

# How Can Nuclear Power Survive after Electricity Market Deregulation?



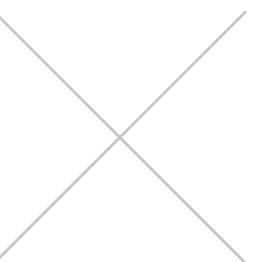
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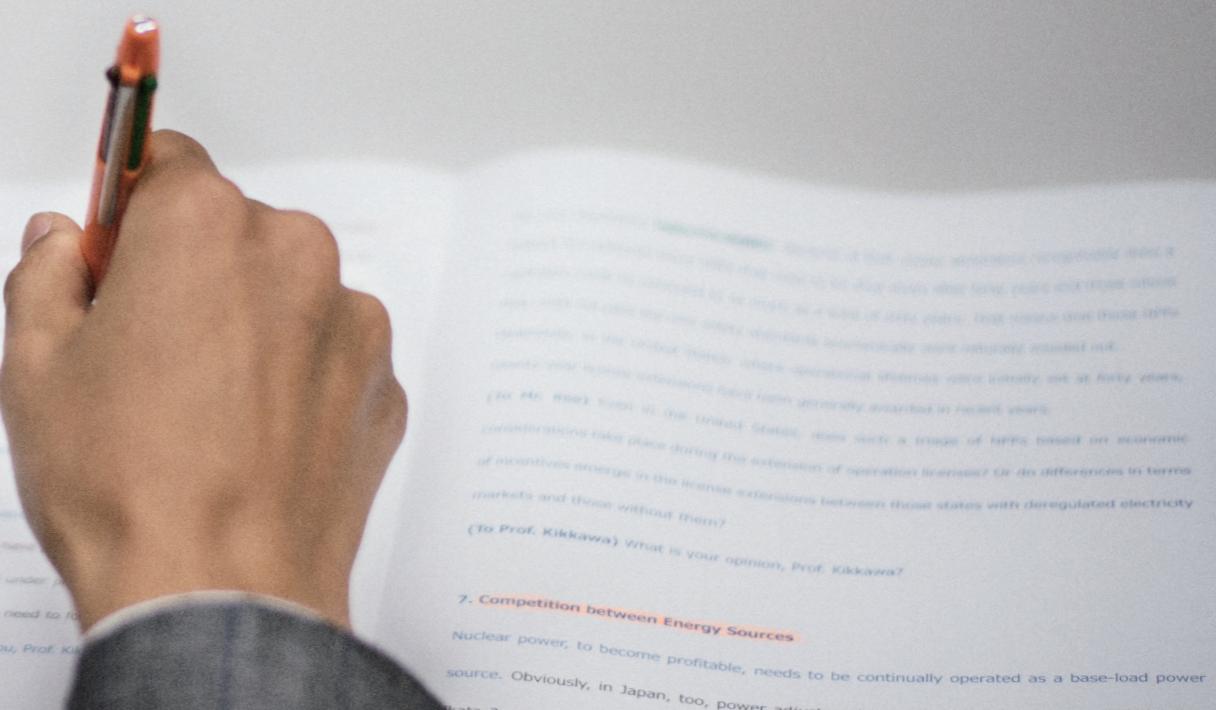
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ISHII: Japan's retail electricity market became deregulated starting this April, and hardly a day passes without headlines appearing in the country's newspapers and other publications containing the words "electricity deregulation." In 2020, moreover, power generation and power transmission will be separated, forcing the existing power companies in Japan to adopt a new business model.

In essence, the major concern of people connected with nuclear power can be boiled down to a single question: can nuclear power survive in a deregulated electricity market? Consequently, we invited two experts from Japan and the United States to comment on Today's nuclear power industry from the perspective of economics.

The first expert we have invited is Mr. Edward Kee, CEO of the Nuclear Economics Consulting Group, based in Washington, D.C. in the United States. The other is Prof. Takeo Kikkawa, familiar to all the likely Japanese readers. Starting last year, he has been affiliated with the Tokyo University of Science. Incidentally—and this is just a coincidence—Prof. Kikkawa is a 20-year senior of mine from the same high school.

Thanks very much to both of you for coming here today.



ISHII: I think that, in the United States, there are two types of electricity markets. One is the deregulated market, where power generation and power transmission are separated. The other is the regulated market, where power generation and power transmission are not separated. In the deregulated market, there are many power companies, and they compete with each other. In the regulated market, there are only a few power companies, and they are controlled by the government. In Japan, the electricity market is still regulated, but it is moving towards a deregulated market. This is because there are many power companies in Japan, and they are competing with each other. However, the government is still involved in the electricity market, and it is trying to encourage more competition. This is why the electricity market in Japan is still regulated, but it is moving towards a deregulated market.

Mr. Kee: In the United States, there are two types of electricity markets. One is the deregulated market, where power generation and power transmission are separated. The other is the regulated market, where power generation and power transmission are not separated. In the deregulated market, there are many power companies, and they compete with each other. In the regulated market, there are only a few power companies, and they are controlled by the government. In Japan, the electricity market is still regulated, but it is moving towards a deregulated market. This is because there are many power companies in Japan, and they are competing with each other. However, the government is still involved in the electricity market, and it is trying to encourage more competition. This is why the electricity market in Japan is still regulated, but it is moving towards a deregulated market.

Prof. Kikkawa: What is your opinion, Prof. Kee?

7. Competition between Energy Sources

Nuclear power, to become profitable, needs to be continually operated as a base-load power source. Obviously, in Japan, too, power adjustment operation tests have been carried out at

# Public Support for Nuclear Power



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Noriyuki Ishii

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**ISHII:** I would like to inquire about the support for nuclear power by the general public—a prerequisite for the industry to exist—in both Japan and the U.S. Mr. Kee, please tell us about the public opinion in the U.S. toward nuclear power.

**KEE:** Thank you very much for the question. First of all, American public opinion is something that's important, but it's not something that has a significant impact on the industry day to day. The Nuclear Energy Institute and others do surveys every year, maybe more than once a year. The latest survey showed that about half of the general public supports nuclear power as a source of electricity. It's a little lower than it has been in past years, but it's still relatively even. Two results of that public opinion survey are important to note: People who live near nuclear power plants, or who know a lot about them, tend to be strong supporters. People who don't know much about nuclear power are more likely to be pretty much indifferent or maybe slightly opposed. There's a fairly small group of people who are strongly opposed no matter what.

The other thing I'll say is that support being a bit lower this last year or so is perceived to have been driven by low prices for natural gas and oil. To some extent, public opinion about nuclear power tends to be more favourable when oil and natural gas are expensive. While the link is not totally clear, there certainly appears to be some linkage. People are worried about energy. They aren't necessarily thinking about nuclear power plants and maybe they don't actively support them. However, when people are worried about energy, they seem to see nuclear power plants as a way to go.

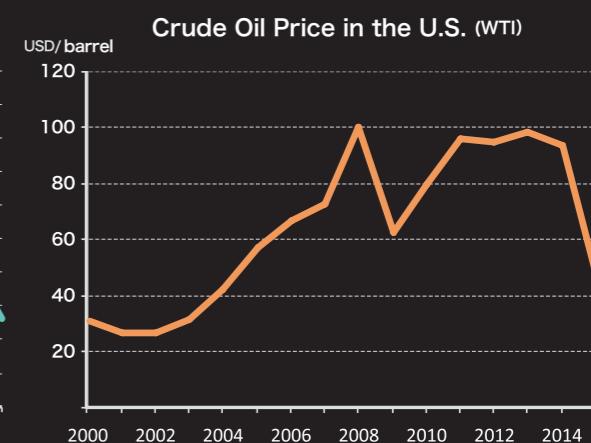
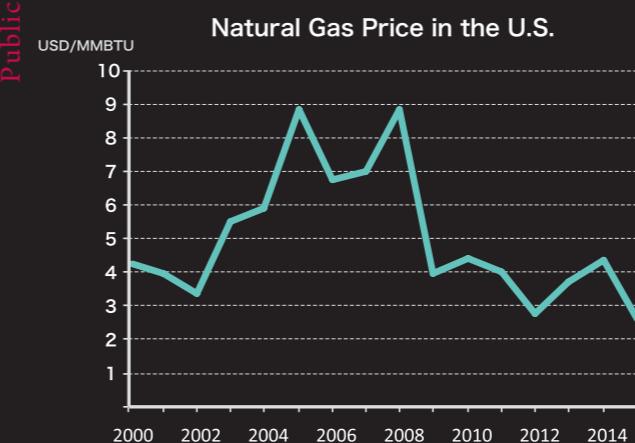
The last point I'll make is that increased concern about global warming and carbon emissions has perhaps been translated very well into American public opinion. Public opinion about nuclear may not be so closely aligned with public concern about global warming.

**ISHII:** Prof. Kikkawa, what is Japanese public opinion on the matter?

**KIKKAWA:** Thank you, Mr. Ishii and Mr. Kee. I think the general sentiment

in Japan among the general public is that nuclear power is a necessary evil. They believe it's necessary on two fronts, in terms of economy as well as global warming. But they are also concerned about the dangers of it as well. I think that the minority would desire to immediately have nuclear power removed from the energy mix, but the general sentiment is to reduce nuclear power.

In terms of the regional differences that Mr. Kee talked about, in Japan, it's also true that the communities immediately around a nuclear plant site are very much in support, but the adjacent communities are actually very much against. And the actual community nearest to the nuclear plant site would have money coming from the nuclear plant as well as job opportunities, but the adjacent municipalities or communities are concerned about, or they believe that they are only going to be adversely impacted by, an accident, so they are very critical. But I believe that the overall sentiment is looking at the balance between the need for nuclear versus the dangers.



Source: International Monetary Fund



Nuclear power is a necessary evil

# 2 The Back-end Problem



Interim on-site storage is the key

**ISHII:** The next problem I would like to raise is that of the back-end of the nuclear fuel cycle, which is arguably nuclear power's weakest point. I want to hear both of your perceptions on the issue. Mr. Kee, one gets the impression that the situation of the Yucca Mountain site in the United States keeps on seesawing back and forth. What is your take on the issue?

**KEE:** The Yucca Mountain project was meant to be a long-term, permanent disposal for intact fuel assemblies. That project was stopped. It was totally defunded by the government. There still is a license application with the NRC, but there's no funding. The site's been totally scrapped; all the equipment was sold, totally demobilized. I don't think many people believe that Yucca Mountain will actually be done. It's pretty much dead.

There are people who would like to see it done, but it's going to be very difficult and very expensive to restart the project.

**ISHII:** Anti-nuclear groups in Japan ridicule nuclear power, likening it to "an apartment building with no toilets," harshly blaming nuclear power for producing non-disposable waste. As far as high-level radioactive waste (HLW) is concerned, some have asserted although the technology for disposal has long been developed, what remains unsolved is the political problem of selecting disposal sites. Nonetheless, I think that it is precisely that political problem which remains the greatest obstacle to resolution of the site-selection issue.

**KEE:** We have developed dry-cask storage, where these fuel assemblies go into a dry cask after they've spent a few years in a spent-fuel pool. And every nuclear power plant site has a spent-fuel pad and a high-level waste area there. Even at the nuclear power plants that have been decommissioned and totally remediated, there still is a spent fuel pad with spent-fuel casks sitting on it. Those are not very expensive. They're very safe, very easy to use, and the NRC has agreed that we can put spent fuel in these casks and leave them there for, I think it's a hundred years. And if that's not long enough, you could always put them in a new cask at the end of the period.

The political problem in the U.S. is that a state or city that has nuclear power has waste sitting at the sites now. And the problem with Yucca Mountain is that people in Nevada, a state that does not have any nuclear power plants, are very unhappy to be taking spent nuclear fuel from other states. They are happy to take money from the Federal Government, but they weren't so happy to take nuclear spent fuel from other states.

Secondly, transporting that spent fuel across state lines was presenting some big concerns politically. And I think there are people, including myself, who feel that these spent-fuel casks on site are about the safest and the cheapest way to manage this spent fuel until a point in the future when we might be able to reprocess it and use it. The problem with Yucca Mountain is we were putting

intact fuel assemblies down into a very deep repository from which they could be recovered but would not be easy, and providing for that option made the whole project more expensive, unlike the French approach, where reprocess-

**KEE:** The electricity supply from U.S. nuclear power plants included a charge to cover spent fuel disposition and we've accumulated an enormous fund of money for this. What that is, we don't know, but it's many billions of dollars in an ac-

Prime Minister Koizumi did mention that it was like an apartment building without a toilet, and I believe that statement is a true characterization.

However, if you think about it, out of the seven billion people in the world, 1.3 billion people do not have electric power. So, if you think about that, it's better to have an apartment building than no apartment building at all, even if it doesn't have a toilet. So, I do believe that the emerging countries will start to employ nuclear power more and more into the future. Former Prime Minister Koizumi's logic was that if you don't have a toilet, therefore you need to stop constructing and operating nuclear power plants immediately, but even if you stopped, that doesn't solve the back-end issue, because we have already generated 17,000 tons of spent nuclear fuel. So, even if you are against, or pro-nuclear, we do need to work this issue out.

**ISHII:** So, in the U.S., is on-site storage called "temporary storage"?

**KEE:** The term is "interim on-site." "Interim" on-site can mean hundreds of years and then it becomes almost permanent. There also have been discussions of making a new repository in a single place in the country—a big parking lot to put on which to put all these dry casks. That still has the same problem of requiring permission to move these things and moving them across state lines. There was the MIT report on the Future of the Nuclear Fuel Cycle

count with the U.S. Federal Government that we've paid in over the years, tacked on to electricity costs. So that's already been taken care of. The cost of these spent-fuel casks—even if they stay there forever—is pretty small, though.

**ISHII:** And I've heard that Prof. Kikkawa has also supported temporary storage.

**KIKKAWA:** Yes, I would agree with you. So, I also believe that the back-end is a very important issue. The former

cask storage area coupled, perhaps, with a reprocessing plant. That doesn't seem to be happening either. So I think we're in a situation that sounds bad, but it's actually pretty stable and pretty efficient.

**KIKKAWA:** As Mr. Kee, you mentioned, in Japan, it's difficult to get the municipalities and the local governments to agree to host the sites, so we always like to use the term "temporary" to get their consent. But I do believe it's important to have that concept of an "interim on-site dry storage" as an intermediate measure and use them for maybe 50 or 100 years, and they will be effective in that way. And then, in the meantime, an ultimate solution could be devised through technological innovation of converting the radionuclides to things that, you know, wouldn't have to be stored in the magnitude of 10,000 years, and instead, bring that figure down to several or a couple of hundred years. And for that, the fast-breeder reactor technology of Monju will become important—not to increase the amount of energy that could be utilized, but to minimize that danger or risk in the spent fuel.

There is some opinion in the discourse right now that the governance of Monju is not effective and therefore that the reactor project should cease immediately, but I am therefore against that type of argument. But as you mentioned, I think that on-site interim dry storage is going to be important.

**KEE:** Thank you very much, Prof. Kikka-



FBR technology will become important



wa, that's interesting. Well, let me make three other points. The on-site dry-cask storage is deemed by many people to have a "natural justice" aspect, meaning that the people who got benefits of jobs or electricity from the nuclear power plant ought to bear the burden of having the spent nuclear fuel at the site. That's a very small burden.

The next point is that Waste Control Specialist LLC (WCS) is developing a project in Texas which is meant to be a central, dry-cask storage project for nuclear power plants that have been permanently decommissioned, with fully remediated sites. You could move those dry casks to this place in Texas. It's a commercial venture and it is not clear to me what's going to happen or how well it will work, but they're actually working on that project now. There's some speculation that the U.S. Department of Energy might be able to take title to the dry casks where they are and move them to this Texas site as a compromise between Yucca Mountain and leaving them in place where they are today.

And the last point—a very good point, frankly—is that these spent-fuel assemblies have a large amount of useful fissile and fertile materials that could be used again. And so, to some people in the nuclear industry, those spent-fuel assemblies are more like a uranium mine than high-level waste, and that if we could reprocess them, there could be a lot of value there, and that value may come in the future, when uranium is more expensive, when the U.S. position on reprocessing has been relaxed or at

least made more rational. We don't like reprocessing as a country, but we think that that will change in the future.

**ISHII:** And the centralized repository in Texas will get nuclear spent fuel from all over the country?

**KEE:** Well, my understanding is that they are not getting any spent fuel now. They're simply working on siting and licensing of the project. But the plan is that it would be used in the first phase, at least, for only the spent fuel from plants that have been closed and decommissioned. But even that's not certain. It's very preliminary.

And I'll also say that more than a decade ago, there was a project in Utah, another Western state, called Private Fuel Storage LLC (PFS), which actually was licensed by the NRC to be exactly that, a big parking lot, effectively, with a bunch of spent fuel casks on it. That was blocked by Utah state officials and Utah state senators, Orrin Hatch in particular. It was licensed to take the fuel but it never operated. It was co-funded by a lot of utilities around the country. It failed because of the political problems. So,

the political problems are more about moving the fuel than they are about storing it. And so, that's some history that is useful to understand.

**KIKKAWA:** So, in Japan, we also have an interim storage facility using dry casks in Mutsu City, Aomori Prefecture, but it can only cover spent fuel from TEPCO and JAPC, Japan Atomic Power Company, so it's not an option. But other

than the on-site facility, there's that option as well.

**ISHII:** The phrase, "the interim storage facility" is more acceptable to the local people than "the disposal site"?

**KIKKAWA:** So, I think that it's an issue of job creation also. I don't think that

that something that's acceptable for the local siting communities can also be worked out as well.

**KEE:** Yes, let me make one additional point. I'm working with "IFNEC", the International Framework for Nuclear Energy Cooperation. It's a multinational group addressing issues related to



bad approach, but there are countries that have a lot of empty space and countries that have a lot of interest in doing this. And you may have seen the South Australian Royal Commission in the past year has considered, in fact, setting up a global multinational repository somewhere in northern South Australia, and basically making money by taking spent nuclear fuel for permanent disposal or on an interim basis. I'm not sure what they'll do.

**KIKKAWA:** Maybe this year.

**KEE:** Well, let's be clear. The Russians take the spent fuel back from their nuclear plants. They have a very strong belief—almost the opposite of the United States—that spent fuel is a valuable resource to use in fast reactors later, and so they're quite happy to take it. They might be willing to take it for some hard currency payments.

And so, IFNEC is working to understand how these multinational repository projects might be feasible, how countries that don't have a repository now, perhaps including Japan and the U.S., but mostly smaller countries, could participate jointly in a single repository in one country. Joint-scale economies favouring one place, one site, one everything. So that's going on in the world as well.

**ISHII:** In the near future, do you think such a business is feasible?

**KEE:** If the near future means this year, no. In the coming decades, it may be feasible. And it kind of depends on each

country's view on reprocessing. A single high-level waste repository after reprocessing would be quite a small facility. Taking intact fuel assemblies and moving them around the world will be a little more difficult, and perhaps not so sensible, given the value of the fissile and fertile materials included in the spent fuel.

**KIKKAWA:** A difficulty with that is it would create dependence on, you know, outside of Japan, on different countries. And maybe not so much with Australia, but, you know, there would be concern with Russia using that as a political token.

**KEE:** Absolutely.

**KIKKAWA:** So it would become a bigger issue than energy.

**KEE:** The political, legal, third-party liability issues would be tremendous. But from an economic and logical point of view, that might be more feasible.

**ISHII:** And in Japan, promising disposal sites from a scientific perspective are to be announced by the end of the year. Won't it still take a lot of time before the actual sites get selected?

**KIKKAWA:** So, I don't think it matters what the government says, it's really about supporting technological innovation and moving things forward. And, of course, I want the government to do its best, but I don't think they're going to be very useful.



# 3 Political Risk / Judicial Risk



There isn't much change with the new president

**ISHII:** And now I would like to ask both of you gentlemen about political risk. Compared with other energy sources, nuclear power is a convenient political target. The fact that the government's stance toward nuclear power changes every time a new administration comes into power makes it highly risky for nuclear power operators, no matter which country, I think. Mr. Kee, the U.S. presidential election is looming ever closer. How does the nuclear industry in the U.S. regard what is happening?

**KEE:** Well, unlike Japan, there isn't much that will change with the new president about nuclear power. The operating plants are not going to change. There really isn't anything ... the only thing that's a big concern in the industry now is if and whether and how the Federal Government might help rescue the merchant nuclear plants that are threatened by deregulated markets. So far, the Federal Government has done nothing, and that's probably going to continue.

The presidential candidates are still in the nominating phase, so it's hard to understand who's going to be the actual nominees, but whether it's Trump or Clinton ... none of them have said very much about nuclear power, and that's probably OK. There really isn't much that they could do, positively or negatively. There are so many issues that are more important right now, with health care and other things. Nuclear power has a very low profile, and that doesn't bother me very much. So we're OK with political issues and nuclear power.

**ISHII:** You mean small modular reactors?

**ISHII:** And Professor, what is your view on the situation in Japan?

**KIKKAWA:** So, in terms of the politicians, regardless of whether they are from the Liberal Democratic Party (LDP) or the Democratic Party (of Japan), you just can't rely on them, and you shouldn't have expectations of them, because all they're concerned about is what's going to happen in their next election. So, if they say something, misspeak on nuclear, they might get less votes. Therefore, what they're doing right now is just avoiding the topic. So, I think what is most important is that you can't expect anything from politicians.

I think the Abe Administration has enjoyed very strong foundation and support, compared to past administrations, but regardless of that, the Abe Administration has been very circumspect about nuclear issues. And the (previous) Noda administration was much more strongly vocal about nuclear in general, so I do believe that there is political risk, but that, you know, you just can't have expectations of the politicians.

**KEE:** Let me say one thing about the political situation that's a bit unique to the American situation, I think. The popularity among the general public of small reactors, advanced reactors, is very high. A lot of people are thinking that the problem is technology, and the solution is small reactors or advanced reactors, or molten salt reactors or some other ....

**ISHII:** You mean small modular reactors?

**KEE:** Yes. There's a lot of public interest in them; a lot of public support. And the demographics of that support is younger people who think that these new, small, modular reactors and advanced reactors are really the answer to everything. They're seen as having a lot of promise, so the one thing that the government



is doing is funding and talking about research and development projects for these new technologies. The actual impact of that on the industry may be decades away, but they're spending a lot of time and a lot of Federal money and placing a lot of attention on how to get those new technologies developed, and I think that's a politically popular policy. Current large light water reactors are seen as bad, but these new reactor designs are seen as good.

**KIKKAWA:** So in Japan, it's not as a widespread sentiment, but something interesting is that the former Mayor of the Tokai Village in Ibaraki Prefecture is against—this is actually uncommon—against restart of nuclear power plants, that are the old type of reactors. But he's actually very supportive of using nuclear

ous. So I think that's an interesting idea.

And the last thing I'll say about political support is that there was a lot made of President Obama having a White House summit on nuclear power in November, prior to the COP21 meetings in Paris. Not much that is concrete came of that summit. It was very important to the industry, to see a Democratic—versus a Republican in our country—administration publicly talking about nuclear power as a valuable resource. And while there wasn't much happening as a result of it, the fact that there was that public forum, sponsored by the White House, was a very important step.

**ISHII:** Professor, is there any possibility for these small modular reactors in Japan from the social perspective?

**KIKKAWA:** So, I don't think that the possibility is very high for that to happen. One of the major differences between the U.S. and Japan is that we do not have the nuclear navy program. There's no nuclear navy in Japan. So, in the U.S., I believe there is trust by, confidence in and trust from the general public towards the navy as they strongly manage the PWR technology, and I believe that it's their reputation, or they're known for this as well. So, it's unfortunate that Japan does not have this nuclear navy program, and therefore the opinion tends to be split into the extreme against, the extreme pro, and there's no third-party trusted type of presence in the discourse. And I think that's one of the issues that Japan faces.

**KEE:** How interesting, thank you very

much. I started my career with Admiral Rickover. I was part of the nuclear navy, but I don't necessarily see that exact kind of support. I see that the nuclear navy supplies a lot of qualified operators. They operate all kinds of PWRs, BWRs, everything, so it's a big source of skills, a skilled workforce. But I guess I haven't seen it so much as a part of public support, maybe not as much as perceived from here. Interesting.

**ISHII:** And the next topic, about the judicial risk. As demonstrated by the injunction by the Otsu District Court, shutting down two reactors at the Takahama Nuclear Power Plants, uncertainty within the Japanese court system has come to be a big element of risk. Some people are fuming that the separation of the three branches of government (administration, legislation, and judicature) has started to collapse.

Mr. Kee, a rush of lawsuits occurred in the U.S. after the Three Mile Island accident, with many new nuclear power projects put at a standstill. Is there any case that Japan's nuclear operators ought to use as reference?

**KEE:** I guess I'm not so sure I agree with the premise of your question. The Three Mile Island accident had a lot of impact on the industry, but it was mostly about stopping plants that were under construction, or requiring retrofits to plants that were completed, to comply with the man-machine interface issues, and that the learning from Three Mile Island caused these plants to be more expensive ... take longer to build, and that



You just can't rely on the politicians



caused some of them to be cancelled. Lawsuits about Three Mile Island have largely been unsuccessful. There was no public health impact. Although a lot people tried to sue, they didn't have much of an impact.

And let me address a higher-level issue. The Nuclear Regulatory Commission—a federal entity—has absolute jurisdiction over nuclear safety matters. And so, if you wanted to bring a lawsuit about a nuclear power plant and safety issues, you'd have to take that case to the Nuclear Regulatory Commission, and somehow get some traction there. If there's no process that takes you to the NRC, you're going to sue someone, and that's going to go to the NRC, and will be dismissed by the courts. So there really isn't the same kind of judicial process that could happen in the U.S. However, if the NRC is considering an application for a new nuclear power plant, or an application to extend the license of a nuclear power plant that's already operating, there may be opportunities in that situation for the public to intervene, to raise issues with the NRC, and to perhaps stop or cause problems for the nuclear power plant.

And I guess I'll talk about three different kinds of cases. The first one is a nuclear power plant called Shoreham. It was on Long Island in New York State. It was built and ready to operate, and to get the operating license, they had to get approval of the local evacuation plans. Those plans weren't forthcoming, and the result was the NRC did not issue an operating license, and the plant—even though it

was built—was totally scrapped, and never operated. So that, in effect, moved the NRC to start a process to improve the new reactor licensing approach. So instead of getting a construction permit and coming back again to get an operating license (as happened in the Shoreham situation), now there's a single integrated process—combined construction and operation license ("COL") —which is approved before the start of new nuclear plant construction. So there's less risk that that will happen.

The next cases I'll point out are the license extension cases, and there's one going on now in Indian Point in New York State and there's one that's coming up in California at Diablo Canyon. In those cases, the nuclear power plant owner is asking permission from the NRC to operate for an additional 20 years, and in both of those cases, the state government and other organizations have intervened at the NRC. Some interventions have to do with water permits; other concern issues that are state matters. And so, those two cases are contentious. They're within the NRC's purview, but because of opposition and lawsuits and state water permit issues, they're both on hold, and both somewhat in doubt. The plants won't be closed down, but they might not be able to operate an additional 20 years.

There have been a number of cases in the U.S. where states have tried to take authority over nuclear safety issues, and in general, the NRC and the courts have ruled that the NRC has exclusive jurisdiction over nuclear safety issues. The last case was at the Vermont Yankee nuclear

power plant in Vermont, where the state tried to stop license renewal. I testified as an expert witness in the district court case there, that essentially ruled that the NRC's jurisdiction was absolute, and set a new Supreme Court precedent. For Japan, the important thing is to have a nuclear regulatory authority that has

important thing.

**KIKKAWA:** So, I actually do think that is an imminent danger that's right in front of us right now in Japan. I feel that the decisions that are being made by the legal courts about nuclear power plants being operated are peculiar, because on

ence. Whether that's an issue with the court system or an issue with the power utility system, or something else, is unclear, but this type of discrepancy, I believe, will have detrimental .... you know, people will lose trust and confidence in the legal system if this happens, so that's why I see that I have this strong sense that things are a bit peculiar here.

be nice if Japan got to the point where their Nuclear Regulation Authority could have the same respected legal position that the NRC has in the U.S. That may not be so easy, though.

**KIKKAWA:** The history of the Japanese NRA is only 4 years.

**ISHII:** And I think that the Japanese NRA has just released only a short comment about the Takahama case.

**KIKKAWA:** So, in Japan, I think that the NRA, in its given position, isn't really concerned. That's all they could say about the legal ruling that was made, and perhaps this is a little bit of an offbeat perspective, but the NRA has been critical of both people against and promoting nuclear power, so in that sense, I think that they're doing a good job.

**KEE:** Well, one last thing about this. The U.S. courts have consistently had the position that the courts and other people who aren't experts on nuclear safety shouldn't be making decisions about nuclear safety, and that they will almost always defer to the Nuclear Regulatory Commission.

And how you get to that status for the NRA in Japan will be interesting, but very important. If local courts can make decisions about nuclear safety, based on less than expert knowledge and information, then you are really vulnerable to having a nuclear power system that's not going to be sustainable.



full and exclusive jurisdiction, so these lawsuits can't happen. They shouldn't happen, and frankly, I see the Sendai Court case, just a few days ago—where the court said "No, no, it's OK"—as a rational and a well-considered process and a very powerful step toward having that in Japan.

**ISHII:** Professor, I have heard that you don't believe judicial risk to be such an

one hand, they have stopped Takahama; on the other, they have let Sendai continue operating. And, ... when you look at the past verdicts or decisions that were made by the courts, they are rather harsh on the nuclear power plants in Shika and Monju and Takahama, in the past, so these are all in the Hokuriku region of Japan, whereas the more lenient decisions have been given in Sendai and Ikata. So there seems to be a geographical differ-





**ISHII:** The next topic is about new nuclear. During the nuclear renaissance years of the first decade of the 2000's, the rehabilitation of nuclear power became widely talked about in the United States.

And Mr. Kee, many projects that either acquired COLs or were applying for them in the United States seemed to have wound up getting frozen. How are we to understand that situation? Perhaps there are limitations to systemic support through streamlined permit and licensing procedures such as COLs and ESPs.

**KEE:** If you look back to about 2007, we had about 30 new nuclear power plant projects that were applying for licenses around the country. What's changed since then? The primary change has been shale gas. We have lots and lots of very cheap natural gas.

Every new nuclear power project in the U.S., whether it's regulated or unregulated merchant, will have an investment decision made by someone. The economics of a new nuclear plant today are massively disproportionate to building a new combined-cycle gas-turbine power plant. These new natural gas power plants are cheap, easy to build, have low fuel cost and the financial capital investment risk is quite small.

And so, what you see happening in the U.S. is that there are these two projects, one in Georgia, the A.W.Vogtle-3 and -4 units, and one in South Carolina, the V.C. Summer-2 and -3 units. They were effectively agreed on by the state regulators in about 2007. And the state commitment—a regulatory process—makes these investments good ones. They're under

construction. They'll be built. No other projects will be built for a long time, as long as we have cheap gas. We've got a combined operating license for Fermi-3, which might be a GE-Hitachi ESBWR, in Michigan, and for the South Texas project, which was going to be a Toshiba ABWR. Those projects are both totally on hold, because of economics. It's just too expensive compared to alternatives.

As a general matter, the value of nuclear power is based on the alternatives to make electricity, and in the U.S., there's just so much cheap natural gas—and everyone believes it's going to be around for a long time—and there really isn't any carbon cost. In that world, no one's going to build a nuclear power plant. And so that's what's happened. It's economics that's driving this situation. There are some criticisms of the U.S.NRC licensing process, but I think in general, it's going along OK. When Vogtle and Summer are completed and enter commercial operation, we'll have better confidence in the NRC process. So far there's a few glitches, but they seem to be going along pretty well.

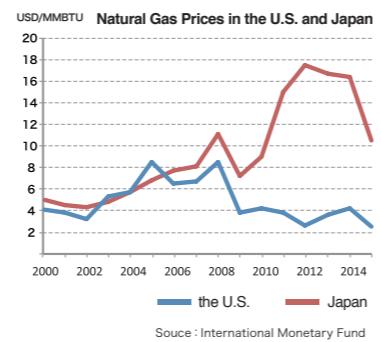
**ISHII:** There seems to be a taboo in Japan about such subjects as NPP replacement or new nuclear. Prof. Kikkawa, do you believe that new NPPs can ever be constructed in Japan as well?

**KIKKAWA:** Well, this might be a minority opinion, but I think there is more possibility for nuclear new build in Japan; more than the U.S. And there's two reasons for that. The first is the situation with gas prices. In the U.S. you have shale gas, and to compare the price by million British Thermal Units (BTUs), it is two dollars

in the U.S. whereas it is eight dollars in Japan, and so there's about a four times difference in that price. And in Japan, also, what's being focused on right now is the safety of nuclear power plants; that's the major concern. And even if you are against nuclear power, you can agree that the newest nuclear power plants would be the safest.

And we have 42 NPPs right now: 22 of them are BWR's; out of those 22, 4 are ABWR's. But the remaining 20 are PWR's, and we do not have any APWR's or AP1000's in Japan, even though China has some AP1000's. So if we are going to continue to use nuclear, the idea would be to build new power plants and close down the older ones. And I believe that if the government is very strong-handed in this, and communicating about it, I think that that would work. And the major areas of focus would be for the JAPC's Tsuruga-3 and -4 and the Kansai Electric Power's Mihama-4.

**ISHII:** The next topic is lifetime extension. Until the Fukushima Daiichi accident, Japan had not specified an operational lifetime for its nuclear power plants. But after the accident, "40 years" suddenly popped up as the figure for reactor lifetime in the new regulations. Because of that, power generators recognizably drew a distinct line between those nuclear power plants



that were to be shut down after 40 years and those whose operation could be extended to as much as a total of 60 years. That means that those NPPs that could not pass the new safety standards economically were naturally weeded out.

Meanwhile, in the U.S., where operational lifetimes were initially set at 40 years, 20 year license extensions have been generally awarded in recent years, I think. Even in the U.S., does such a triage of NPPs based on economic considerations take place during the extension of operation licenses? Or do differences in terms of incentives emerge in the license extensions between those states with deregulated electricity markets and those without them?

**KEE:** OK, a couple of points. One, the NRC has established a process to apply for a 20-year license renewal. Those have generally been granted. None have been refused. The NRC process is not automatic. There are a series of requirements, but it's a path to approval. If you do the things the NRC asks you to do—the tests, the replacement of major components, those kinds of things—you will get the approval, and everyone who's asked for and done those things has gotten the approvals. The cost is not that great. And in the American situation, the NPPs are generally very well maintained. There's some major long-term issues like buried fire main piping, and some other things we've had to do some work on. But generally, it's a fairly small expense to get an approval. So almost everyone is, or has done, that. Even plants that perhaps are not that economic have done it. It's more of an option, if you will. You have the option to operate for 60 years.

You may not use it, but it's a valuable option. However, in the last five years, as the magnitude of shale gas availability has become clearer, and the duration of that low gas-price period has become longer, so some newer NPPs are not applying for license extensions because there's some doubt about whether they need to do it.

More importantly, the nuclear plants that have shut down for economic reasons—Vermont Yankee and Keweenaw—had approved 20-year license extensions, but they shut down for economic reasons anyhow. There really hasn't been any state issues. In the Vermont Yankee case, the state tried to block license renewal; they were rejected in Federal courts. In New Jersey, the oldest plant in the U.S., Oyster Creek—a very early BWR—got a license extension for 20 years, but agreed with the state to only operate for 10 more years because of issues about cooling towers and once-through cooling: getting water out of a bay and back in again. The state wanted them to build cooling towers, and the operator said, "Well, we'll agree with you not to do that. We'll only operate for 10 more years, and not for 20." That's a fairly unique situation, though. Most people ... most companies who wanted to get a license renewed have gotten one. And so there really isn't much of an issue about that.

And, the NRC and the industry are studying another 20-year license period, maybe from 60 to 80 years, and what issues are involved in that. There may be long-life issues with concrete and other things that are not so easily resolved. But there's a good chance that the newer U.S.

plants that are operated today may actually operate to 80 years or even longer.

**ISHII:** And what is your opinion, Professor?

**KIKKAWA:**

So, I agree with you in terms of having to look at both the safety as well as the economy of the plants, but what is different in Japan is that we do have earthquakes and tsunamis, and also very stringent, demanding regulations regarding these areas as well. So, I think that the balance is more difficult to get for Japan than in the U.S., looking at the amount of additional investments that need to be made in order to comply with those regulatory standards, especially if you're looking at the older plants.



# Renewable Energies



Projects that would be built, yet built due to subsidies

**ISHII:** And next, I would like to hear what you both think about how much renewable energy should account for, percentage-wise, in the total amount of generated electricity. As seen in Germany, subsidies for renewable energy through feed-in tariffs (FITs) just seem to create chaos in the electricity market.

**KEE:** I don't think there should be a cap on the share of renewables, but I will note that renewables are only being built because of subsidies, and one of the problems with those subsidies is that projects that wouldn't get built, get built anyhow even if the economics don't work. The system impacts of those renewables are generally not included. There have been some studies in the U.S. showing that up to 15%, maybe 20%, renewable penetration is something that can be handled without building a lot of extra peaking or extra load-following capacity. That's probably OK. My main concern about renewables, for nuclear power, is

that the wind-production tax credits lead them to bid into the markets in a negative bid, which, when there's a lot of wind blowing and demand is low, results in negative market prices in almost every U.S. market. And if you're a nuclear power plant, that's a real problem.

**ISHII:** Professor, you have suggested a level of 30% for the ratio of renewables within the total power mix. Thermal power sources need to be kept available to respond to frequency variability on the part of renewable energy. Who is to shoulder those costs? Is it possible to develop a scheme whereby the burden of complicated output adjustment could be assumed appropriately by wind and solar power generators?

**KIKKAWA:** So, the 30% figure I gave was the level in 2030, and at the time of 2030, the FIT (the feed-in tariff) would be over. That is more in the near future. So, that would be over, and it would be renewables based on the market being

implemented. And I think that there are three facets that need to be considered or options that would be available.

First of all, the major problem would be the transmission grid. And one option is to use the transmission lines that are left over from NPPs decommissioning.

need to study more about the situation in parts of the U.S., Australia, China and the Nordic countries in areas where they have renewables in their system without a feed-in tariff and process, and see how that is developing.

**KEE:** I'll say that one region of the U.S. that has a lot of hydropower and wind power, the Pacific Northwest, has come to the point where they're curtailing the output of the wind projects, and that's been a very big legal issue. And so, we're probably moving in the U.S. toward a system where we can—if there's a lot of wind or a lot of solar—turn them off, rather than having to find a way to take power that is not needed. It's a large problem, and California is facing it now. There probably is a way to resolve that issue through curtailment, although that impacts the economics of the renewable projects and makes the owners of those renewable projects very unhappy when we turn them off.

Market-based renewable energy system should be implemented



# 6 Governmental Involvement in Supporting Nuclear Power

**ISHII:** I would like to ask about governmental support for nuclear power. For nuclear power—not just new nuclear power projects—to be established as a business enterprise, what should the involvement of the government be like?

Given that nuclear power is positioned as a semi-domestic energy source in Japan, is it alright for countries that lack resources, such as Japan, to allow the nuclear power option to be eliminated by removing governmental support and leaving everything up to market principles? From the perspective of energy security, then, might not governmental protection become necessary?

The UK adopts a system of contracts for differences (CfDs) and the government guarantee scheme, while the United States uses loan guarantees, and Japan a fully distributed cost (FDC) method. Mr.

Kee, are support policies working properly in the UK and the United States? Won't they come up for review in the future?

**KEE:** Well, let me talk briefly about the U.S. In the U.S., there were these packages of incentives in the Energy Policy Act of 2005: loan guarantees, tax credits, and a few other things. The only nuclear projects coming out of that exercise were the ones in South Carolina and Georgia: Summer and Vogtle. Summer didn't even take the loan guarantees. They applied for them and didn't follow through. They didn't need them. The cost of money wasn't that high. Their regulatory arrangements and the revenue certainty made them a fairly low-risk investment, and the same thing was true in Georgia for Vogtle. In fact, Georgia Power made an investment decision and started construction on the Vogtle project before they closed on a loan guarantee. The loan

guarantee was almost an afterthought. So I don't think that (a) it was much of an incentive, and (b) it didn't really have much of an impact on the U.S. market.

**ISHII:** What makes me feel concerned about the Hinkley Point C project in the UK is that the kind of projects that would be advanced in Japan from the perspective of energy security are being evaluated in the UK putting priority on investment viability. EDF Energy is eager to recover costs in the short term precisely because it is a private company. Despite the setting of a relatively high strike price for the CfDs by the UK government, I cannot help but see it as a case of reserving final judgment indefinitely. Aren't the risks too high for nuclear power under market mechanisms?

**KEE:** In the U.K., where all generation is (or will be) merchant—selling into the

market—the U.K. needed a mechanism to help the government manage what gets built. And so, the whole electricity market reform program was about giving the government tools they thought they needed to get new nuclear built, because they needed that to meet their carbon targets, given their legal commitments and the potential and near-term retirement of the existing nuclear fleet, or most of it. That's a very difficult thing for them to do. EDF is acting like a private company in the U.K., even though it is a French government utility. But it's a big ask of a private company to be bearing all the financial risk for a new nuclear project, especially an EPR-based nuclear project. I'm not surprised that EDF is having problems getting to a financial investment decision. Contrast, if you will, the U.K.'s approach of having incentives for a private investor to an approach where the U.K. government simply builds a new

nuclear power plant itself: a return to the old Electricity Generating Board, perhaps. They might already have the plant finished by now. I think it's an issue for the U.K. about how they get to a future mix of generation. Incentivising private companies in the market might be very expensive, and it may in fact be almost too expensive to do.

**ISHII:** Prof. Kikkawa, Japan, too, has entered an era of deregulation. What will happen to the FDC method in the future?

People are starting to show up frequently spouting such nonsense as "all Japanese NPPs should be put under the control of JAPC and then shut down permanently" as if it were really going to occur, thus demoralizing young people in the nuclear industry. What should the future shape of Japan's nuclear power be like?

**KIKKAWA:** So, first of all, for the fully distributed cost method, for the generation side, it is going to be over momentarily, and that's not just for nuclear, but also for all the other power plants as well. And therefore, it will be difficult to actually build or construct new power plants in general, regardless of whether it's nuclear or not. And if we look at a more realistic picture of the situation, we see, for some reason, that there's a difference in circumstances between the BWRs and PWRs in Japan.

For some odd reason, all the earthquakes and equipment failures and impacts are happening at the BWR plants. For the March 11 (2011) tsunami, damages and all were at the BWR plants as well. So there are very many headaches, or troubles, in the BWR group. And so, I believe that it will move closer to almost a public-, or government-run type of situation with

The loan guarantee didn't really have much of an impact





After deregulation the power companies take actions strategically

the BWR camp. For example, the Kashiwazaki Kariwa nuclear power plants will not be operated by TEPCO, but, perhaps they will use JAPC, but it will be some kind of government-operated entity, and the power that is generated would be put into the wholesale market and used as a kind of public-service power supply. And that's I believe what will happen with the BWR's.

On the other hand, for PWR's, if we even look at their past, they have had about a 10% higher operation ratio compared to the BWR's, and I think it will, of course, be up to the companies, and what they decide, but they might be able to continue on as a private company on the PWR side. I think that the Tsuruga-3 and -4 endeavor, if it were to happen, would be led by Kansai Electric Power, but in order for the private nuclear operations to continue, I believe a major prerequisite would be the nuclear damage compensation system.

Of course, the nuclear plants or businesses are not very conducive to an insurance type of system, but there need to be some changes in the compensation system, and it will be necessary to have limited liability for the companies themselves and some kind of system in line with international standards where the companies have limited liability and the government will cover the rest of the liability in case an accident does occur, so that private companies would be able to

make necessary investments in this area. If that type of change occurs, it would be a possibility that private nuclear would continue.

I'm not saying this for the power company's sake, but for the sake of the people, the local residents, because if there is an accident, then no single company will be able to pay out, to cover all of the damages. Therefore, you need to have limited liability for the companies, and the government covering the rest.

**KEE:** The third-party liability issues are very important, and government decisions after the Great East Japan Earthquake—that a “grave natural disaster” had not happened, were very interesting, and very worrying to the Japanese nuclear industry. They thought they were protected from third-party liability if there was a grave natural disaster and certainly that the March 11 tsunami and earthquake would qualify as one. The government didn't let TEPCO or them, have that protection which was unfortunate. But there is a system of third-party liability treaties and regimes around the world that work very well. I think Japan needs to rethink how their own government's role in that, and make it clear to the industry. If it's open-ended as it is now, it's a worry, I agree.

**KIKKAWA:** If you look at March 11, and I think it's going to be very difficult or challenging, in that the Japanese nuclear

program was developed and started as a national strategy, a government strategy, and implemented by private companies, so it has been an integrated effort between government and private entities, and when the March 11 accident occurred, the government decided that it was not going to be receiving the criticism. It wanted to be the one criticizing the operators.

So that's what they decided—that they are not going to be the ones apologizing to the public, but the ones that are heavily reprimanding the operators, and appearing, you know, to be the proponents of “justice” in this situation. And they believed that that would be beneficial for them, for elections, obviously. So they basically decided to, you know, hand off the responsibility, and that was the issue, I believe. But at the same time, I think it's difficult to expect that the government will take the noble, the high road, and do what it's supposed to do.

**KEE:** Yes, the theory of third-party liability, with the government being the ultimate insurer of last resort, has really never been tested, so to some extent, you're plowing new ground here with the Fukushima Daiichi accidents. And there's a lot of confusion by people outside of Japan about what's really happening, who's really paying for those third-party claims, and the Japanese government involvement—call it a “takeover” of TEPCO, perhaps funding those things indirectly—

make that very difficult to understand. But I think you're exactly right—a company doesn't have the resources to provide that kind of compensation, and so there ought to be a very clear mechanism about when and how the government will be involved, because if not, then nuclear can't proceed.

**ISHII:** And in addition, I'd like to ask about the carbon tax. I think that it would demonstrate to the electricity market the superiority of nuclear power. How about that, Mr. Kee?

**KEE:** Well, let's be clear. We've talked in the U.S. about carbon taxes for a long time, but we haven't done anything. We're doing this thing called a Clean Power Plan (CPP) instead, which is more of a regulatory, top-down approach to controlling carbon. The problems with the carbon tax are that to make the changes in assets and investments in the electricity sector, a carbon tax has to be quite large. And with a very high carbon tax, there's very high taxes and government revenue, and a very high economic impact on the country, and so, to do that, you need to put the money you collect back to the people: income-tax credits or something else, to make it an economy-neutral approach. And the big worry in the U.S. is that if all that money from a carbon tax comes into the government, it won't go back out again; they'll spend it on something else. It's called the “revenue recycling problem”. And so, we haven't

Currently, the CPP has been put on hold by the U.S. Supreme Court, while various legal challenges are decided by the lower courts. The delay was sought because the cost of implementing the CPP may be significant and incurring these costs while the CPP was being challenged in court would be inappropriate.

**ISHII:** Could I have your thoughts on that, Professor?

really been serious about a carbon tax.

And if you did a small carbon tax, the marginal impact might be the right direction, but it wouldn't be enough to, for instance, encourage new investments in nuclear power plants. In the U.S., the low cost of gas is already causing natural gas to replace coal. You don't need to do much else right now. And so, we're OK, meeting our carbon targets almost doing nothing to 2030, because coal plants will close and natural gas plants will replace them. After 2030, it becomes an issue. We may have to build new nuclear power

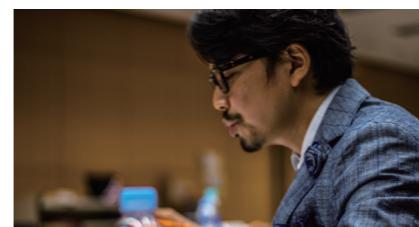
plants to get to a zero-carbon electricity sector after we've just built a lot of new natural gas plants before 2030, which is an unfortunate thing, and the industry's trying to react to that. There has been a judicial stay on the CPP; not much hope of changing it, but there's a lot of back and forth about what might be done to help nuclear power get more benefit from that CPP.

But if you look at steel mills, or coal-based thermal generation in chemical plants, there might be some other impact, so I think it needs to be only focused on the generation of power companies. In the past, the power industry as a whole has been said to be against carbon pricing or carbon taxing, but now, after deregulation, for example, for Kansai Electric Power, which has less dependence on coal-fired thermal, carbon pricing may be an advantage to them, whereas Hokuriku Electric Power and Chugoku Electric Power have higher dependence on coal-thermal, and so I think there will be a difference in the perspective before deregulation and after deregulation.

**KIKKAWA:** Well, I'll keep this concise since we're running out of time. In Japan, I think that there's already some small-scale carbon pricing, already included. Whether this becomes larger than what it is now, it's something that is a potential prospect. And in Japan, the target is to reduce by 26% against 2013 figures, and right now there is a voluntary effort on behalf of industry. But for electric power companies, it will be difficult for them to reduce this much based on just voluntary initiatives, and therefore, that kind of carbon taxing or carbon pricing concept might be effective.

But if you look at steel mills, or coal-based thermal generation in chemical plants, there might be some other impact, so I think it needs to be only focused on the generation of power companies. In the past, the power industry as a whole has been said to be against carbon pricing or carbon taxing, but now, after deregulation, for example, for Kansai Electric Power, which has less dependence on coal-fired thermal, carbon pricing may be an advantage to them, whereas Hokuriku Electric Power and Chugoku Electric Power have higher dependence on coal-thermal, and so I think there will be a difference in the perspective before deregulation and after deregulation.

**ISHII:** The time limit has approached. Thanks again for coming here today.



# E p i l o g u e

Nuclear power faces large challenges in electricity markets.

There is increasing evidence that nuclear power may not be compatible with electricity markets.

Japan should take great care in restructuring the electricity industry to ensure that nuclear power remains a viable generation option.

*Edward Kee*

In the latter 20th century, nuclear power contributed to the development of humankind. That situation will probably remain unchanged throughout the first half of the 21st century. Well, then, what about the latter half of the century?

The future of nuclear power depends on whether or not the back-end issue can be resolved. If that problem can in fact be resolved, the future of nuclear power will open up. If not, however, we need to think about reactor decommissioning. Keeping in mind that both of those paths exist, it behooves us to start making preparations now.

*Takeo Kikkawa*



**Edward Kee**

Mr. Kee, an expert on nuclear power economics, is currently the CEO of Nuclear Economics Consulting Group (NECG). He provides strategic and economic advice to companies and governments on nuclear power and electricity industry issues. He has testified as an expert witness in the U.S. and international legal and arbitration cases. Kee was qualified as chief engineering officer on Nimitz-class nuclear aircraft carriers before becoming a consultant. He holds an MBA from Harvard University and a BS in Systems Engineering (Distinction) from the US Naval Academy.



**Takeo Kikkawa**

Prof. Kikkawa is an expert on electricity industry structure. After serving for more than a decade as a professor at the University of Tokyo and at Hitotsubashi University, he is now professor at the Tokyo University of Science. He is also the President of the Business History Society of Japan. Having served on government councils, Kikkawa actively comments on the future of nuclear power, without mincing any words. He graduated with an economics degree from the University of Tokyo in 1975, and completed all course credits in the Ph.D. course in the same department in 1983, receiving his degree in 1996.

photo: Takako Kubo

text: Noriyuki Ishii