ECONOMICAL EVALUATION OF BIOMASS-FIRED POWER GENERATION IN JAPAN

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Introduction

Biomass, that is carbon neutral and a renewable resource, becomes attractive after the decision of Biomass-Nippon strategy in Japan. We are trying to construct a database concerning utilization of woody biomass. There are many kind of biomass and the conversion technologies are also manifold. Therefore, in this study, biomass-fired power generation was aimed because it has been already substantiated and the information would be collected easily.

In general, woody biomass is more expensive than fossil fuels such as coal because it is used not only as power plant feedstock but also for building materials. Therefore, the economics of this process is an important issue, and an economical power generation system is required. In this study, the economical evaluation of biomass-fired power generation in Japan was examined. The data concerning the economics in biomass-fired power generation were collected. Finally, they were expressed as functions of plant capacity and a simulator which can evaluate the economics in brief was made.

Estimation Method

Composition of Woody Biomass

Although the chemical composition of woody biomass differs between the regions, the Elemental composition is relatively similar. In the combustion, the heating value of biomass is important. It can be estimated from the elemental composition. The compositions in the trunk and bark that were estimated from reference[1)] are shown in Table 1.

Efficiency of Electricity Generation and Plant Capacity

It has been reported that the efficiency of electricity generation is related to plant capacity in that it increases with the increase in plant capacity. In this study, the relationship between the efficiency of electricity generation and the plant capacity has been reported (Fig. 1). In this study, these values were estimated from the relationship.

Construction Cost

Although the total cost of construction of a power plant increases with higher plant capacity, the unit cost of construction decreases. The relationship between the unit cost of construction and plant capacity is shown in Fig. 2. That is, the total construction cost could be estimated from the relationship.

Table 1 Properties of woody biomass[1)]

	Ash [dry%]	C [dry%]	H [dry%]	O [dry%]	HHV [MJ/kg]
Trunk	1	52	6	41	21
Bark	3	52	6	39	20

Personal Cost

The staff number in the plant also correlates with the plant capacity. Fig.3 shows the relationship between the staff number and the plant cost. The personal cost for a staff was assumed to consist of the averaged annual income (¥5,527,000) and the cost that was borne by employer (20% of the averaged annual income).

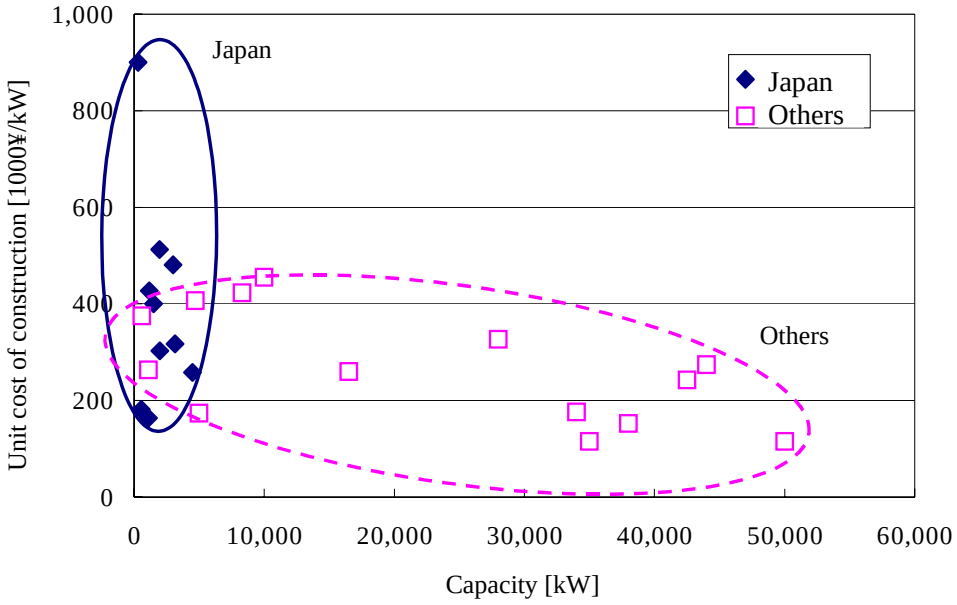

Fig. 1 Relationship between plant capacity and electricity efficiency[2)]

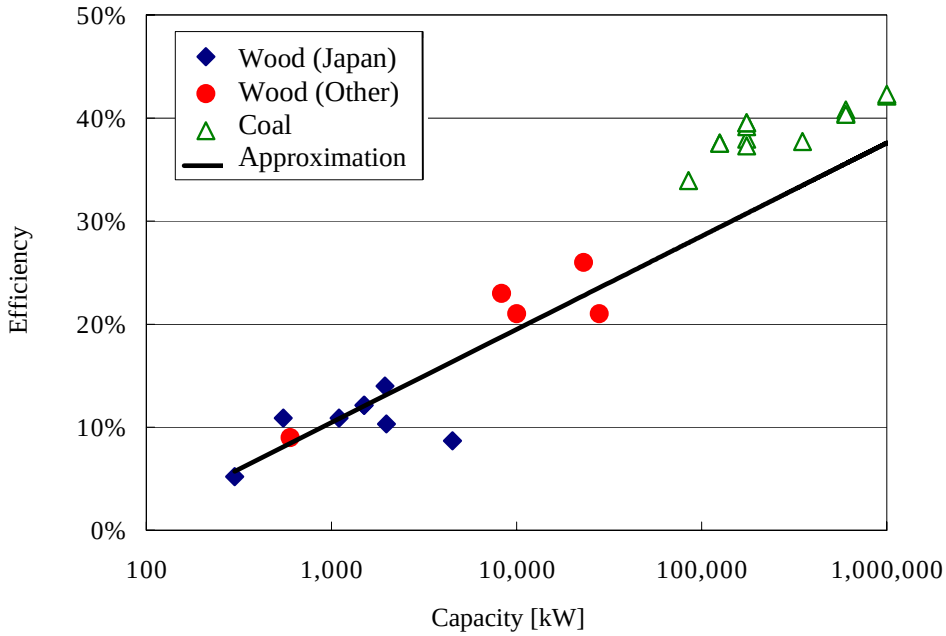

Fig. 2 Relationship between plant capacity and unit cost of construction[2)]

Maintenance Cost

It is approximately assumed that the maintenance cost is 3% of the construction cost in general. In this study, it was also assumed to be 3%.

Cost of Ash Treatment

Woody biomass contains ash that accounts for approximately 1% of biomass weight. The ash was emitted by biomass combustion; the cost of ash treatment was ¥10000 per ton.

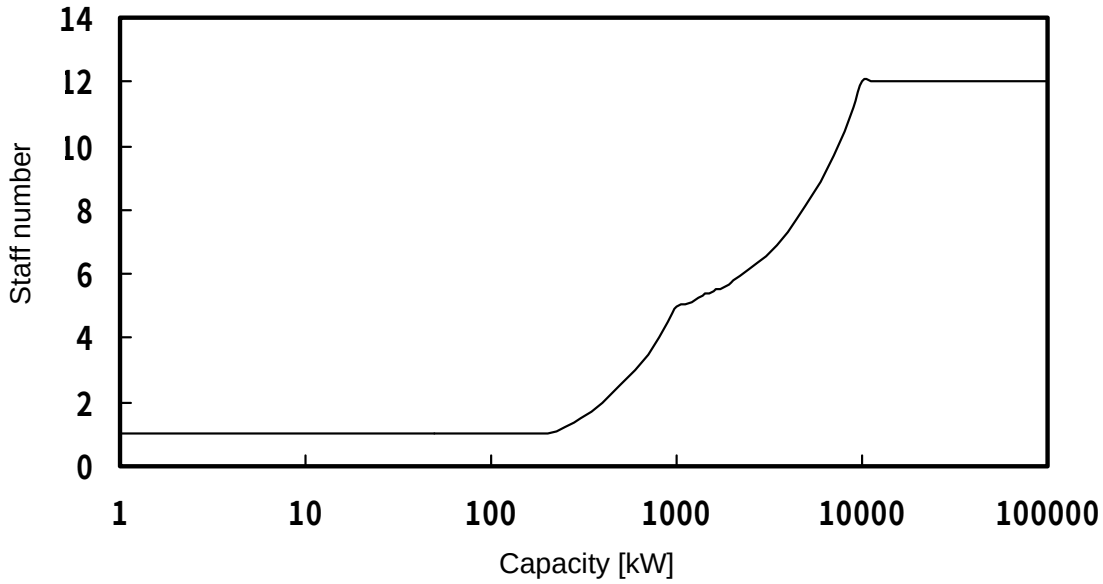

Fig. 3 Relationship between plant capacity and staff number[3)]

Payback Period

The payback period is a variable for the benefit and the total investment generally. However, in the estimation of the electricity cost, it was assumed to be 15 years[4)].

CO_2 Mitigation by Electricity Generated from Biomass

Biomass-fired power generation can be used as an alternative to power generation by the existing methods that involve CO_2 emission; therefore, the amount of CO_2 mitigated by using biomass-fired power plants also includes that emitted by the existing power plants. The CO_2 emission factor for electricity generation is 0.555kg-CO_2/kWh[5)].

Economical Evaluation

A simulator which evaluates the economical efficiency of the biomass-fired power generation in Japan from the above estimations was made. Fig. 4 shows the window of the simulator. At first, the biomass type (trunk or bark), moisture content, and the amount of biomass must be inputted in the simulator. From the values, total heating value can be obtained. Then the plant capacity and electricity efficiency are estimated. Finally, the electricity cost, the economical payback periods etc. can be estimated.

The estimated data were compared to those in commercial plants. The estimated data relatively corresponded to those. Although a location and cost of estate was not taken account of in the simulator and a detail process design would be required later, it enables us to typically evaluate biomass-fired power generation in Japan from the economic viewpoint. Therefore, it is considered that the simulator that was developed in this study can be effectively used for first step of introduction of biomass-fired power generation.

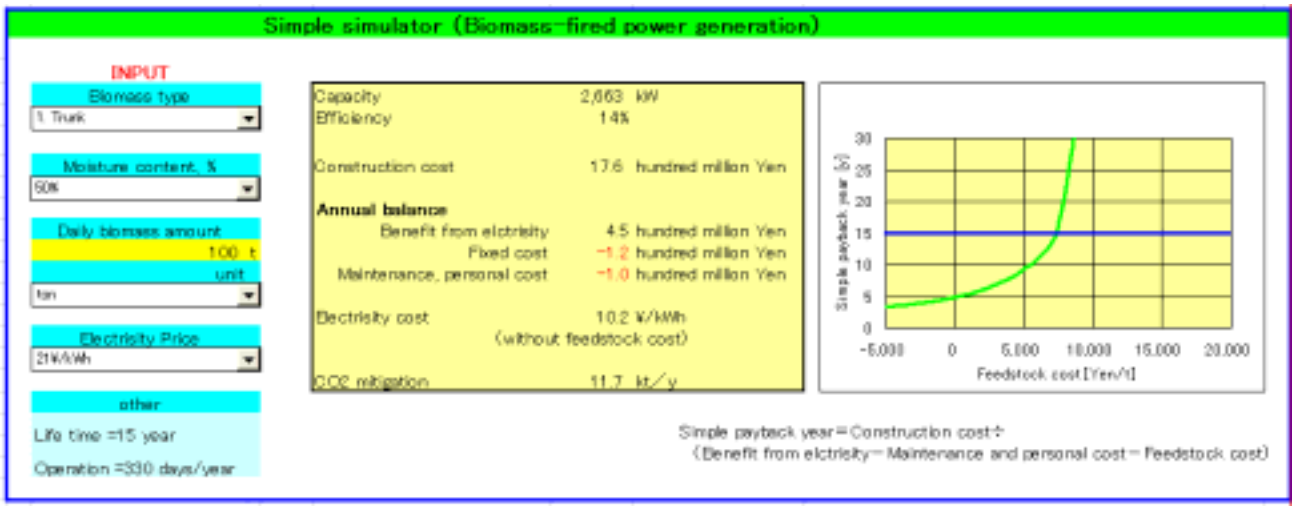

Fig. 4 Simulator of biomass-fired power generation in Japan

Conclusions

Biomass, that is carbon neutral and a renewable resource, becomes attractive after the decision of Biomass-Nippon strategy in Japan. In this study, biomass-fired power generation was aimed. The fixed cost and the running cost were expressed as functions of plant capacity and a simulator which can briefly evaluate the economics was made. The properties of biomass such as the heating value and the moisture content were considered in the simulator. The estimated data relatively corresponded to those in commercial plants. It enables us to typically evaluate biomass-fired power generation in Japan from the economic viewpoint.

References

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