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環境と経済を両立させた持続可能な社会のあり方を考える

Some Doubts about Oxford's Argument on Stranding Thermal Coal in Japan

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On May 12, the electronic version of the Nikkei carried a Financial Times article entitled "Japan's Plan to Promote Thermal Coal Criticized for Increasing Risk" with the sensational lead "Japan could shoulder stranded assets of over USD 60 billion due to its plan of significantly increasing coal-fired power based on incorrect forecasts". The source of this article was a paper entitled "Stranded Assets and Thermal Coal in Japan" published by the Smith School of Enterprise and Environment at the University of Oxford.[1]

1. Summary of the Oxford Paper

The analysis in the Oxford paper is outlined below.

To begin with, it lists the risks of coal-fired power plants on a national and local level. Risks on a national level are listed as future electricity demand, renewable resources, renewables policy support, decentralised renewables and 'utility death spiral', growth of utility-scale renewables generation, growth of gas-fired generation, falling utilization rates, regulatory water stress, legal environment on CCS and the nuclear restarts. Japan' national level risks are analyzed and their comparative differences with other countries are shown in Table 1. Red and green indicate higher and lower risk respectively. Higher percentage number at the bottom means higher national risk. As far as national risk is concerned, Japan's risk level is comparable with Germany and lower than that of the United States where shale gas revolution is progressing.

Table 1: Summary of National Risk Hypotheses

	Japan	Australia	China	Germany	Indonesia	India	Poland	South Africa	United Kingdom	United States
NRH-1: Future Electricity Demand	Red	Yellow	Green	Red	Green	Green	Red	Yellow	Red	Yellow
NRH-2: Renewables Resource	Green	Red	Green	Green	Yellow	Yellow	Yellow	Red	Yellow	Yellow
NRH-3: Renewables Policy Support	Red	Yellow	Red	Red	Green	Red	Green	Yellow	Yellow	Red
NRH-4: Growth of Decentralised Renewables	Red	N/A								
NRH-5: Growth of Utility-Scale Renewables	Green	N/A								
NRH-6: Growth of Gas-Fired Power	Yellow	Yellow	Red	Green	Red	Yellow	Green	Green	Green	Red
NRH-7: Falling Utilisation Rates	Yellow	Yellow	Red	Green	Yellow	Red	Yellow	Red	Yellow	Yellow
NRH-8: Regulatory Water Stress	Green	Green	Yellow	Green	Red	Yellow	Green	Yellow	Green	Green
NRH-9: CCS Regulatory Env.	Yellow	Green	Red	Yellow	Red	Red	Yellow	Red	Green	Green
NRH-10: Nuclear Restarts	Yellow	N/A								
TOTAL*	50%	60%	60%	50%	40%	45%	40%	55%	45%	60%

*Higher percentage equates to a worse risk outlook. Total for Japan based on this publication. Total for comparator countries based on *Stranded Assets and Thermal Coal.*

Source: Stranded Assets and Thermal Coal in Japan (2016) Smith School of Enterprise and Environment

With regard to risks on a local level, the paper lists carbon intensity, plant age, local air pollution, water stress, CCS retrofitability, future heat stress and nuclear restart risk. With a recognition that there are 49 planned coal-fired power plant projects accounting for 28 GW in total in addition to 1.9 GW of projects under construction, the Oxford paper then assesses these local risk hypotheses for each operating and planned coal-fired power plant. For example, the risk exposure of J-Power's operating and planned coal-fired power plants is shown in Table 2 and Table 3.

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[1] http://www.smithschool.ox.ac.uk/research-programmes/stranded-assets/publications.php

Table 2: Environment-related risk exposure of J-Power operating plants

PLANT	CAPACITY[ii] [MW]	GENERATION[ii] [GWH]	UR[iii]	LRH-1: CARBON INTENSITY [kg.CO2/MWh]	LRH-2: PLANT AGE	LRH-3: LOCAL AIR POLL'N [µgPM2.5/m3]	LRH-4: WATER STRESS [% RENEWABLE RESOURCE]	LRH-5: CCS RETROFITABILITY [1=RETROFITABLE]	LRH-6: FUTRE HEAT STRESS [Δ°C]	LRH-7: REGIONAL NUC. RESTARTS [MW]
MATSUSHIMA	1,002	6,730	77%	922	1980	11.8	0%	0	0.90	4,699
MATSUURA	2,000	15,633	89%	887	1993	11.9	19%	0	0.90	4,699
ISHIKAWA	312	2,134	78%	880	1986	4.2	100%	0	0.68	0
TAKEHARA	1,300	8,136	71%	913	1978	8.6	05%	0	0.88	820
TAKASAGO	500	3,761	86%	928	1969	8.3	35%	0	0.88	0
TACHIBANAWAN	2,100	16,182	88%	823	2001	8.5	10%	1	0.88	2,022
SHIN ISOGO	1,200	7,367	70%	786	2006	10.4	89%	1	0.92	1,100
TOTAL[i]	**8,414**	**59,943**	**81%**	**867**	**1991**	**9.8**	**26%**	**39%**	**0.89**	**2,465**

i. MW-weighted for LRHs and UR; ii. Capacity and generation only for owned portion; iii. UR: Utilisation Rate

Source: Stranded Assets and Thermal Coal in Japan (2016) Smith School of Enterprise and Environment

Table 3: Environment-related risk exposure of J-Power planned plants

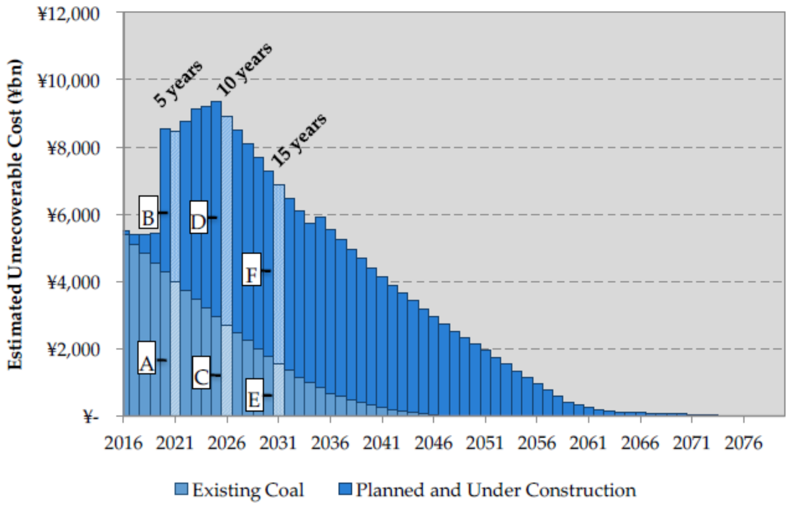
PLANT	CON/ PLN	CAPACITY[ii] [MW]	LRH-1	LRH-2	LRH-3	LRH-4	LRH-5	LRH-6	LRH-7
TAKEHARA	PLN	600	766	2020	8.6	05%	0	0.88	820
TAKASAGO	PLN	1,200	759	2024	8.3	35%	1	0.88	0
NISHIOKINOYAMA	PLN	400	872	2023	10.8	15%	0	0.90	820
OSAKI COOLGEN	CON	84	692	2017	8.9	04%	0	0.88	820
KASHIMA POWER	PLN	320	767	2020	10.1	30%	0	0.88	1,100
YOKOHAMA	PLN	500	900	2020	10.4	89%	1	0.92	1,100
SHIN YOKOSUKA	PLN	500	767	2020	10.2	89%	1	0.92	1,100
YOKOSUKA	PLN	500	807	2020	10.2	89%	1	0.92	1,100
TOTAL[i]		**4,104**	**794**	**2021**	**9.5**	**47%**	**66%**	**0.90**	**704**

i. MW-weighted for LRHs; ii. Capacity only for owned portion;

Source: Stranded Assets and Thermal Coal in Japan (2016) Smith School of Enterprise and Environment

Based on such local risk assessment, the Oxford paper judges that all projects have a substantial risk of becoming stranded assets. Furthermore, under the assumption that all 49 projects are realized, it judges that all coal-fired power plants including existing ones will be removed from the power system in 5 years, 10 years or 15 years and become stranded assets. Assuming installation cost of ¥250,000,000/MW (US$2.25m/MW) and 40 years' depreciation period, the value of stranded asset of certain project is calculated as the amount which will not have been depreciated yet at the time of its removal from the power system. The light blue bars indicate the scale of stranded assets for existing coal-fired power plants and the deep blue bars indicate those for new coal-fired power plants.

Figure 1: Estimated scale of asset stranding for existing and new build coal generators



NB: The difference between the value on the y-axis and zero represents estimated stranded assets charge.
Letters in the chart correspond to the labels in Table 6.

Source: Stranded Assets and Thermal Coal in Japan (2016) Smith School of Enterprise and Environment

The total value of stranded assets related to coal-fired power plants depending on the timing of their removal in 5 years, 10 years and 15 years are estimated to be ¥8,453 billion ($75.96bn), ¥8,924 billion ($80.19bn) and ¥6,857 billion ($61.62bn) respectively.

Furthermore, the Oxford paper calculates the scale of asset stranding for five companies: J-Power, Tokyo Electric Power CO (TEPCO), Chubu Electric Power CO (Chubu EPCO), Kyushu Electric Power CO (Kyushu EPCO) and Kansai Electric Power CO (Kansai EPCDO) (see Table 4). It points out that Tokyo Electric Power has the largest economic risk exposure to stranded assets, and that J-Power has the biggest risk exposure to stranded assets relative to total assets.

Table 4: Selected utility estimates of total stranded assets (¥billion)

	Ratio Analysis[i]				Env.-Related Risks[i]							Stranded Assets[ii]		
	DEBT / EQUITY	CURRENT RATIO	(EBITDA – CAPEX) / INTEREST	OPR / PLN[iii]	LRH-1	LRH-2	LRH-3	LRH-4	LRH-5	LRH-6	LRH-7	2021 (5 year)	20 26 (10 year)	2031 (15 year)
J-POWER	84%	56%	94%	OPR	40%	58%	88%	55%	32%	53%	53%	¥586.2 (23%)	¥406.3 (16%)	¥237.5 (9%)
				PLN	44%	44%	68%	88%	41%	56%	6%	¥608.2 (24%)	¥904.9 (35%)	¥773.3 (30%)
TEPCO	91%	47%	66%	OPR	32%	22%	22%	20%	100%	12%	95%	¥730.1 (5%)	¥541.0 (4%)	¥351.9 (3%)
				PLN	47%	44%	68%	79%	53%	65%	76%	¥1,309.3 (9%)	¥1,136.3 (8%)	¥963.3 (7%)
CHUBU EPCO	78%	87%	86%	OPR	42%	35%	60%	80%	15%	30%	65%	¥384.6 (7%)	¥253.2 (5%)	¥121.7 (2%)
				PLN	26%	6%	76%	91%	38%	68%	74%	¥114.1 (2%)	¥339.5 (6%)	¥290.4 (5%)
KYUSHU EPCO	100%	62%	ND	OPR	35%	58%	88%	15%	30%	17%	85%	¥248.2 (5%)	¥145.7 (3%)	¥83.6 (2%)
				PLN	94%	62%	35%	50%	29%	15%	44%	¥406.0 (9%)	¥353.0 (8%)	¥299.2 (6%)
KANSAI EPCO	96%	98%	ND	OPR	20%	5%	30%	95%	15%	88%	12%	¥288.5 (4%)	¥230.8 (3%)	¥173.1 (2%)
				PLN	53%	18%	68%	74%	44%	59%	65%	¥439.2 (6%)	¥661.3 (9%)	¥566.4 (8%)

i) Ratio and environment-related risk presented as a percentile relative to Japan utility peer group, with a higher percentage indicating higher risk:
$N_{D/E}$, $N_{Current\ Ratio}$ = 45; $N_{(EBITDA-CAPEX)/INT}$ = 35; N_{OPR} = 40; N_{PLN} = 34;
ii) Stranded Assets expressed in bn¥ and as a fraction of total utility assets
iii) OPR: Operating plants; PLN: Planned and under construction plants;

Source: Stranded Assets and Thermal Coal in Japan (2016) Smith School of Enterprise and Environment

The paper then concludes, “Given significant proposed coal expansion on the one hand and growing environment-related risks on the other, companies, investors, and policymakers should examine the exposure of Japan’s existing and proposed coal-fired power plants to the risk of asset stranding. Stranded coal assets would affect utility returns for investors; impair the ability of utilities to service outstanding debt obligations; and create stranded assets that have to be absorbed by taxpayers and ratepayers. Moreover, new coal-fired power stations will generate significant negative externalities for the duration of their shorter than anticipated lives, particularly in terms of carbon emissions that cause climate change, as well as air pollution that harms human health.”

2. Doubts about the Oxford Paper

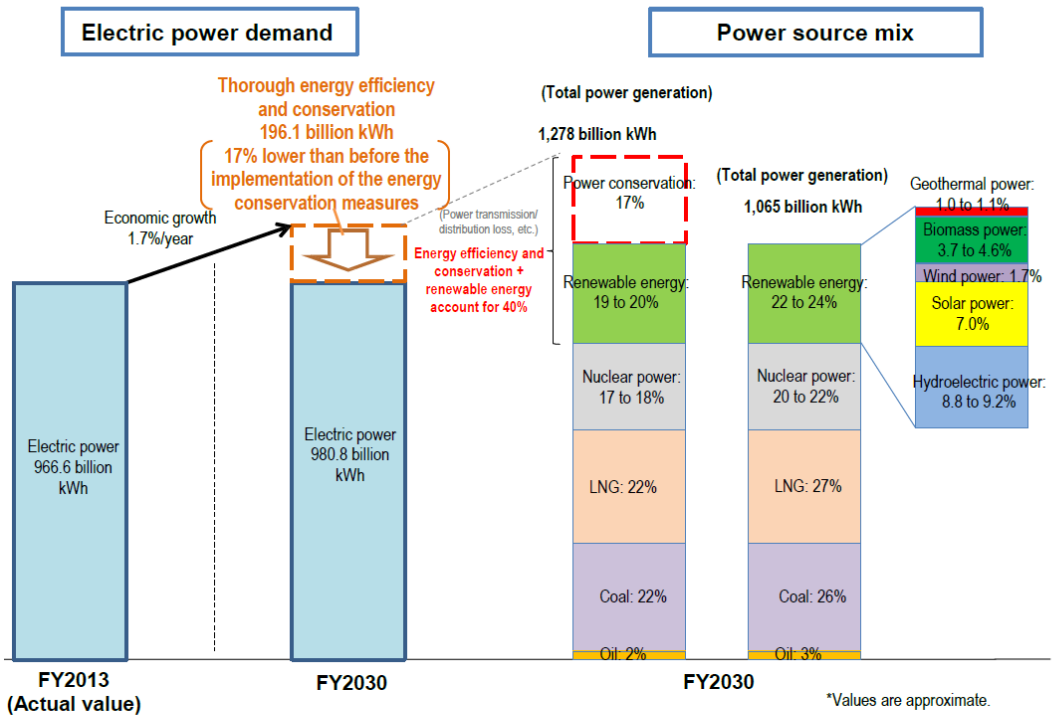
Indicating sensational figure of ¥9,000 billion ($80 billion) and naming specific power utilities with high risk exposure, at first glance, the Oxford paper looks to have significant implication. However, there are many doubts about its assumption and analytical approach.

(1) Unrealistic assumption of “zero coal-fired power” in 5 to 15 years

The fundamental assumption of this paper is that all existing and new coal-fired power plants will be removed from the power system in 5 to 15 years, meaning “zero coal-fired power” by 2031 at the latest. However, to what extent is this assumption realistic?

The power generation mix announced by the Japanese government (see Figure 2) assumes that coal-fired power will account for around 26% (281 TWh) out of total power generation in 2030. It does not take a view that the share of coal will be zero as assumed in this paper.

Figure 2: 2030 energy mix presented by the Japanese government

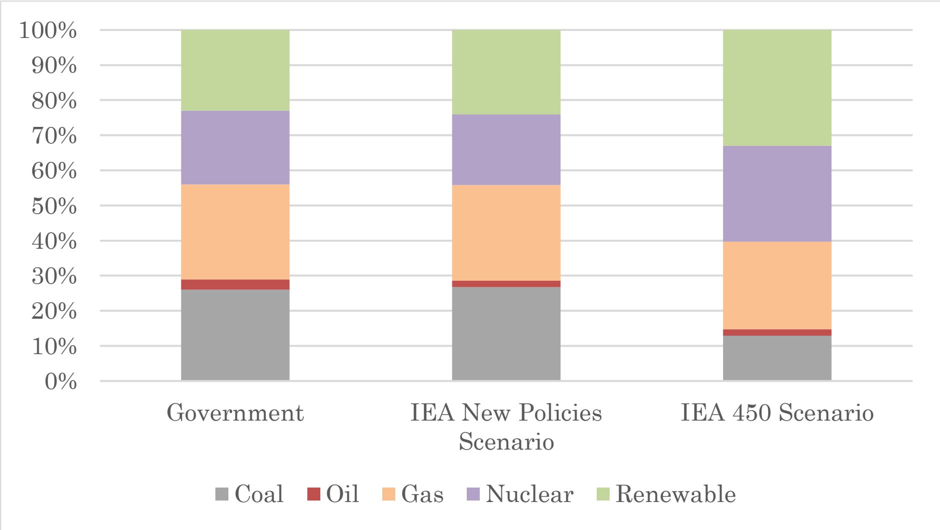


Source: Ministry of Economy, Trade and Industry

“Such assumptions (26% in 2030) are wrong from the perspective of preventing climate change”, the author of the paper would argue. However, according to the IEA’s World Energy Outlook 2015, Japan’s coal-fired power capacity and its power generation are 48GW and 290 TWh in the New Policies Scenario (central scenario), accounting for 27% out of total power generation. Even in its most ambitious 450 scenario, these are 40 GW and 122 TWh, accounting for 13% of total power generation (see Figure 3).

These figures clearly show clearly how extreme the assumption of zero coal-fired power in 2030 is. It leads us to conclude that the Oxford paper is based on the predetermined conclusion that “coal-fired power is undesirable and should/must be removed from the electric power system.” Such an arbitrary assumption can hardly be called "analysis."

Figure 3: Comparison of the Japanese Government's Goal and the IEA's Scenarios



Source: Ministry of Economy, Trade and Industry; IEA World Energy Outlook 2015

(2) Lack of perspective of the best mix

What is fundamentally missing in the Oxford paper is the comprehensive perspective of "the best mix" taking into account energy security, affordability of energy cost and prevention of climate change. Eliminating coal from Japan's power mix, what kind of energy mix does this paper envisage then?

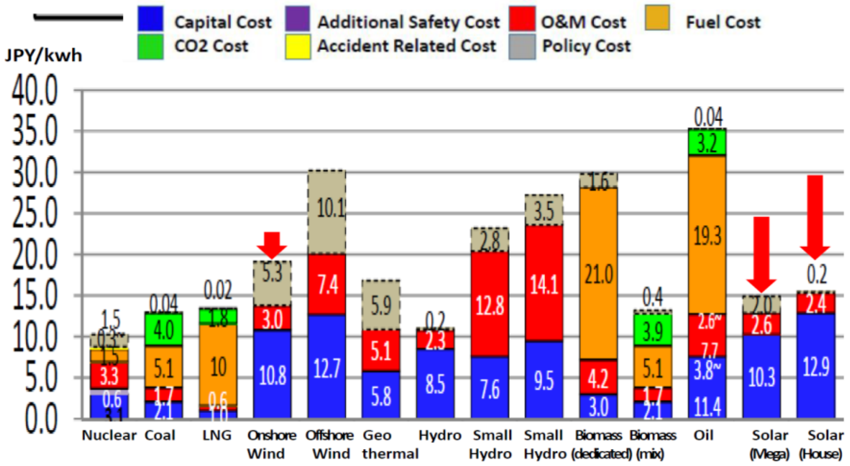
The 20-22% share of nuclear power indicated in the government's power mix assumes that all nuclear power plants resume operation, some of which are permitted life time extension. However, judging from the current situation surrounding nuclear power, these are extremely challenging conditions. A series of recent plans for new construction of coal fired power plants should be regarded as attempts to provide inexpensive base load power sources making up the loss of nuclear power amid market liberalization on one hand and uncertain prospects of nuclear restarts on the other. In this respect, the paper is correct in recognizing that the restart of nuclear power is a risk factor for new coal-fired power plants. If nuclear power steadily resumes operation, a considerable number of new coal-fired power projects will lose their raison d'etre. Environmental groups are criticizing the new coal-fired power projects on the ground that they are incompatible with prevention of climate change. However, they are also opposed to nuclear power restarts, which is also incompatible with prevention of climate change. If the Oxford paper intends to emphasize the risk of coal-fired power plant plans, it should highlight the need to accelerate the nuclear restarts as the most effective measure to reduce the need for new coal-fired power plants.

Having said that, even though all nuclear power plants resume operation, they won't be able to generate sufficient amount of power unnecessitating the current 41GW of coal-fired power. Since the Fukushima accident, Japan has lost 10 GW of nuclear power as 10 reactors already decided to be decommissioned. There are additional nuclear power units slated to be decommissioned. Prior to the earthquake, nuclear power accounted for almost 30% of power generation. As base load power sources, nuclear and coal-fired power were supplying 55% of total power generation. Policymakers are now struggling hard how to make up the above shortfall with other power sources while taking their operating characteristics, costs and carbon constraints into consideration.

The Oxford paper not only rejects additional coal fired power plants but also suggest complete elimination of coal currently accounting for 25% of total power generation.

Does this mean natural gas will drive out coal like in the United States? Unlike the United States where cheap domestic shale gas is displacing coal, Japan has no domestic natural gas resources and completely relies on imports in the form of expensive LNG. While launching imports of the U.S. shale gas could lower the cost of natural gas to some extent, its impact could be limited considering the cost of liquefaction and transportation. The decline in oil prices has lowered the cost of natural gas, but it is overly optimistic to assume that the current slump in oil prices will continue in the future. The comparison of cost of power generation (see Figure 4) shows that coal-fired power will still have a cost advantage over LNG-fired power even in 2030. It is therefore unrealistic to assume that coal-fired power will be completely driven out in competition with LNG-fired power.

Figure 4: Comparison of cost of power generation based on 2030 models of plants



Source: Ministry of Economy, Trade and Industry

Will coal-fired power generation be driven out by significant increase of renewable energy? Looking at the above cost comparison, even if the cost of renewable energy is forecast to decrease by 2030, it will hardly be cost competitive to the point of driving out coal-fired power generation.

Does this mean that the government will forcibly remove coal-fired power generation by significantly raising the price of carbon or introducing strict regulations? As mentioned above, Japan is not blessed with domestic shale gas like the United States, and is not connected to neighboring countries through the transmission network to cover each other's shortfalls like EU member states. To address the difficult problem of balancing energy security, energy cost and prevention of climate change, multidimensional simultaneous equations must be solved. Considering such difficult restrictions, it is inconceivable that the government would abandon the option of coal-fired power generation as a low-cost base load power source.

Complete elimination of coal-fired power generation would have an enormous impact on the economy. As shown in the sensitivity analysis (see Table 5), if the 26% share of coal-fired power generation is entirely replaced with LNG, additional cost would be ¥1.7 trillion at the time of 2030. If it is entirely replaced by renewables, additional cost would be ¥4.8 trillion. The cumulative cost of the whole period to 2030 would be even greater. Without building new nuclear power plants as well as restarting existing nuclear plants and their life-time extension, "zero coal-fired power generation" will place an enormous burden of cost on the Japanese economy. Under such situation, entire Japanese economy, not just coal fired power generation assets, could be stranded.

Table 5: Impact of changing the energy mix

	Coal ▲1%	LNG▲1%	Nuclear ▲1%	RE ▲1%
Coal +1%		+4.4 mt-CO2 ▲64 billion JPY	+8.4 mt-CO2 +34 billion JPY	+8.4 mt-CO2 ▲184 billion JPY
LNG +1%	▲4.4 mt-CO2 +64 billion JPY		+4.0 mt-CO2 +98 billion JPY	+4.0 mt-CO2 ▲120 billion JPY
Nuclear +1%	▲8.4 mt-CO2 ▲34billion JPY	▲4.0 mt-CO2 ▲98 billion JPY		±0 ▲218 billion JPY
RE+1%	▲8.4 mt-CO2 +184 billion JPY	▲4.0 mt-CO2 +120 billion JPY	±0 +218 billion JPY	

※ All approximate figures

Source: Ministry of Economy, Trade and Industry

(3) Unrealistic assumption that "all plans will be realized"

It is equally unrealistic to assume that "all of 49 planned projects will be invested to realize 28GW". Investments are always fraught with risks. In particular, there are various uncertainties surrounding new power generation projects in the fully liberalized electricity market from this April, which demands extremely delicate investment decisions. The greatest challenge in a liberalized electricity market is how to avoid underinvestment amid high uncertainty.

While the Oxford paper highlights only the risk of stranded coal-fired power generation assets, investment risk is not limited to coal-fired power. In the case of nuclear, German decision in June 2011 to phase out nuclear by 2023 caused huge stranded assets and triggered free-fall in stock price of Big 4. Though Japan intends to maintain nuclear option, it is not certain when operation will resume even after huge investment for implementing additional safety measures. Even once its operation is resumed, it could be suspended again in cases such as the Otsu District Court decision this March. As for gas-fired power, its profitability could be seriously eroded if its operation is adjusted as back-up for growing share of intermittent renewables. In Germany, this has resulted in the closure of several gas-fired power plants. The capacity of gas-fired power plants closed in Europe over the past decade totals 50GW. If the use of renewable energy significantly increases in Japan as indicated in the report, a similar risk could arise. Even renewable energy is not risk free. In Spain, the effective cutback of feed-in tariff has resulted in the assets stranding in solar power and wind power. In the United Kingdom, the conservative government is proceeding with a review of costly renewable energy promotion measures and renewable energy industry lobby is calling this as serious risk on renewable projects. In this way, the risk of stranded assets is present in all types of power source, and analysis of the risks should be performed across each type of power generation facility. It is not a balanced argument just to focus on risk of asset stranding related to coal-fired power plants.

The Oxford paper is right in indicating variety of risk factors in projects to build new coal-fired power plants. This is exactly why existence of plans does not mean their actual realization. The paper's conclusion says that the investment risk should be considered. In fact, even without being told to do so, companies carefully consider actual investment decisions by taking into account the future power demand, prices of oil, gas, coal and other fuel, and the prospect of nuclear power restart, without being told to do so.

"Planned projects" range from those under construction to, those for which environmental impact assessments have been completed, those under assessment, those for which plans have been announced and those prior to that stage. According to Kiko Network's Japan Coal Plant Tracker[2], 4 projects (1.98GW) are under construction, 2 projects (0.22GW) have completed environmental impact assessments, 24 projects (12.35GW) are under assessment, 8 projects (3.54GW) have been announced, and 8 projects (4.42GW) have not been announced. Apart from those under construction, the final decision on actual investment in those under assessments will be subject to prospects of factors including power demand, fuel prices and nuclear power restart. This would further be the case for those that have only been announced or not even been announced yet. The Oxford paper calculates the scale of stranded assets based on the assumption that all plans will be realized regardless of differences in the maturity of such plans, but it is unrealistic that companies will make investments without any risk assessment. As discussed above, it is unrealistic as well to assume that coal-fired power generation will be completely eliminated in 5 to 15 years. Even assuming that such a risk would be materialized for argument's sake, no operators would invest in assets that would be stranded in several years. Put differently, it is meaningless to calculate the scale of stranded assets based on such unrealistic assumptions.

(4) Exaggerated scale of stranded assets

The Oxford paper's calculations of the scale of stranded assets are based on the assumption of depreciation over 40 years, but the National Tax Agency's table on the useful life of facilities states that the statutory useful life is 15 years for turbines and generators and 40 years for buildings. Calculating the useful life of a coal-fired power plant as simply 40 years not only deviates from the actual financial accounting practice, but also overestimates the residual value and thus the value of stranded assets.

2 http://sekitan.jp/plant-map/

Moreover, with the exception of the plants under construction, the basis for including all 49 projects accounting for 28GW in calculations is unclear. Looking at the references cited, Global Coal Plant Tracker Q4 2015 and Platts World Electric Power Plant Database Q1 2016, those listed as "planned" account for 7GW and 13 GW respectively. Furthermore, looking at Enipedia and Carbon Monitoring for Action Database, which are also cited as data sources, there is no status category, and most of the data does not indicate the type of fuel. When the Ministry of the Environment objected to the plan to build a new coal-fired power plant in Ube in the environmental impact assessment process in 2015, it mentioned the figure of "plans for 17 GW in 30 new projects". The Ministry of Economy, Trade and Industry's materials on improving the efficiency of coal-fired power generation[3] states 18GW. Even Kiko Network, which keeps a watchful eye on new coal-fired power plant projects states that planned capacity is 20.GW in 42 new projects excluding those under construction. Compared to these figures, "28GW in 49 projects" seems apparently excessive. Moreover, J-Power, which is referred to in the aforementioned case study, states that it does not recognize 3 plans (totaling 1.5 GW) out of the 8 shown in Table 3, which raises questions about the reliability of the data.

Unrealistic assumptions that all plans will be implemented without any determination of risk to become stranded assets in 5 to 15 years, calculation with a longer useful life than actual accounting practice, and overestimation of projects lead to exaggerating the scale of stranded assets.

3. A call for more realistic discussion

As discussed above, there are many doubts about the Oxford paper. It is based on the doubly unrealistic and arbitrary assumptions that all plans for the construction of coal-fired power plants will be realized without any risk assessment, and that all coal-fired power generation will be removed from the power system in 5 to 15 years. It neither considers the perspective of a power mix balancing energy security, energy costs and the prevention of climate change nor the impact of removing coal-fired power generation on the economy. It also exaggerates the scale of stranded assets by overestimating plans and overextending the period of depreciation. This paper could better be characterized as a position paper advocating elimination of coal-fired power generation rather than an analysis.

Around the time the paper was published, a discussion paper entitled "Quantitative Evaluation of Generation Adequacy based on the Long-term Energy Supply and Demand Outlook"[4] was published by the Central Research Institute of Electric Power Industry. It is a quantitative assessment of how much power generation facilities can recover costs (capital costs, operating and maintenance costs, fuel costs and start-up costs) from revenue from the sale of power if the long-term supply and demand outlook is realized under competitive conditions in the deregulated electric power market while maintaining the flexibility required for renewable energy introduced on a large scale. Though its contents are not discussed here, what Japan needs is such a robust and realistic analysis, not a position paper advocating elimination of specific power source.

3 http://www.meti.go.jp/committee/sougouenergy/shoene_shinene/sho_ene/karyoku/pdf/003_01_00.pdf

4 http://criepi.denken.or.jp/jp/serc/discussion/16001.html