The Comparison of Damage Costs for Various Power Generating Sources Using the SimPacts Model

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1. Introduction

Decision-makers are increasingly concerned about the physical and economic consequences to the public and the environment regarding their decisions. Also, proper management of the environmental risks and associated damage costs has to be made in order to achieve a sustainable development in the energy sectors. Therefore, we estimated the damage costs for various power generating sources and compared them.

2. Methods and Results

In this section the characteristics of AirPacts, NukPacts, and HydroPacts built within SimPacts are described. Simpacts packages are developed by IAEA for the estimation of damage costs from the operation of various power generation systems. And the results and discussions for three typical power generation sources, i.e., coal, nuclear, and hydro are presented and compared.

2.1 SimPacts Model

The general structure of the SimPacts model is shown in Figure 1. In the SimPacts model, three sub-models are built in, i.e., AirPacts[1], NukPacts[2], and HydroPacts[3]. The Airpacts program calculates the physical impacts and the associated damage costs for the following types of pollutants: particulate matter (PM), sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon dioxide (CO), and secondary species such as nitrate and sulfate aerosols. The NukPacts model implements a method for quantifying and evaluating the potential adverse health effects to people arising from routine atmospheric releases of radioactivity from nuclear generating systems. The HydroPacts model calculates the impacts and the associated damage costs for the construction and operation of dams.

2.2 Results and Discussions

The reference site for calculating the damage costs using AirPacts resulting from the release of pollutants is Taeahn coal-fired plants[4]. The emission rates of PM, SO_2, NOx in tons per year are 112, 1002, 2820, respectively. We assumed that the location of the plants was Ulchin in order to compare the damages costs resulting from the pollutants of both plants consistently. And the site specific data such as the population density and wind speed have the same value used in the calculation of the NukPacts model.

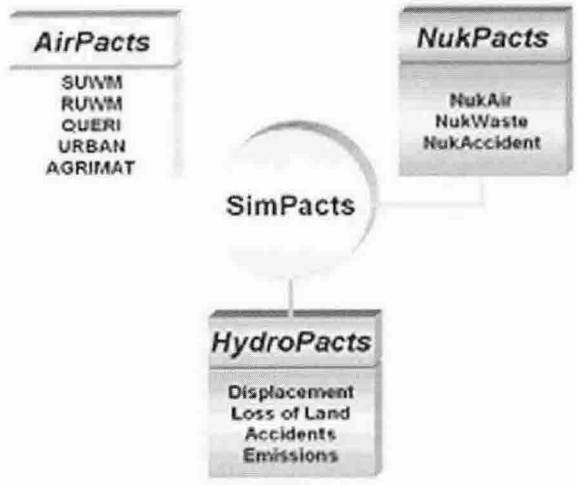

Figure 1. Organization of SimPacts

The total damage costs and damage cost per unit mass of pollutants are plotted in figures 2 and 3. According to the results, the damage cost resulting from the releases of NOx and SO_2 is very small. This is attributed to the fact that the pathway for impacting the human health of SO_2 is only an acute mortality and the pathway of NOx is none. However, the damage cost of secondary pollutants such as nitrates and sulfates is very high.

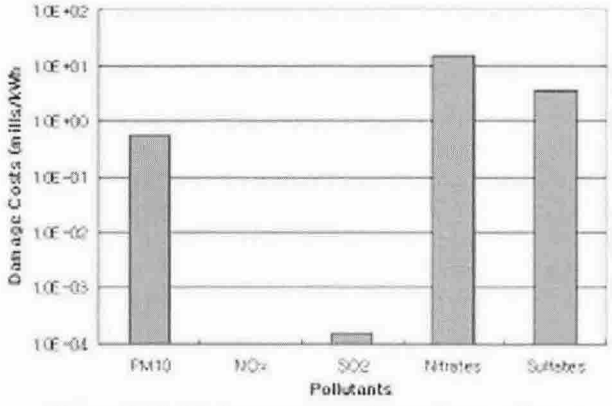

Figure 2. Total damage costs for various pollutants

The site for calculating the damage costs resulting from the construction and operation of dams using HydroPacts is the Yongdam dam[5]. The cost items calculated in the HydroPacts model are displacement, loss of land, loss of life, emissions of green house gases, and loss of production.

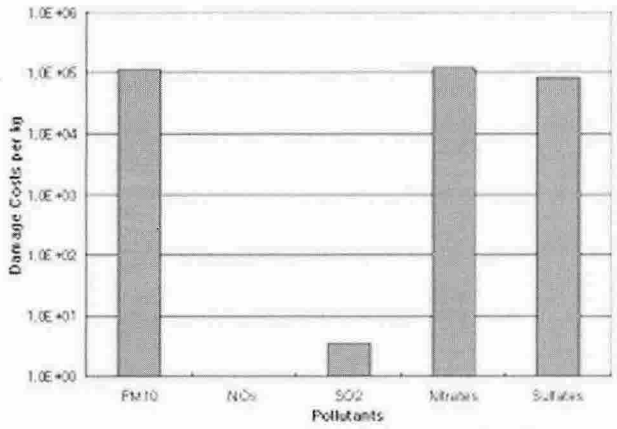

Figure 3. Damage costs per unit mass of various pollutants

The results for damage cost per MWh from the construction and operation of Yongdam hydro power plants are plotted in figure 4. The most important cost item is a loss of production and the cost of loss of life which comes from the accident is the lowest. Among the five cost items, loss of life and emissions of greenhouse gases can be classified as external cost items. The resulting external cost is about 2 % of the total damage costs.

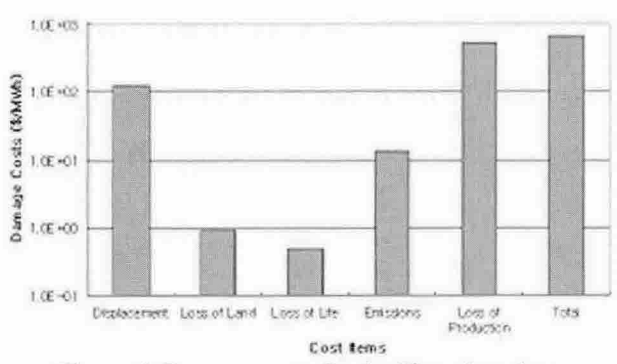

Figure 4. Damage costs for the Yongdam dam

The comparison of the damage costs for various power generation sources in mills per kWh are plotted in figure 5. The damage costs resulting from the hypothetical severe accidents of nuclear power plants and the routine atmospheric releases of radioactivity are derived from the results in reference [6].

The damage costs resulting from the normal operation of nuclear power plants are much smaller than those of the coal and hydro power systems. And even the damage costs resulting from the severe accidents of nuclear power plants are smaller than those of the coal and hydro power systems. The highest damage cost comes from the construction and operation of dams. Especially, the cost for a loss of production in the hydro power system is a dominant cost item.

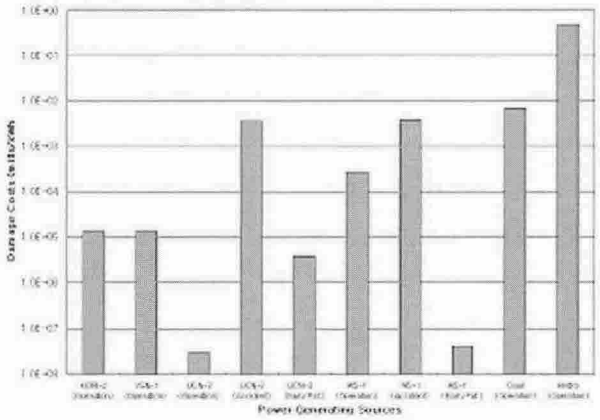

Figure 5. Comparison of the damage costs for various power generating sources

3. Conclusion

The damage costs in mills per kWh were estimated and compared for coal, nuclear, and hydro power systems. The nuclear power systems are superior to the other power generation sources from the viewpoint of external costs which are not internalized at market prices. The external costs estimated in this study can be used as a comparative measure for the decision making of electricity system expansion planning.

Acknowledgement

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