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The CenterSquare Globetrotter is an ongoing series designed to share insights from research trips around the globe.

JAPAN'S ROAD TO RECOVERY

Four years after an earthquake and tsunami devastated the nation, Japan is looking to infrastructure to help buoy its economy. Our recent research trip focused on the country's power and transportation sectors and the progress each is making in the wake of the disasters.

> *"The Great East Japan Earthquake moved the main island of Japan eight feet east and shifted the earth 4 to 10 inches on its axis. Sound waves from the seismic event could be detected in space."*

SEISMIC REVERBERATIONS

On March 11, 2011, a 9.0 magnitude earthquake struck off the northeastern coast of Japan. Known as the Great East Japan Earthquake (GEJE), it was the most powerful recorded seismic event to ever hit the island nation. It also triggered a second natural disaster—a massive tsunami with waves swelling to 133 feet and reaching six miles inland.[1] Devastation was widespread, both in terms of life and structural damage. Extensive disruptions to Japan's industrial production and the displacement of whole communities caused further upheaval. In the aftermath, the World Bank estimated the cost of the natural disasters to be $235 billion, the most expensive in history.[2]

The magnitude of the natural disasters did not leave the country's power sector unharmed. The tsunami caused a Level 7 meltdown inside three different reactors at the Fukushima Daiichi Nuclear Power Plant in northeastern Japan, when cooling systems failed after the loss of electricity. This prompted the Japanese government to close all nuclear power facilities over the next two years as a precautionary measure, and to form an independent agency, the Nuclear Regulation Authority (NRA), to oversee new industry safety standards.

NUCLEAR LOAD

For decades before the Fukushima disaster, nuclear accounted for 30-40% of Japan's electricity production, providing the majority of its base load electricity.[3] As Japan's nuclear reactors went offline, a yawning gap in electrical generation grew. Japan quickly ramped up its thermal fuel plants to cover both base and peak load, which in turn elevated the resource-poor country's demand for imported fossil fuels. In fiscal year (FY) 2013, fossil fuels including liquefied natural gas (LNG) and coal accounted for 88% of Japan's electricity use, compared to 62% in FY 2010.[4] This increase, paired with a weakening yen, pushed Japan's trade deficit to an all-time high of $109 billion in 2014.[5]

> "Nuclear power generation is cheaper and more efficient, can sustain constant demand, and is environmentally cleaner than fossil fuels, making it an advantageous choice for base load power."

Moreover, electricity rates rose $33 billion post-disaster.[6] Domestic electricity users saw a 19.4% increase between 2010 and 2013, while industrial users suffered a 28.4% spike in the same time period.[4]

RESTARTING JAPAN

Although sitting idle, nuclear facilities have not been inactive. Power companies have kept reactor facilities in operational readiness, employing full staff to conduct testing, maintenance and repairs. They have also committed massive capital to implement the upgrades needed for commercially viable reactors to reach full NRA compliance. Of the 48 commercial reactors in use pre-GEJE, 24 have submitted to the NRA for recertification approval. Currently, Kyushu Electric Power's Sendai reactors are the closest to restarting after gaining approval from the NRA and municipal governments; still pending is approval by the national government and the government of the hosting prefecture.

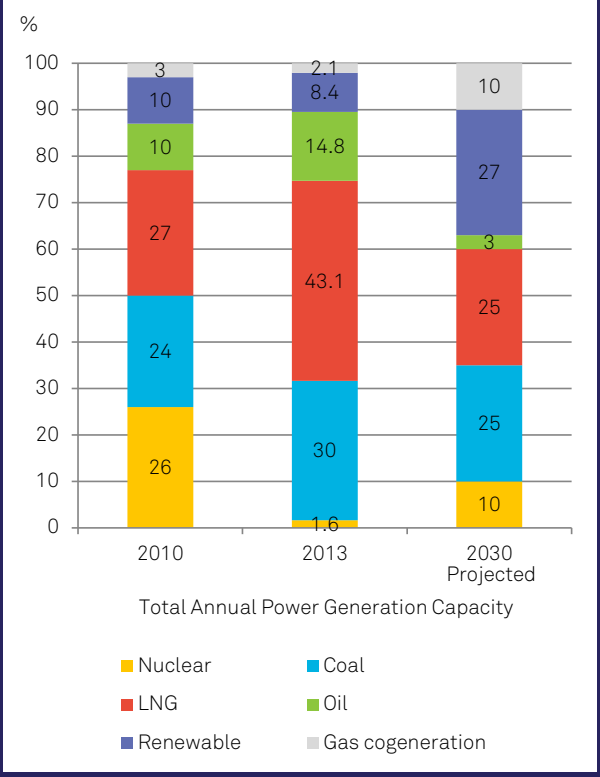
The restart of one gigawatt of nuclear power output would save Japan roughly $83 million a month or nearly $1 billion a year, a cost hard to ignore.[3] Additionally, bringing nuclear reactors safely back online would fit Prime Minister Shinzo Abe's plan to reduce imports of more expensive fossil fuels; his government is supportive of restarting Kyushu Electric Power's Sendai reactors.[6] Moreover, the basic energy plan of Japan's Ministry of Economy, Trade and Industry (METI) states that "nuclear power is an important source for base load that contributes to the stability of energy demand and the supply structure, provided its safety is completely assured. After the Authority recognizes that the plant meets the strictest regulations in the world, its decision is respected and the plant is restarted."[7]

Although there is still lingering public concern about nuclear power's inherent safety in a seismically active country, it is our impression that both regulators and power corporations continue to work to address local concerns. Nuclear restarts appear inevitable and it is possible that by the end of FY 2015, some of the reactors could be back online. Expectations are that some of the 48 facilities that were operational pre-GEJE will be decommissioned, as costs to bring these older rectors in line with new safety regulations may be prohibitive. We believe inclusion of nuclear in Japan's energy mix is foreseen and vital for the country's economic sustainability. The mindset shift toward nuclear as a public-interest power source, the push to recapture Japan's low emission standards by reducing thermal-based electricity, and support by regulators and Prime Minister Abe's government are drivers toward a sustainable energy plan that includes nuclear capabilities.

Electric Power Generation Capacity Mix

A report released by Japan's Ministry of Economy, Trade and Industry described the importance of sustaining a multi-layered energy mix inclusive of nuclear to support its industrial base. Likewise, Japan's Institute of Energy Economics favored inclusion of nuclear production to meet energy and economic security and sustainability, as well as environmental commitments.

Sources: "Nuclear 'an important power source for Japan'", World Nuclear News, February 25, 2014; "Japan will prosper from nuclear restarts", World Nuclear News, January 27, 2015.



Note: *Renewable includes hydro power*
Source: *FEPC, Nomura, October 14, 2014*

Shinkansen (Bullet Train): A more convenient way to travel

Services

Between Tokyo and… (Operating distance)		Osaka (552.6 km)	Okayama (732.0 km)	Hiroshima (894.2 km)	Fukuoka (1,174.9 km)
Travel Time *1	Shinkansen	2 hr 25 min *3	3 hr 12 min	3 hr 47 min	4 hr 50 min *4
	Airlines *2	1 hr 5 min (About 2 hr 40 min)	1 hr 10 min (About 3 hr)	1 hr 15 min (About 3 hr 10 min)	1 hr 30 min (About 2 hr 40 min)
Departures / day	Shinkansen *5	250	128	99	67
	Airlines	108	22	34	114

*1 Travel times are in case of the fastest service
*2 Travel times in parenthesis include transfer and access times between city centers and airports
*3 Travel time between Tokyo and Shink-Osaka stations
*4 Travel time between Tokyo and Hakata stations
*5 Excluding extra service
Source: Central Japan Railway Company Annual Report, 2014

THE FUTURE OF TRANSPORTATION

As the country recovers from the economic aftershocks of the GEJE and subsequent Fukushima disaster, Japan continues to look to the future and invest in efficient transportation systems to support economic growth and meet climate goals.

Japan is considered a pioneer in high-speed rail transportation, introducing its Shinkansen or "bullet trains" in 1964.[8] Since then, numerous transportation companies have not only adopted the high-speed system, but have been advancing and testing the next generation of the Shinkansen, the superconducting magnetic levitation (maglev) system. With this technology, train levitation occurs at about 90 mph, at which point the train lifts off the walled track or "guideway", suspended and propelled by superconducting magnets.[8] The lack of friction and the superconducting maglev train's aerodynamic design allows for speeds of 311 mph, compared with in-force Shinkansen that travel up to 168 mph.

After years of testing, approval was granted to build the first installment of a superconducting maglev train track, a stretch linking Tokyo to Nagoya by 2027. This line will cut travel time between the two cities from 90 to 40 minutes and will cost an estimated $52.8 billion.[9] Expectations for an additional length connecting Nagoya to Osaka by 2045 will link the country's three largest cities and push the project total to about $74 billion.[9]

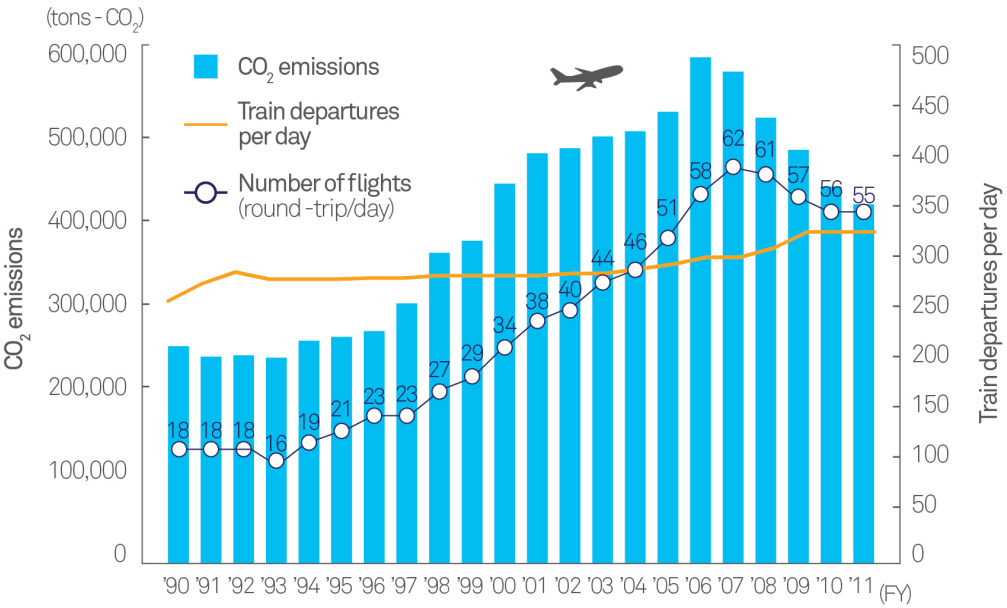
BY TRAIN, NOT PLANE

With an aging population, extensive timeline and expensive construction, many have questioned the commercial viability of a superconducting maglev line. However, maglev technology allows for cheaper, faster passenger transport than traditional means,

Shinkansen vs. Airplane: Tokyo to Osaka

Energy Consumption and CO_2 Emissions Per Passenger Seat

Airplanes Losing Market Share to Trains with Lower Emissions



Source: Created based on the "Annual Aggregate Air Transportation Report (FY2011) , the "Transportation Related Statistics" (Ministry of Land, Infrastructure, Transport and Tourism), and the Central Japan Railway Company Fact Sheet 2014.
*1 Calculation based on running performance (JR Central figures) Series N700 "Nozomi" (Tokyo-Shin-Osaka)
*2 Calculation by JR Central while referencing ANA's Annual Report 2011 B777-200 (Haneda~Itami Kansai Airport)

and the longevity of the system is high due to reduced mechanical contact and wear. It is energy and environmentally efficient, and its narrow guideway is less intrusive than highways, airports or traditional rail.[10] It also provides excellent safety features such as elevated tracks and automatic controls, which reduce collision and human error.[10] Moreover, by the completion date, the current bullet train system will be over 50 years old, at which point its guideways will need to be replaced by the new line.

But beyond improving existing passenger train travel, the superconducting maglev line is poised to take market share from airlines operating within a three-hour radius of its stations. Maglev trains can move passengers at lower prices and higher volume than airplanes.[10] More frequent daily departures, a quieter and smoother ride, fewer delays and reduced wait times will provide greater passenger flexibility and comfort. Additionally, the in-force Shinkansen line produces about 1/12 of the carbon emission per seat as compared to a Boeing 777-200.[11]

Our impression of the viability of a superconducting maglev line is positive. The superconducting maglev line appears poised to compete not only with existing passenger rail providers but also airlines, forging Japan as a pioneer in the next generation of long-distance, high-speed transport.

JAPAN'S RESURGENCE

The Japanese economy is set for a reboot. Prime Minister Abe's re-election in December 2014 and the government's continued commitment to structural reform is a positive. Monetary easing by the Bank of Japan to break the deflationary cycle continues to provide additional stimulus to the economy. Also, Japan is experiencing a major increase in inbound tourism driven by a weaker yen and the governmental easing of visa policies. Anticipated restarts of nuclear reactors will reduce the country's dependence on imported fossil fuels and its trade deficit, while also decreasing electricity costs for residential and industrial users. Additionally, approval of a superconducting maglev line anticipates the future of high-speed travel by investing in advanced technology to create a commercially and environmentally viable intra-Japan transport model.

Although the effects of twin natural disasters still resound four years later, the response of an orderly and progressive Japanese culture have helped the country emerge from the devastation. Confidence in the economy, as was shown with Prime Minister Abe's re-election in December, and forward momentum in both the power and transportation sectors bode well for Japan's ability to meet both current and future needs.

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[1] http://www.livescience.com/39110-japan-2011-earthquake-tsunami-facts.html*
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[6] "Japan court battles could delay nuclear restarts further", Thomson Reuters, March 5, 2015.
[7] "Japan's Nuclear Policy", Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI) Japan, February 2015.
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[10] "MAGLEV: The New Mode of Transport for the 21st Century", James Powell and Gordon Danby, 21st Century Science and Technology Magazine, Summer 2003.
[11] Central Japan Railway Company Fact Sheets, 2014.
Cover image is of Tokyo Station.

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