financial aid is 50% of the installation cost.

3) Are you willing to recommend to the other people the fire-wood boiler?

59% of the households gave positive answer on the question and 21% answered strong recommendation, indi-

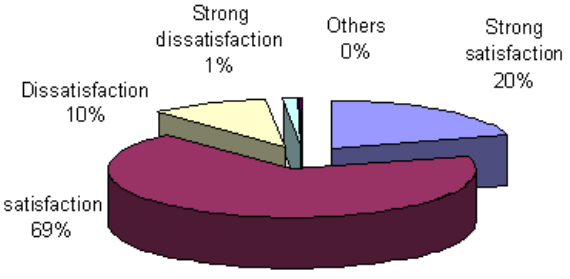

Fig. 20. Satisfaction index on use of fire-wood boiler.

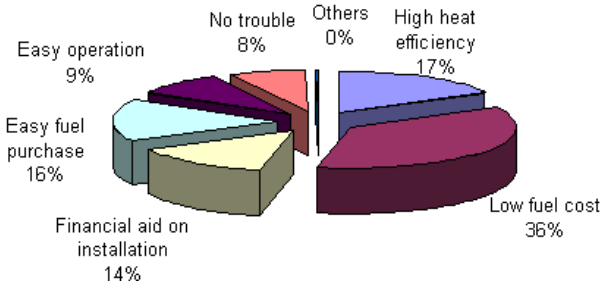

Fig. 21. Reasons of satisfaction on use of fire-wood boiler.

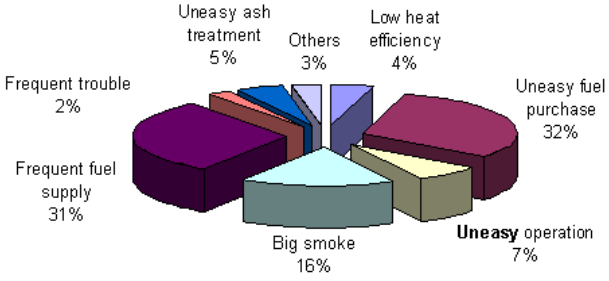

Fig. 22. Reasons of dissatisfaction on use of fire-wood boiler.

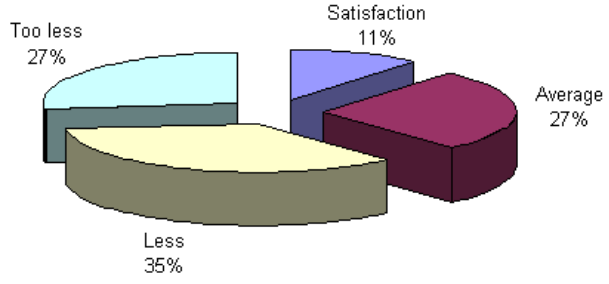

Fig. 23. Answers on financial aid for boiler installation.

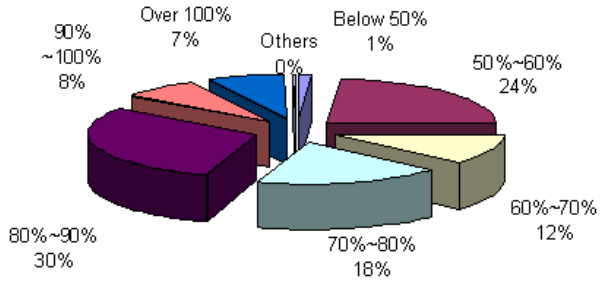

Fig. 24. Answers on amount of financial aid forboiler installation.

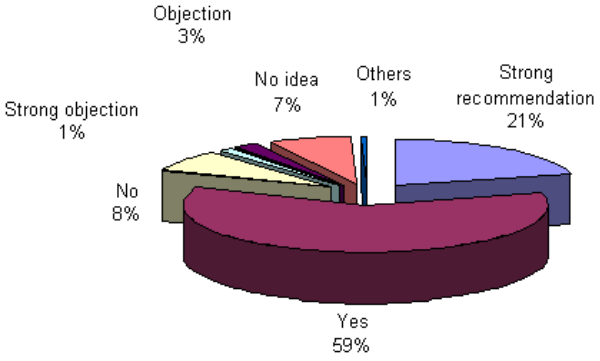

Fig. 25. Answers on recommendation of fire-wood boiler.

cating more than 80% of the households are willing to recommend (Fig. 25).

Thus, the demand of fire-wood boiler will be continuously increased hereafter and Gangwon province has to prepare the long-term plan on the demand increase of fire-wood boiler.

CONCLUSION AND SUGGESTION

It will be inevitable to develop the substitute energy in the time of high oil price, considering the situation Korea is the 10th petroleum-consuming country in the world and has nothing in the petroleum-related resources. Korean Ministry of commerce, Industry and Energy has a plan that substitutes 5% of the consumption of domestic gross energy with the substitute energy until 2011, and is trying to develop new renewable energy. Gangwon province has the abundant forest resources and the condition that is desirable to supply wood-based biomass energy, and also activates, for the first time in this country, the energy plan of rural and mountain areas by the installation of fire-wood boiler through the positive financial aid system.

The general problems in use of fire-wood boiler are fuel purchase, collection and transportation. Thus, the development of the household heating boiler using wood-based forming fuel which is cheap, small volume, easy handling, convenient purchase and high heat efficiency could be an alternative to improve the problems. Also the continuous expansion of the supply of fire-wood boiler can prevent the devastation of forest through the regulation of imprudent fuel supply.

Although the financial aid plan on the installation of fire-wood boiler is in active, many petty households in rural and mountain areas lose a chance to install the fire-wood boiler due to the unsatisfactory information. Thus, it will be desirable for municipal government to prepare the information plan to offer the equal chance and condition to all households in rural and mountain areas.

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