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## Accident Cleanup Costs Rising to 35-80 Trillion Yen in 40 Years

Considering the postponing of decommissioning with “Confinement-managing” scenario as a possible option

— Urgent need for measures to manage contaminated water —

Japan Center for Economic Research<sup>1</sup>

In March 2017, JCER calculated that the final cost of disposal after the accident at the Fukushima Daiichi Nuclear Power Plant could potentially balloon to nearly 70 trillion yen. After the passage of two years, we have attempted a recalculation based on the limited information available from hearings with stakeholders and others. As a result, we found that there was a risk that the cost would exceed 80 trillion yen due to the increase in contaminated water. We also carried out a preliminary calculation for the so-called “confinement-managing” scenario where decommissioning is temporarily postponed without removing the melted nuclear fuel debris. It showed that the scenario would limit total costs to around 35 trillion yen by 2050 (subsequent disposal costs are undecided). Eight years have passed since the accident, and JCER thinks that it is now time to decide how to deal with nuclear power in the medium- to long-term energy plan.

### 1. Potential 40% Reduction in Cost (35 trillion yen) by Postponing Decommissioning and Contaminated Water Treatment

Based on hearings with the stakeholders, we have made the following assumptions regarding the change in conditions since the calculations in March 2017.

#### 1-1 Need for Another 800,000 Tons of Water to Cool the Nuclear Fuel Debris in the Reactor

If the cooling of the fuel debris inside reactors 1 to 3 would continue until 2030 (when dry storage of debris will be available), it is expected that another 800,000 tons of water will be required. This would be another 800,000 tons of contaminated water. Since nearly 1.2 million tons of contaminated water is already stored in tanks on the site at Fukushima Daiichi Nuclear Power Plant, this would take the total to 2 million tons (the 2017 calculation assumed 1 million tons of contaminated water). The attempt to remove both strontium and tritium from the contaminated water would cost approximately 40 trillion yen.

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## 1-2 Cost of About 150 Billion Yen Per Year for the Management of Contaminated Water

As the hearings with the stakeholders indicated that the cost of managing contaminated water was a little more than 100 billion yen a year, we assume the costs of 150 billion per year. If it were not possible to carry out the decommission of the reactor without removing the nuclear fuel debris (confinement in water coffin or sarcophagus), the management cost will be 150 billion yen by 2030. After that, assuming that the costs will gradually taper off, and will reach zero by 2050, the total would be 3.25 trillion yen.

## 1-3 Purchasing of All Land in “Difficult-To-Return Zone” in the Case of Postponing the Decommissioning.

In the case in which the removal of the nuclear fuel debris is temporarily postponed, we assume that the government will buy lands in all “Difficult-to-return zones” where residents are not allowed to return home. We used the pre-disaster posted price of land within a 20km radius of the Fukushima Daiichi Nuclear Power Plant as a reference. Assuming that the size of the area to be purchased is the same as the semicircle within a 10km radius of the Fukushima Daiichi Nuclear Power Plant, we estimate the purchase price to be 1.1 trillion yen (purchases at posted land prices are fairly expensive).

Table 1: Comparison of accident cleanup costs at Fukushima Daiichi Nuclear Power Plan (Estimated by JCER in March 2019)

Trillion yen	(1) Decommission with cleaning up the tritium water	(2) Decommission with releasing the tritium water into the ocean	(3) Postpone of decommission with releasing the tritium water into the ocean
Treatment of decommission and contaminated water	51	11	0
compensation	10	10.3	10.3
decontamination	20	20	20
<b>Total</b>	<b>81</b>	<b>41</b>	<b>30</b>

Note: The figures for calculation (1) include the disposal cost of the tritium water (20 million yen/ton, 2 million tons of stored water) based on hearings with experts in decommissioning of nuclear reactors and disposal of contaminated water. Calculation (2) includes diluting 2 million tons of tritium water including, and releasing all into the ocean (not included as the costs are small), and 300 billion yen to compensate for 40 years of damage caused by misinformation. Calculation (3) includes the cost explained in 1-2, 1-3 without the costs required after 2050. The cost of land purchases is the same as the cost calculated in “[Impact to last Decade or more if Existing Nuclear Plants Shut Down](#)” (April 25, 2011). The processing costs for the final disposal of 14 million cubic tons of rubble and soil arising from the decontamination is based on the unit price for processing low-level radioactive waste at Rokkasho in Aomori Prefecture in Calculation (1), (2), (3).

Reference Table: March 2017 calculations

Trillion yen	Previous government estimates	Government estimates (12/20/2016)	JCER estimates (1)	(2)
Treatment of decommission and contaminated water	2	8	32	11
compensation	5	8	8	8.3
decontamination	4	6	30	30
Total	11	22	70	49.3

The difference between the calculation outcomes in Table 1 and in the reference table are outlined below.

- For the calculations for Table 1, we assumed that there was a total of 2 million tons of contaminated water, and that tritium water was to be disposed of. The previous calculation, Reference Table, was based only on the 1 million tons of water stored in tanks.
- The amount of compensation to be paid by TEPCO has already increased to more than 8.7 trillion yen and we assume it will balloon to around 10 trillion yen (Ministry of Economy, Trade and Industry indicated by March 19 that the TEPCO compensation payments of 8.7 trillion yen included approximately 2 trillion yen of decontamination costs. Approximately 2 trillion yen is counted twice in the total amount of 35 to 81 trillion yen).
- Since Ministry of the Environment has changed its estimate for the amount of rubble and soil generated in the process of the decontamination from 22 million m<sup>3</sup> to 14 million m<sup>3</sup>, we have revised the figure down from 30 trillion to 20 trillion yen.

Otherwise, the calculations are based on the same conditions as the previous report ([Accident Cleanup Costs May Rise to 50-70 Trillion Yen](#)).

## 2. 35 Trillion Yen for the “Confinement-Managing” Scenario—Excluding the Cost for Compensation and Semi-permanent Management

For this estimation, we also consider a situation like Chernobyl, where postponement of the removal of debris leaves no alternative other than permanent control in sarcophagus or water coffins. The cost of 35 trillion yen does not include any of the expenses that would emerge in case of postponing of decommissioning, such as additional compensation to residents who returned on the understanding that the reactor would be decommissioned, the relocation issues, or the management costs after 2050. The amount, incidentally, will be about 1.4 trillion yen, assuming that the roughly 9,000 persons who evacuated within Fukushima Prefecture will receive annual compensation of 10 million yen per person with the amount gradually reduced over a period of thirty years to reach zero in 2050 (unverified).

However, examinations of the debris only began in February 2019. Whether or not it

is technically possible to remove all the debris will be verified in the future. TEPCO also recognizes the difficulties of complete removal of the debris.<sup>2</sup> In the long term, removal of the debris is preferable to confinement and permanent management as it poses less of a risk. Yet, not only is there no guarantee that all debris can be removed, but also there is a high risk in removing the debris. Even though the basic policy remains to remove the debris, it is also necessary to investigate plan B—the confinement and permanent management in stone coffins or water coffins.

### 3. Inevitable Additional Compensation to Fisheries If Contaminated Water Is To Be Released into the Ocean

Measures to manage contaminated water controls are required with urgency. Thanks to a number of measures, the amount of groundwater seeping into the reactor has decreased to one quarter to one fifth of what it once was, but even so roughly 100 tons is still seeping in every day and becoming contaminated. At present, the site has only secured locations for storage tanks to hold 1.37 million tons of water, but nearly 1.2 million tons is already stored at the site. It is necessary to promptly secure additional storage sites. The Nuclear Regulation Authority has approved of releasing contaminated water, which still contains tritium, after the removal of strontium and other radioactive materials. Yet, they have failed to obtain understanding from the local fisheries community. Taking consumer state of mind into consideration, it is not simply a matter of settling the reputational damage. It is vital to consider additional compensation if the water were to be released into the ocean.

### 4. Clear Explanations for the Purpose of Retaining Nuclear Power

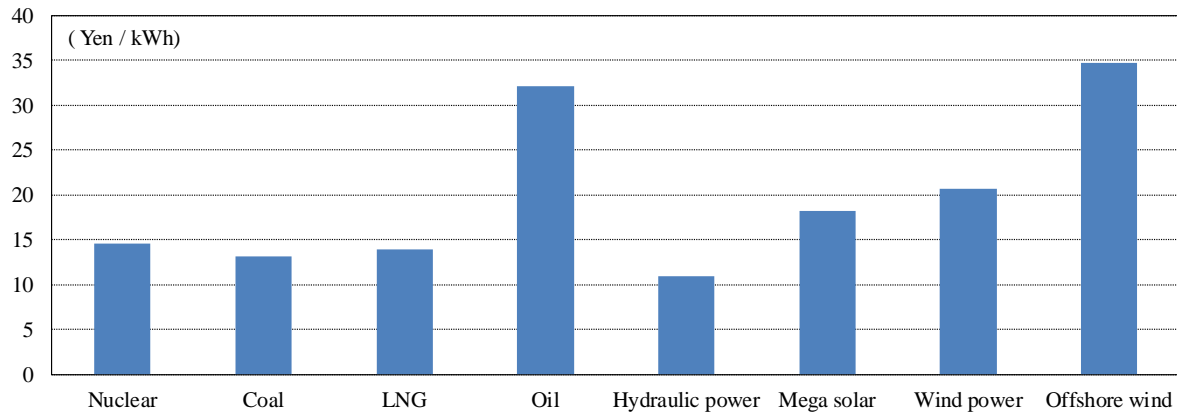
According to the “Strategic Energy Plan,” nuclear power generation will supply a little over 20 percent of electric power in fiscal 2030. Yet, the purpose of the plan is becoming ambiguous. METI and the power industry have claimed that nuclear power is an inexpensive power source even when the policy costs are included. A report published two years ago pointed out that nuclear power plants were hardly an inexpensive power source with a construction cost of 1 trillion yen per 1 GW reactor (Fig. 2). Since then, Hitachi Ltd. has shelved<sup>3</sup> its nuclear power business in the UK, indicating that the private sector considers the new construction of nuclear power in industrialized countries too great a risk. Nuclear power is viewed by the government as necessary to guarantee energy security and counter global warming, but there has not yet been any cost-benefit performance comparison done, which includes future forecasts for rapidly-developing energy conservation and renewable energy.

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<sup>2</sup> Page 12 of the Nikkei Shimbun evening edition, March 4, 2019 (Japanese)

<sup>3</sup> Front page of Nikkei Shimbun morning edition, January 18, 2019 (Japanese)

Fig. 2: JCER Cost Comparison among various power sources



(Note)Based on the published trial calculation files used by the Advisory Committee for Natural Resources and Energy (ACNRE) at METI (spring 2015) with the 2020 model.

Conditions for the calculations

ACNRE

JCER

At model plant: unit cost for constructing nuclear power plant 370,000 yen/kW → 740,000 yen

The ACNRE calculations in Fig. 2 assume crude oil prices above 100 dollars per barrel, but the current price is around 60 dollars. In addition, the cost of solar energy and wind energy are substantially decreasing worldwide, and has become cheaper than thermal power generation in some cases. Considering the progress of technology, we do not know how much longer Japan may soon get rid of its “common sense” of regarding renewables as expensive sources of energy. Insisting on the retention of nuclear power generation on economic grounds shows a failure in logic.

There is also a lack of explanations regarding the public financial burden, decommissioning cost, and compensation costs. At the time of the Chernobyl nuclear power accident, the economic conditions in the former Soviet Union and the Ukraine were poor. Therefore, the decommissioning plans and the cost burdens were implemented under international cooperation and with full transparency.<sup>4</sup> It should be time for decommissioning in Fukushima to gain international cooperation to establish new systems, and to examine and construct highly transparent funding cooperation and

<sup>4</sup> In 1995, the G7, the EU, and Ukraine signed a memorandum of cooperation. Western countries provided support of nearly 2 billion dollars by 2000. Later, when the new Shelter Implementation Plan (SIP) became necessary, the SIP was approved at the Denver Summit in July 1997 with total contributions of 300 million dollars from the G7 countries. In addition, 13 countries pledged to contribute a total of approximately 37 million dollars. The European Bank for Reconstruction and Development was entrusted with the management of the funds and project implementation. The assistance of neutral experts was sought where important technical decisions were concerned. This was the International Advisory Group (IAG). The technical methods were selected in keeping with IAG recommendations and there was transparency around the placement of orders. (Takeda, Atsushi. 2008. “How is the Chernobyl new shelter project going forward?” Journal of the Atomic Energy Society of Japan, Vol. 50, No. 2, pp. 87-91).

The Federation of Electric Power Companies of Japan also contributed 18 million dollars toward cleanup costs after the Three Mile Island accident in the United States.

implementation systems.

In January 2013, JCER made the following policy recommendations to regain confidence in nuclear energy policy. These recommendations date back to January 2013, but, disappointingly, hardly any of them have been implemented. On the contrary, we get the impression that the government is even avoiding any investigation.

- I. The major premise is the investigation to determine causes of the Fukushima Daiichi accident, and the establishment of new safety standards— “no safety, no continuation”
- II. Expedite calculations for the decontamination, compensation, and future decommissioning—specify the total cost of the Fukushima accident
- III. Establish an insurance system for state compensation, and severe accidents at nuclear power plants—the nation as a whole needs to be prepared for the cost
- IV. Maintain nuclear power technologies through the cooperation between public-private sector—establish a centralized control agency for the entire nuclear power operations
- V. Review the targets for reducing greenhouse gases—will determine dependency on nuclear power
- VI. Secure a site for final disposal of high-level radioactive waste by 2030— if unable, abandon nuclear power

(Note) [“Looking at Retaining Nuclear Power Plants”](#)

There is no guarantee that decommissioning and other measures to abolish nuclear reactors will be completed by 2050. It is clear from both economic and technological perspective that TEPCO alone will not be able to complete the decommissioning of the Fukushima No. 1 reactor. The government needs to step up efforts to establish a decommissioning body and to build systems that can bring together international expertise and resources. The Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF) and the International Research Institute for Nuclear Decommissioning (IRID) have been established as public-private partnerships, but the systems are still insufficient. We would like to conclude the report with a number of points identified two years ago in [“Accident Cleanup Costs May Rise to 50-70 Trillion Yen.”](#)

1. In addition to optimistic scenarios that says “it is possible to retrieve the debris and for all victims to return home,” the government should also present pessimistic scenarios with the reasoning behind them.
2. If the whole nation is to be required to contribute to the cost of cleaning up after the accident at the Fukushima Daiichi Nuclear Plant, the upper limit should not be set by Cabinet decision, but be written into legislation.
3. It is necessary to establish a third-party agency that inspects the decommissioning process, and to revise the Atomic Energy Damage Compensation Law, which regulates the unlimited liability of power companies.
4. There must be prompt decisions on methods to deal with nearly 50 tons of excess plutonium and methods for the final disposal of high-level radioactive waste. For example, considering the reduction in the transportation risks, one idea is for Japan to bear the cost of disposal by the UK and France of the surplus plutonium stored in their respective countries.
5. It should also be possible to treat spent fuel and plutonium as waste. Nuclear power generation cannot continue unless there is consensus about the final disposal of these and other radioactive waste. From the commercial viewpoint, there is no margin for investing large amounts of money into the research and development of fast reactors and nuclear fuel cycles.
6. It should be the responsibility of the government to set up an organization that takes care of measures to decommissioning of Fukushima Daiichi reactors, and to gather international expertise and resources. The government and the private sector should jointly tackle the decommissioning, disposal, and research and development to maintain nuclear power technology. The government should make sure that the nuclear power departments at all electric power companies, manufacturers, and the government itself do not lose their researchers and engineers.

Even though eight years have passed since the Great East Japan Earthquake and the severe accident at Fukushima Daiichi nuclear power plant in March 2011, more than 40,000 people still remain as evacuees. There is no end in sight for the depopulation of Fukushima prefecture and it seems that the reconstruction is not even at the halfway mark. We sincerely hope for speedier reconstruction.

## References

- Cabinet decision, Basic Policy for Accelerating Fukushima's Reconstruction from the Nuclear Disaster (December 2016)
- TEPCO Committee, TEPCO Reform Proposal (December 2016)
- Advisory Committee for Natural Resources and Energy, Report on the Long-term Energy Supply and Demand Subcommittee Report on Verifying the Cost of Power Generation for the Subcommittee for the Outlook for Long-term Energy Supply and Demand (May 2015)
- Japan Center for Economic Research, [Accident Cleanup Costs May Rise to 50-70 Trillion Yen](#). (March 7, 2017)
- Japan Center for Economic Research, [Looking at Retaining Nuclear Power Plants](#) (July 25, 2012)
- Japan Center for Economic Research, [Looking at Abandoning Nuclear Energy by the 2030s](#) (September 18, 2012)
- Japan Center for Economic Research, [Impact to last Decade or more if Existing Nuclear Plants Shut Down](#) (April 25, 2011)

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