Impacts of Post-Fukushima Nuclear Policies on Roadmaps towards a Low-Carbon Society in Japan

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1. Introduction

On March 11, 2011, Japan suffered an enormous earthquake and tsunami. On that day, 55 units were in commercial operation (including 18 units under periodical inspection) and 12 units were under construction. After the earthquake, 15 plants were shutdown due to the earthquake. The nuclear accident in the Fukushima awoke public concern about nuclear energy policy as well as overall energy policy in Japan. Before the earthquake, the priority of Japan's energy policy was ensuring a stable supply of energy, but in contrast it now seems that ensuring the safety of the supply of energy has become the priority of energy policy. Although key policy actions are on the table and representatives and experts have made proposals for ensuring safe energy by, for example, denuclearization and/or the phase-out of nuclear power, enhancing renewable energies and spreading fossil-fueled power plants, it is still unclear how these will affect energy policy options for the long-term energy situation, especially pathways towards a low-carbon society in Japan.

2. Methodology for the analysis: AIM/Backcasting Model

The AIM/Backcasting Model in this study is used to investigate and select which options (countermeasures and policies) to introduce, and when and at what intensity, in order to best achieve the future social and economic activities portrayed in the scenarios while satisfying the service demand today and throughout the period up to the target year, based on certain criteria. Energy consumption, industrial structure, and the composition of CO_2 emissions in the base and target years are set exogenously, and the values for the other years (intermediate years) are estimated endogenously by the model. Mixed integer programming is used for formulation and the Cplex solver with the General Algebraic Modeling System (GAMS) is used for derivation of the optimal solution. Figure 1 shows an assessment of the schemes in the AIM/Backcasting Model.

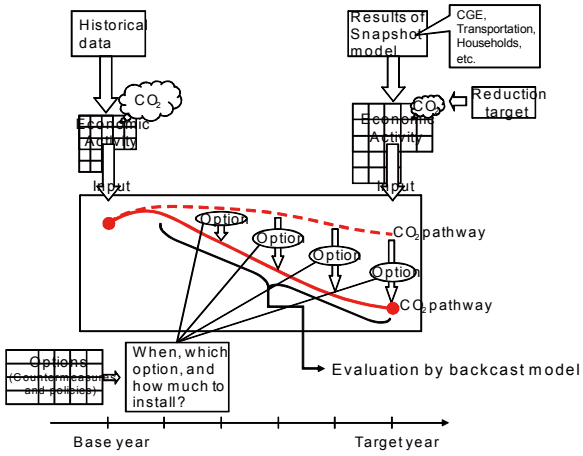

Figure 1: Schemes of the flow of estimation using the AIM/Backcasting Model

3. Energy policy options in the future

Future energy policy will respond to the availability of nuclear power, so two sets of scenarios have been made as future energy policy options. All scenarios are based on the premise that the Fukushima Daiichi Nuclear power plants never restart.

The first scenario set is for existing nuclear power plants. The set has five options: (1) no restart (all nuclear power shutdown now and never restarted), (2) partial restart with a life of 40 years (restarting will allow for nuclear power with the exception of plants damaged by the earthquake, and continue to commercial operation for 40 years), (2) partial

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restart with a life of 60 years (restarting will allow for nuclear power with the exception of plants damaged by the earthquake, and continue to commercial operation for their lifetime. The lifetime of power plants extends from 40 years to 60 years), (3) full restart with a life of 40 years (all nuclear power plants are allowed to restart and continue commercial operation for 40 years), and (4) full restart with a life of 60 years (all nuclear power plants are allowed to restart and continue commercial operation for their lifetime. The lifetime of power plants extends from 40 years to 60 years).

The second scenario set is for new nuclear power plants. The set has three options: (1) withdrawal (all nuclear power both under construction and under planning is withdrawn), (2) construction only (only nuclear power plants currently under construction will be allowed to start commercial operation, and plants under planning are withdrawn), and (3) enhancement (future nuclear policy continues to follow the policy that was conducted before the earthquake).

The analysis was conducted based on a combination of two scenario sets as shown in Table 1. Under the no restart scenario, the new construction of nuclear power is quite unlikely to be permitted, so in the analysis two scenarios (No-CON and No-EH) have been eliminated. The partial restart scenario assumes that the nuclear power status quo will be maintained and the Part40-EH and Part60-EH scenario was dropped from the scenario set. Figure 2 shows the capacity of nuclear power by scenario.

Table 1: Scenario sets analyzed

		Options for new nuclear plants		
		Withdrawal	Construction only	Enhancement
Options for existing nuclear power plants	No restart	No-WD	-	-
	Partial restart with a life of 40 years	Part40-WD	Part40-CON	-
	Partial restart with a life of 60 years	Part60-WD	Part60-CON	-
	Full restart with a life of 40 years	Full40-WD	Full40-CON	Full40-EH
	Full restart with a life of 60 years	Full60-WD	Full60-CON	Full60-EH

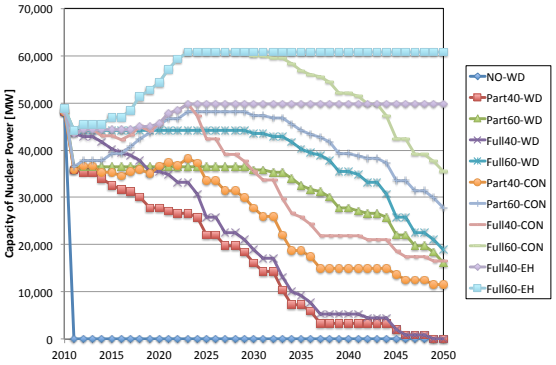

Figure 2: Capacity of nuclear power by scenario

4. Impacts of energy policy options

Figure 3 shows CO_2 emission pathways from 2005 to 2050. Japan has been set an 80% reduction of GHGs by 2050 as a long-term climate change mitigation target. 95% of Japan's GHG emissions come from CO_2 emissions from energy use, and the mitigation target interprets an 80% reduction of CO_2 emissions by 2050. We can see from the figure that, even in the No-WD scenario (denuclearization), an 80% reduction target in 2050 is feasible, and availability of nuclear power mainly affects CO_2 emissions over the mid term (2015-2030).

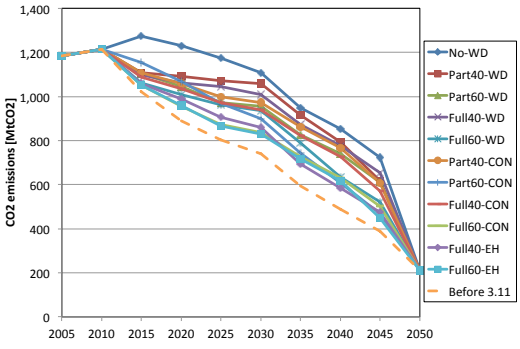

Figure 3: CO2 pathways towards Low-Carbon Society in 2050 by energy policy options

5. Conclusion

Discussion of energy policy after the earthquake is likely to commence soon, and denuclearization is an option for the energy policy portfolio in Japan. Based on the analysis, we found that from a long-term viewpoint, Japan can satisfy both denuclearization and low-carbonization. However, without an intelligent strategy for low-carbonization, CO_2 will continue to grow and the climate change mitigation target of 80% reductions in GHG emission by 2050 will be left unfulfilled, because nuclear will be substituted by coal, which is a large fossil fuel emitter of CO_2.