Fukushima and the future of nuclear energy

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The impact of the incident at the Fukushima Daiichi nuclear power plant, which resulted from the devastating earthquake and subsequent tsunami on March 11th, 2011, will have wide-ranging consequences for the global energy mix as governments and companies seek to address the challenges of providing a sustainable supply of energy for the greatest benefit of all. As part of the World Energy Council's flagship Scenarios study a Nuclear Task Force was set up to consider the impact of this incident and look into all aspects of nuclear, including safety systems and how nuclear governance is organised worldwide. In a series of 24 conference calls task force members discussed the future of nuclear and also drew on the results of a perception survey conducted through WEC member committees in countries where nuclear power is already part of the energy mix, with 27 out of 33 countries responding. All aspects of the topic will be further developed as a critical issue within the energy scenarios exercise, with this note focusing mainly on thoughts around the question of public perception and international governance of nuclear following Fukushima.

When evaluating the impact of Fukushima and the future development of nuclear energy, we need to take into account that positive as well as negative aspects of nuclear energy have to be seen from both a reality and a public perception point of view. The history of nuclear power is one of constant improvement and technological development based on the lessons learned in the construction and operation of the plants and great public debate and division about the safety of the technology. Accidents, like Three Mile Island, Chernobyl and now Fukushima tend to polarise these discussions and emphasise the public perception angle. In reality, past accidents triggered in-depth examinations of equipment, training procedures and safety culture, and these led to profound changes and adaptations to increase safety. The Fukushima accident will undoubtedly also contribute with major inputs for continuous improvements into the design and emergency operation aspects of the technology, once the circumstances have been thoroughly analysed and understood.

Over the last 10 years the world nuclear energy production has been practically constant, with the so called "nuclear renaissance" happening at the public perception front, where the major concerns after Chernobyl changed little by little from large accident to questions around final waste disposal. Contributing factors were the price volatility of fossil fuels (and the actual or expected long-term rise of their current prices), the problem of security of supply and the environmental issues connected to greenhouse gas emissions. Going forward, safety concerns, economic considerations, public perception and very long lead times will form large obstacles for "greenfield" nuclear projects. Most reactors currently under construction are in China (27), Russia (11), South Korea (5) and India (6).

Out of the existing 30-plus countries that have nuclear energy programmes, a few countries appear to have experienced the most profound public reactions and public policy changes: Japan, Germany, Italy, and Switzerland. The most significant development has been in Germany where the government shut down the seven oldest nuclear power plants within a few days following the Fukushima event, in addition to the one plant that was temporarily offline due to technical reasons. The German government has now decided to keep these 8 facilities closed permanently while it is accelerating its plans to phase out all of its remaining nuclear power plants stepwise by 2022 (one plant each in 2015, 2017, 2019; 3 plants each in 2021 and 2022). Nuclear not only accounts for approximately a quarter of electricity generated in Germany, but the impact of Germany's decision to phase-out nuclear by 2022 is going to affect the energy system in Europe, as more electricity will be traded across borders and as gas-powered plants are expected to be brought online to balance the system. This will have price implications for both the electricity and gas markets in Europe which are unknown at the moment. It seems likely, however, that the price of energy will have to increase during the transition period and that Germany's exit from nuclear power will increase CO_2 emissions until renewable energy sources have filled the gap. Switzerland will decommission its five nuclear power plants stepwise between 2019 and 2034. While the Swiss phase-out steps will be orientated on the safety of the operating plants and is expected to lead to a total lifetime of about 50 years for each plant, the German phase-out path is supposed to be the fastest possible way of shutting down the remaining nuclear power capacities without running into critical system-instabilities, leading to an average plant-lifetime of approximately 30 years. Japan and Italy have decided to scale back their previous plans to increase or, in the case of Italy, to begin nuclear-generated electricity. For the remainder of the world's nuclear energy programmess, governments to date continue to stand by their use of nuclear energy in principle.

Anticipated longer-term outcomes of public reaction to nuclear in light of Fukushima include a justification of pre-existing views on nuclear energy in regions and countries that have long held ambivalent to negative opinions on nuclear energy and its safety. The Fukushima accident will serve as an additional example of why to oppose it and local, national, and regional politics will prevail over the longer-time frame. There will also be an increase in "not in my backyard" mentality, with the general public not wanting facilities/plants in their immediate vicinity or neighbourhood. In particular, these will be a larger issue for those living in areas vulnerable to natural disasters. Those in favour of nuclear energy will call for improved safety procedures and plans and point out that the global community can learn from Fukushima. Risk profiles are reactor-dependent and site-dependent and therefore response capabilities will have to be different, which makes discussions about minimum safety standards problematic. But at least best-practice examples of nuclear safety should be shared between countries and operators.

The WEC member survey shows that most countries that have existing nuclear power installations believe that their own national nuclear authority is independent, resourced, transparent, and empowered with enforcement. But most respondents also answered with a lot of uncertainty with regard to the perception of other countries' nuclear governance. There seems to be a high willingness to strengthen national nuclear authority in light of Fukushima and there is very high agreement that there is a need to improve public understanding of nuclear technology/costs/risks. While there seems to be relatively high political support for the adoption and convergence of international safety regulations, there seems to be comparatively lower political support for the international enforcement of safety standards. The response has been unanimous: that the media affects the public discourse of nuclear energy the most. Therefore the most pressing barrier for the future of nuclear has been identified as public perception, followed by lack of policy. Skills shortage was not deemed a major barrier.

When asked about the potential for substitution fuels,

Changes in government policy toward nuclear energy following Fukushima in countries using or intending to use nuclear energy (as of June 14, 2011)

Existing Nuclear Installations

Use of nuclear power in principle is not being contested[1]	Argentina, Brazil, Belgium, Bulgaria, China, Czech Republic, Finland, France, Hungary, India, Japan, the Netherlands, Romania, Russia, Slovakia, South Africa, South Korea, Spain, Sweden, Switzerland[2], Ukraine, United Kingdom, United States
Use of existing nuclear power is being rejected[3]	Germany

Construction of New Nuclear Installations

Construction projects in principle are not being contested[4]	Brazil, China, Czech Republic, Finland, France, Hungary, India, Jordan, the Netherlands, Poland, Russia, Saudi Arabia, Slovakia, South Africa, South Korea, Sweden, Turkey, Ukraine, the United Arab Emirates, the United Kingdom, the United States, Vietnam
Basic assessment of extension-pathways respectively the introduction of nuclear power	Japan
Construction projects are precluded	Germany, Switzerland, Italy, Venezuela

Notes: (1) Assessment of safety installations (incorporating lessons learned); (2) expected closure of the five nuclear power plant units between 2019 and 2034 (after the end of approximately 50 years of operating time); (3) immediate shutdown of 8 nuclear installations following the Fukushima event and phased-out closure of remaining power plants as fast as possible, independently from safety aspects; (4) possible partial modification of safety standards or licensing procedures.

gas has emerged as the clear winner globally, with biomass being a strong contender. Renewables are only mentioned in countries with high potential, e.g. solar in Spain. Higher electricity prices have been deemed as the most direct implication of nuclear substitution, with energy security concerns and higher GHG emissions also highlighted by many countries. Regional analysis further shows that the perception of nuclear safety in developing countries has not changed significantly compared to developed countries. Especially the lack of skilled technicians/engineers is an important barrier for the future of nuclear in developing countries and coal as well as fuel imports will continue to play an important part for energy security in those areas compared to developed countries. China and India are special "planets" which use local resources (mainly coal and some hydro) with however strong development of new nuclear plants.

Undoubtedly, the consequences of nuclear power production provide unique challenges for governance. National boundaries are irrelevant when considering the impact of nuclear incidents and there is still room for improvement of international governance arrangements. Currently, nuclear governance rests with nation states, along with a limited level of oversight provided by the International Atomic Energy Agency (IAEA) and peer review arrangements such as WANO and INPO. The fundamental objective of the IAEA is to ensure that atomic energy is not put to any military use and it has no power to intervene in the nuclear affairs of a state, unless it is specifically requested to do so by the state itself. In all cases the sovereignty of the state supersedes that of the IAEA. In addition to the IAEA, the World Association of Nuclear Operators (WANO), based in London, exist to help its members achieve the highest levels of operational safety and reliability. They do this through peer reviews, technical support and access to a global library of operating experience. While they work directly with their members, WANO is not a regulatory body and they do not advise companies or countries on reactor design issues.

Under the existing system of nuclear governance there is clear need to strengthen global regulation of nuclear energy. The aircraft industry, for example, also has competing designers, manufacturers and operators, all functioning under national aviation authorities, but there is also a process of international certification standards for airworthiness, as well as protocols for navigation systems etc. In line with this train of thoughts, the following points were highlighted by the nuclear task force as a contribution for further debate at the energy leader summit in Rio de Janeiro and similar events in future:

1. Standards – National nuclear safety agencies must adopt minimum safety operation, maintenance, and transparency standards, including site location parameters, and training certification.
2. Verification – An international organisation should be empowered to work with each national nuclear safety agency to draw up these standards and verify adherence to them. Such verification should be publicly available to enhance transparency.
3. Design – The same organisation should produce an international accreditation standard for reactor design.
4. Finance – Funding mechanisms should be revised to ensure strict compliance to national and international standards.
5. Structure – At national and international levels there should be unbundling of responsibilities for the promotion and safety of nuclear power to reduce the potential for conflicts of interest. ❑

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