

The Japan earthquake - impact on the energy sector

The 9.0 magnitude earthquake that hit Japan on 11 March 2011 was one of the most exceptional in known history. According to the US Geological Survey, it was the fourth largest in the world since 1900 and the largest in Japan since modern instrumental recordings began 130 years ago ⁽¹⁾. It was followed by a tsunami of similarly exceptional destructive power.

The immediate impact on Japan's energy sector

The earthquake and the resultant tsunami caused considerable damage and destruction to Japan's energy infrastructure. The greatest challenge is managing the cooling and containing contamination problem at the six-unit Fukushima Daiichi nuclear power plant but the disaster has also had a major impact on other energy infrastructure. The effect on the energy sector includes:

- Nuclear plants have been effected by the earthquake and tsunami at four locations: Fukushima-Daiichi (six reactors), Fukushima-Daini (four reactors), Onagawa (three reactors) and Tokai (one reactor), with the shutdown of 12GW of nuclear capacity unlikely to come back in service, for some time, if at all. This adds to the three reactors still not in operation of the Kashiwazaki-Kariwa plant since the 2007 earthquake.
- At least 2GW of the 12GW—Fukushima Daiichi units 1, 2, and 3—have been permanently lost because of the corrosive nature of seawater injected into the reactor vessels ⁽²⁾.
- Six coal-fired stations, with 8.3GW capacity, are reported to have suffered major damage and are expected to be out of commission for many months ⁽²⁾.
- Six main oil refineries have been shut down and there was major fire damage at the 220,000 bpd Chiba refinery ⁽³⁾.

Rolling blackouts have been necessary as power companies manage supply shortages. It is forecasted that larger-scale blackouts will be required if high temperatures in the summer stimulate demand by 15% to 30% compared to spring, as has happened in previous years. Avoiding blackouts would require utilisation of hydro and conventional power plants to be increased by more than 20% from the pre-earthquake level. But this would require considerable transformation and revitalisation of old assets.

The impact on the global nuclear sector

The nuclear emergency in Japan will reopen discussion and debate on nuclear power. Most immediately, discussion will focus on safety considerations and learning from the unfolding events in Japan. More widely, the events are likely to spur debate on the overall role of nuclear power in the energy mix as governments seek to balance a range of public and stakeholder viewpoints.

Policy-makers are likely to weigh a range of factors, including:

- a considered and full assessment of the specific sequence of events affecting nuclear plants in Japan and the safety learning that comes from that.

- an understanding of the differences and similarities with their own country's nuclear installations and the implications of these similarities and differences.
- a wider assessment of risk and scenarios affecting nuclear power plants and other sensitive energy installations.
- the cost of any changes to design and operations.
- an assessment of the risk and cost of alternatives in the electricity generation mix.

It is too early to reach any kind of definitive view on the likely outcomes of such discussions in the years to come, however we note that most countries with a nuclear power program have already announced safety reviews.

There are established mechanisms for ensuring that the nuclear safety lessons from Japan are shared among all the participants in the global nuclear energy industry, the nuclear safety authorities and the policy-makers. International agreements on nuclear safety such as the IAEA's Convention for Nuclear Safety adopted in 1994 and in force since 1996 and the IAEA's Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency could help to ensure that lessons learned from the events in Japan are integrated globally.

The impact on the global energy market

Understanding the implications for the global energy market will require an in-depth analysis of events and responses as they evolve over time. Nevertheless, our preliminary analysis highlights the following issues:

- Capacity losses in Japan will have a major impact on power generation and, to a lesser extent, oil refinery output.
- The loss of coal plants in Japan is nearly as significant as the loss of nuclear capacity and is likely to be a long-standing problem.
- If Japan's oil refineries do not restart rapidly, the global refining industry will have to supply up to 1 mbd of incremental imports to Japan. The impact on oil may also be mitigated by reduced industrial and transportation demand because of the disaster itself.
- Events in North African and the Middle East are likely to be more significant for global oil markets than those in Japan.

The greatest short to medium term impact on the global energy market arises from the power generation switches necessary to compensate for lost nuclear and coal generation capacity. On the whole, Japan's gas generation capacity has emerged intact from the earthquake and tsunami. Liquefied natural gas (LNG) is expected to fill much of the gap. Japan is already the world's largest market and LNG demand will increase.

Some of the additional demand will be able to be met from additional LNG production, but much will need to come from the diversion of cargoes originally intended for other destinations, with Europe being the most likely source. Previously, the US shale gas glut had allowed LNG to switch from the US to Europe but, now, LNG shipments are more likely to be focused on Japan. This is likely to result in a tightening of the gas market and upward pressure on prices in Europe as it reverts to greater reliance on pipeline gas. It is also likely to accelerate movement to a worldwide tightening of the overall gas market that was already anticipated for the period 2012-2014.

The extent of the longer-term impact on the global energy market will depend on how far government reviews of nuclear energy are confined to safety modifications or whether they extend into wider shifts in the energy mix. Even without changes in new build plans, safety audits of existing nuclear plants may result in significant upgrades or, in some cases, plant shut down. But any reductions in current and planned nuclear capacity will have a profound implication for energy security and the need to source power from other sources. Nuclear power accounts for 14% of world electricity generation and is projected to climb from 2 731 TWh in 2008 to 4 900 TWh in 2035, with 40% of this growth from China alone ⁽⁴⁾.

The impact on the global CO₂ outlook

Nuclear power is expected to play an important role in the shift to a low carbon economy. Almost 400 new nuclear power plants have been proposed around the world – many to meet Asia’s growing need for electricity. Heightened caution and a tighter policy stance from governments on nuclear, already evident from government announcements following the earthquake, will have an impact on progress towards a low carbon economy. Currently, annual rates of decarbonisation are not enough to limit climate change to two degrees of warming.

The exact impact on CO₂ depends on a number of variables, including:

- how far a tightened nuclear programme translates into less nuclear capacity than would otherwise be the case, either because of delays or cancellations.
- what mix of fuel sources are mobilised to replace reduced or delayed nuclear capacity.
- the extent to which market and policy reactions spur added investment in renewables.

One immediate market reaction, for example, has been a 10% rise in EU carbon allowance prices following the German moratorium on its nuclear programme and closure of older plants. Wholesale gas prices in Europe have also risen strongly on anticipation of LNG diversions to Japan. A continuation of these trends would help the cost position of renewables, as would the impact of any increase in nuclear capital costs following the current round of safety reviews. Notwithstanding this, it is difficult to envisage renewable technologies filling any significant gap left by nuclear in the short term. On the other hand, replacement of lost nuclear capacity with fossil-fuel generation, in the absence of complete carbon capture and storage, will increase CO₂ emissions.

Sources

- (1) US Geological Survey, USGS updates magnitude of Japan’s 2011 Tohoku Earthquake to 9.0, 14 March 2011
- (2) HIS CERA Alert, The unfolding crisis in Japan and what it means to energy, 16 March 2011.
- (3) Hydrocarbon processing, Update on dire refining situation in Japan, 15 March 2011.
- (4) International Energy Agency, World Energy Outlook, 2010.

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