



## Executive Summary

# Lessons Learnt from the Triple Disaster in East Japan

### Main proposals and messages

#### **Balancing Japan's Energy and Climate Goals: Exploring Post-Fukushima Energy Supply Options – Report of the Disaster Study Project**

The study demonstrates that transitioning from a fossil-fuel nuclear dominated energy mix to a renewable energy dominated fuel mix is economically feasible and environmentally attractive as the country can achieve an 80% emission reduction at a limited increase in energy system costs. Japan's target of an 80% emission reduction can be achieved with a fuel mix that comprises a higher share of alternative energy sources, advanced energy efficiency technologies and economically viable carbon capture options.

#### **The Power-saving behavior of the residential sector in the wake of the Great East Japan Disaster**

Since the Great East Japan Earthquake, in the region served by Tokyo Electric Power Company (TEPCO), there was an approx. 11.8% reduction (temperature adjusted) in electric power usage in households during summer 2011 (July and August) compared with the preceding year, against a goal of a 15% reduction in power usage. A questionnaire on energy consumption in the household sector conducted in January 2012 in Kanagawa Prefecture, which is served by TEPCO, revealed variations in the actions taken by energy consumers to conserve power depending on gender, age group, size of household, and other factors. To encourage more energy conservation among a broad range of age groups it is important to recommend the most effective methods suited to such households.

#### **Reconsidering Resilience: Vitalisation of Inter-municipality Collaboration in Northeast Japan Earthquake**

During the Great East Japan Earthquake, disaster area aid activities by local governments and communities to compensate for the inadequacies in existing disaster countermeasures displayed swiftness of action and the flexibility to respond to a wide range of needs. It will be important, going forward, for cooperation among local governments to complement the vertical aid provided by the national government. It will also be important to strengthen the coordination functions among the local governments in disaster areas and among those providing aid, to ensure that effective support for disaster areas is carried out.

## I Introduction

On March 11, 2011 a deadly succession of an earthquake, tsunami, and nuclear power plant accident led to damage of a catastrophic level being wreaked over a vast expanse of land, concentrated on the northeastern coastal prefectures of Miyagi, Fukushima, and Iwate. Many of the coastal cities, towns, and villages were decimated, bringing local economies to a standstill and the loss of many jobs, homes, property, families and friends. The death toll from the disaster one year later stood at 15,854 (28 March, 2012; National Police Agency). Operations at the nuclear power plants in Fukushima were shut down as a result of this disaster, plunging the entire Kanto region into a power shortage. Businesses had to scale back operations, and households were forced to save power in the face of planned blackouts. The power shortages left post-earthquake Japan with a disjointed economy and society. In order to suppress any such future impacts on the economy and society caused by another major earthquake, we need to formulate appropriate energy policy measures fit for the task. In the societal aspect as well, it is imperative to obtain a clear picture of the needs of those in disaster areas and to construct frameworks that enable a rapid return to stable lifestyles and commerce. It is necessary, via the recovery from this earthquake disaster, to effect a transformation in economic and social systems toward ones that are strong in the face of disasters—to lessen or avoid their impact altogether, with a focus on mitigation to minimise the damage during a disaster.

In April 2011, IGES commenced research on the March 11 earthquake to ascertain what sort of measures and policy approaches would be effective in helping to build a resilient society that is strong in the face of disasters—and to speed up recovery from the destruction wrought by this earthquake. This research aims to

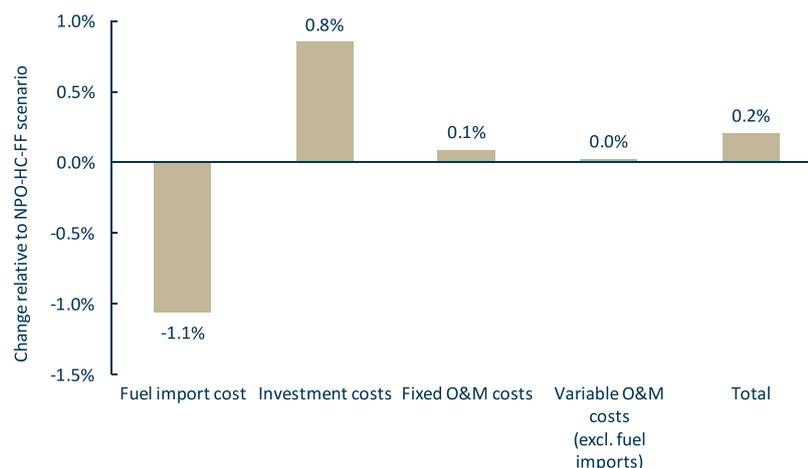
review existing energy resources to help ensure a stable supply of energy in Japan, explore solutions (energy-saving actions) that can be implemented at the grass-roots level to limit energy demand, and make policy recommendations through an examination of methods of avoiding or mitigating earthquake risks and rapid recovery measures after an earthquake. To achieve this, a research study was conducted on the following three themes: 1. An analysis of the long-term energy supply options available to post-Fukushima Japan in consideration of Japan's energy mix and greenhouse gas reduction targets; 2. An examination of regional policy measures on effective energy usage learnt from actual emergency energy-saving conditions after the earthquake; and 3. Suggestions for cooperative structures among local governments toward the construction of a society that is resilient to disasters. The results of this research and the associated policy recommendations posit important implications not only for the rapid recovery from the recent Great East Japan Earthquake, but also in exploring an ideal global societal system that is resilient against disasters.

This report was created based on the results of the research study on the above three themes conducted as part of earthquake research. It is hoped that this report will not only raise awareness of disaster prevention but also energy-saving efforts in households and businesses to enable a stable and continuous supply of energy essential for the economy and society at large. It further aims to raise awareness, from a global perspective, of the importance of constructing networks that are indispensable to post-earthquake recovery and in the creation of sustainable societies that are disaster-resilient. The key research results and recommendations from each research theme are given below.

## 2 Balancing Japan's Energy and Climate Goals: Exploring Post-Fukushima Energy Supply Options – Report of the Disaster Study Project

This chapter assesses the implications of a long term phase-out of nuclear energy supply in Japan toward 2050 and its replacement with renewable energy—unhindered by the technical aspects of intermittency. It is assumed

that there will be no new commissioning of nuclear power plants and mandatory decommissioning of old power plants at the end of their 40 life. This study performed two sets of modelling analyses using the technology driven



Note: the numbers under each category in the figure are the percentage changes of a particular cost component. Therefore, simple addition of the percentage values for individual cost components does not obtain the total percentage change.

**Figure 1 Analysis I. Discounted total energy system cost for 2010-2050 for the renewable energy promotion (NPO-REN) scenario relative to the fossil fuel-dependence (NPO-FF) scenario by component.**

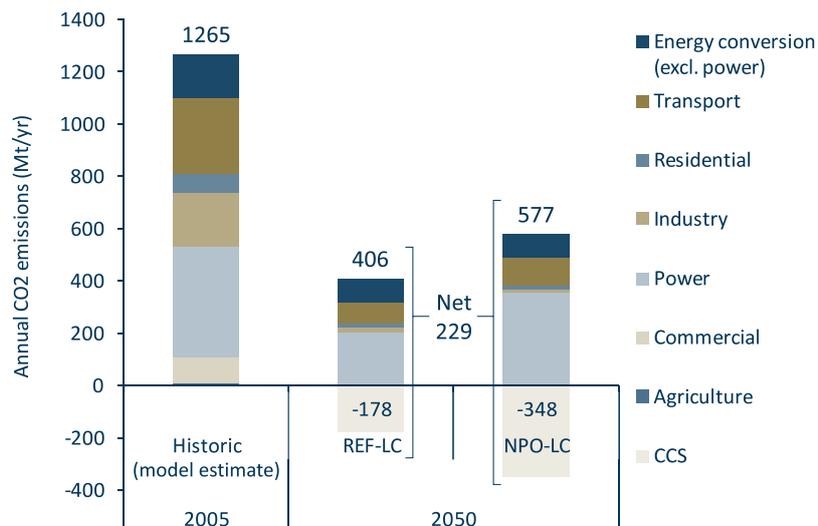
bottom-up TIMES Integrated Assessment Model (TIAM-WORLD). The indicators used for the comparison are: (1) total energy supply system cost, (2) amount of fossil fuel imports, and (3) CO<sub>2</sub> emissions.

The first analysis (Analysis I) assessed the implications of the choice of energy source: renewable energy or fossil fuel, to compensate for the nuclear power phase-out by 2050. In Analysis I, the renewable energy promotion (NPO-REN) scenario and the fossil fuel-dependence (NPO-FF) scenario were compared in the absence of any long-term GHG target but with same amount of CO<sub>2</sub> emissions, with a view to highlighting the difference between the two options for energy source choice. The results showed that the renewable energy promotion scenario is only 0.2% more costly than the fossil fuel-dependence scenario in terms of discounted total energy system cost for 2010-2050. The increase in annual total energy system cost for the renewable energy promotion scenario compared to the fossil fuel-dependence scenario is on average 0.04% of national GDP. Moreover, the renewable energy promotion scenario also showed significantly lower fossil fuel imports, which increases the national wealth to a value approximating the total increase in system cost.

The second analysis (Analysis II) investigated the

scenario with mid- to long-term GHG emissions reduction targets (80% reduction of CO<sub>2</sub> emissions in 2050 compared to 1990 level) and a nuclear phase-out by 2050. The results show that in the nuclear phase-out (NPO-LC) scenario, wind and solar power plants are installed to the capacity limit of 80 GW and 176 GW, respectively. Final energy consumption was found to drop by nearly 35%, from about 310 Mtoe in 2009 to 200 Mtoe in 2050, which was similar to that for the scenarios without GHG targets. The major part of final energy consumption needs to be shifted from primary fuel to electricity with CCS to meet the 80% target. Without the use of nuclear power this points to the necessity of large-scale deployment of CCS to achieve the 80% target, as the additional need for CCS in the nuclear phase-out scenario was projected to be 170Mt/yr in 2050 higher compared to the pre-Fukushima nuclear development scenario (REF-LC scenario). The increase in discounted total energy system costs for 2010-2050 for the NPO-LC scenario compared to the REF-LC scenario was found to be 1%. In annual terms, the average energy system cost increase was found to be about 0.13% of national GDP.

The study demonstrates that transitioning from a fossil-fuel nuclear dominated energy mix to a renewable energy dominated fuel mix is economically feasible and environmentally attractive as the country can achieve an



**Figure 2 Analysis II. Breakdown of CO<sub>2</sub> emissions in 2050 for the scenarios with mid- to long-term CO<sub>2</sub> emissions reduction targets. Historic emissions data for 2005 is also given for reference.**

80% emission reduction at a limited increase in energy system costs. Japan’s target of an 80% emission reduction can be achieved with a fuel mix that comprises a higher share of alternative energy sources, advanced energy efficiency technologies and economically viable carbon capture options.

Based on the results obtained, the following recommendations are highlighted in order to ensure long term energy security while meeting the environmental goals.

It is critical to promote investment for building CCS facilities, which requires the government to take the initiative and set up a long-term plan for CCS technology development and deployment. It is also necessary to develop alternative energy technology, to promote regulatory and institutional reform in the power sector, and to require implementation of policy tools such as the Feed-In Tariff scheme. At the same time, a shift from coal to natural gas and further control of energy demand are also needed to reduce the heavy reliance on CCS.

### 3 The Power-saving behavior of the residential sector in the wake of the Great East Japan Disaster

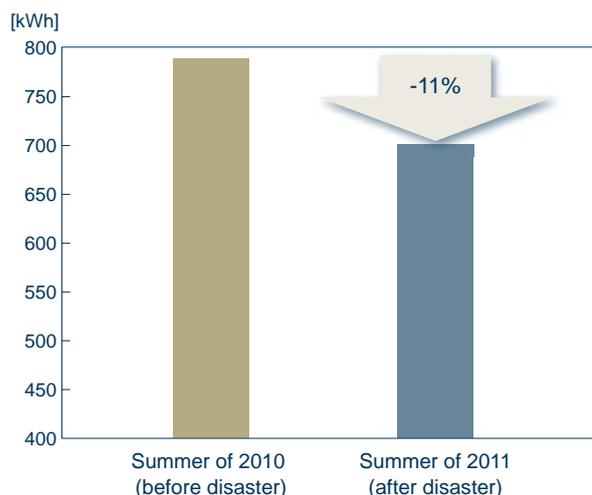
The power shortfall brought about by the Great East Japan Earthquake and its secondary disasters had a substantial impact on Japan’s economy and society, including suppressed business and compulsory energy-saving efforts in households. These occurrences not only served to stimulate debate on energy policy measures in Japan, but also spurred a transformation in actions and awareness across all energy consumers. In the heavily energy-dependent household sector, in particular, it has constituted a wake-up call of sorts. It is important to incorporate the behavior patterns of energy consumers, including the household sector, and reforms of social infrastructure to enable energy-saving measures to be taken, in the formulation of a new energy strategy for Japan.

This research compiles recommendations on the appropriate orientation of continued and efficient energy consumption lifestyles from an assessment of the actual conditions of energy usage in the household sector in Kanagawa Prefecture. To achieve this, a survey was conducted of 1,000 married citizens in Kanagawa Prefecture in January 2012 via the Internet. The research compiled recommendations to contribute to energy-saving measures based on the actual conditions gleaned from this internet survey.

According to the trends in power sold in the area served by TEPCO, it was reported that there was an approx. 11.8% reduction (adjusted for temperature

differences; the target was a 15% reduction) in electric power usage in households during summer 2011 (total for July and August) compared with the preceding year. To compare this figure, the summertime energy-saving effect per household in Kanagawa Prefecture was calculated. The result, as shown in Figure 3, reveals that an 11.0% energy saving compared with the previous year was also obtained in Kanagawa Prefecture, which agrees with the year-on-year reduction in power sold in the area served by TEPCO. The quantity of power saved by each household during summer in Kanagawa Prefecture was approximately 87 kWh, and estimating the total energy-saving effect for all households in the prefecture based on this figure gives a power saving of 328 GWh during the two-month period of summer 2011. However, in and after October when the energy-saving campaign ended the energy-saving effect began to decline, partly because air conditioner usage times decreased. In terms of age groups, the rate of energy-saving was large for the 50–60 age group, but low for the 20–30 age group (almost half), thus appeals to the younger group will be important in further promoting energy-saving measures in the future.

Variations are seen in the power saving efforts of energy consumers due to gender, age group, size of household, and other factors. In order to encourage energy-saving among a broad range of age groups it is important to disseminate, permeate, and establish more appropriate modes of usage that produce the maximal effect through the combined effect of small efforts by all. The most effective means of doing this is by expert-led public awareness-raising, the content of which would be based on the household and numerical data contained in this research with specific focus on identifying target age groups. Moreover, new means of energy efficiency can be obtained through dissemination and establishment of household energy-saving practices that have emerged



**Figure 3** Year-on-year change in power use per household in summer (July-August; N = 961)

since the earthquake. Replacing appliances with more energy-efficient models improves lifestyle comfort, but has an economic effect for households because most of the initial investment in such appliances can be recovered. In light of the actual energy usage situation in households, there is a need for information provision and mechanisms to encourage the actions of consumers. Providing economic incentives, such as subsidies, and disseminating information regarding cost-benefit analyses of energy-saving investment would help permeate a more favorable mindset geared towards saving energy.

Due to variations in energy consumption in different households and age groups, as well as at different times of the year, it is also important to identify what energy-saving information is appropriate, and tailor such for a target group. Formulating policy to clarify energy consumption features, approaches to find specific policies for local governments and municipalities, and assessment schemes after policy implementation, etc, would establish such initiatives and pave the way for households to set into motion appropriate energy-saving lifestyles.

## 4 Reconsidering Resilience: Vitalisation of Inter-municipality Collaboration in Northeast Japan Earthquake

As an earthquake-prone country Japan has suffered numerous natural disasters since ancient times and has drawn upon this past experience to set in place disaster prevention and disaster response measures. However,

the Great East Japan Earthquake of March 2011, together with the massive tsunami and catastrophic nuclear power plant accident that followed, inflicted damage in many sectors over an extensive area. Therefore,

an awareness is spreading that it is not only necessary to establish hardware and systems to prevent disasters but also to strengthen resilience against disasters to enable rapid recovery and reconstruction.

The Japanese government has historically instituted measures categorised by the type of disaster, rules on the application of laws to promote mutual support agreements (cooperation frameworks) between regional governments, and other related aid measures and implementation plans. The cities, towns, and villages in each metropolis and prefecture have also formulated regional disaster prevention plans that include necessary post-disaster actions and mutual support agreements with other local governments. During the Great East Japan Earthquake as well, the disaster countermeasures of the national and local governments that were already in place were put into effect, and at the same time intensive support activities were carried out to compensate for any inadequacies in the existing disaster countermeasures. Regional governments and local communities in particular were noteworthy for the speed of their support and the flexibility in meeting a broad range of needs in the relief and recovery stages. This study looks at cases of actual aid provided to disaster areas during the Great East Japan Earthquake and recommends policy measures that would enable more effective disaster area support.

Carrying out effective disaster area support through cooperation among local governments requires coordination between the disaster-struck local governments and the aid-providing ones, which can be classified into: 1) the central government playing a major role (fire-fighting, police), 2) existing national-level coordination organisations assuming coordinating functions during disasters in liaison with the central government (water and sewage, staff dispatches from local governments), 3) mutual support agreements among local governments during disasters, and 4) autonomous aid activities by local governments carried out immediately after a disaster.

It is naturally preferable for aid to the disaster areas to be provided quickly after a disaster occurs, to be flexibly aligned with the diverse needs of the disaster area, and to be carried out in a sustained manner until the disaster area is well on the road to recovery. To meet these conditions coordination at three stages is required: 1) “twinning” (pairing disaster-hit local governments with aid-providing ones), 2) coordinating the services and supplies sought in the disaster area with that available on the supplier side, and 3) coordination to enable sustained support by lightening the burden on the aid-providing side. This study examined the prerequisites for coordination at these three stages to be effectively carried out, as well as the hurdles that were faced, based on an examination of aid activities witnessed after the Great East Japan Earthquake. Aid to disaster areas is fundamentally provided from the national government, but this sort of vertical aid by itself may not be fast enough or suit the actual conditions on the ground. To complement such aid, horizontal cooperation among local governments is required (refer to Figure 4).

Finally, considering the coordination functions at the three stages required for disaster area support, the following five recommendations are given to ensure that speedier, more flexible, and more sustained aid activities are provided during future disasters. The recommendations are: 1) promotion of mutual support agreements with stakeholders (private businesses, citizen groups) other than local governments, 2) establishment of mutual support agreements with a broad geographical base of local governments, 3) creation of frameworks executable in an emergency, e.g., temporary legal flexibility, 4) strengthening of coordination functions to ensure swift cooperation, and 5) support from the national government to invigorate mutual support. The recommendations given here are thought to be applicable across the globe, and comprise regional governments equipped to provide a fast, flexible, and sustained cooperation framework during a disaster, thus forming the preconditions for recovery.

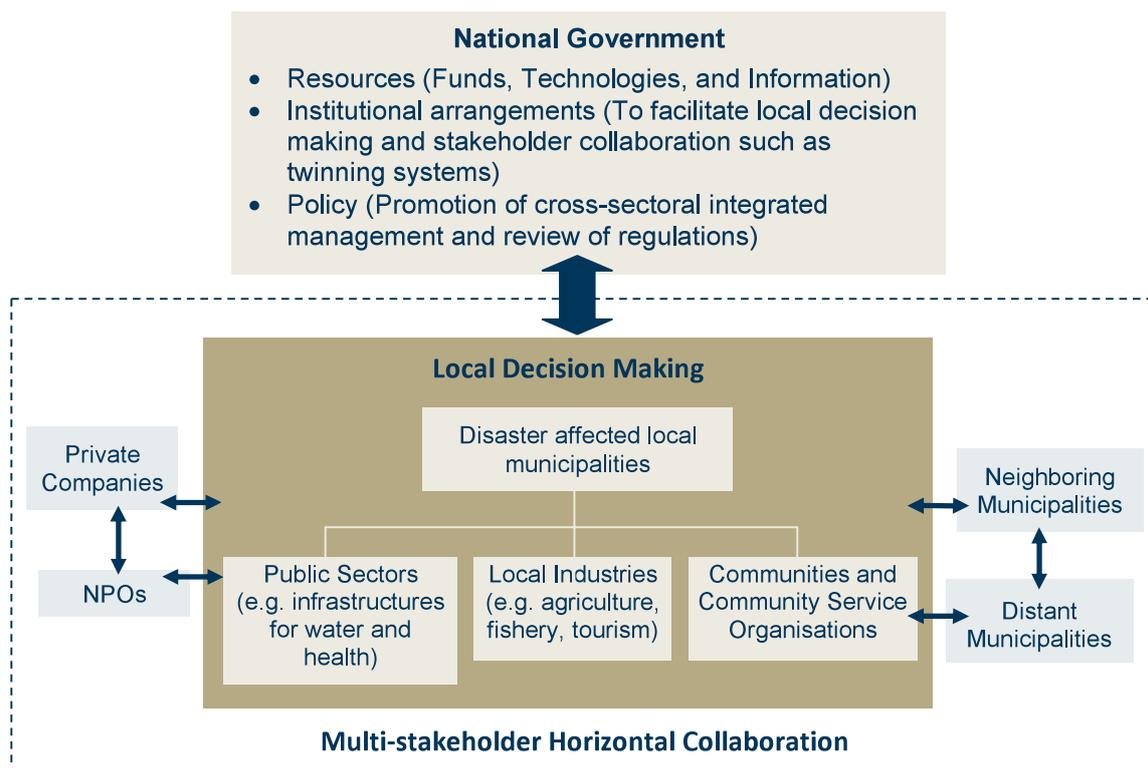


Figure 4 Flow of mutual support during a disaster

## 5 Conclusion

We have learnt many lessons from the Great East Japan Earthquake. Among these, the reconsideration of Japan’s medium- to long-term energy policy following the Fukushima Dai-ichi Nuclear Power Plant accident, which IGES selected as a research theme, is an unavoidable issue in determining the long-term picture for Japan’s future. In addition to energy supply the issue of how energy demand can be controlled going forward is also important in respect of medium- to long-term energy policy measures. Furthermore, it is crucial to strive to create a resilient and sustainable society that incorporates further disaster mitigation and prevention measures to prepare for major disasters that are bound to occur in the future.

Japan’s future energy mix will be substantially influenced by the formulation of energy policy measures based on changes in the nuclear power industry and targets set for long-term climate change countermeasures. Achieving greenhouse gas reduction targets and responding to energy demands while phasing-out nuclear power generation will require considerable

policy accommodation to strengthen the energy sector. Policy measures are likely to include the establishment of organisational mechanisms for promoting renewable energy, promotion of effective demand-side management, improvement of the country’s energy system for the integration of standards, and the integration of energy plans at the regional and national levels.

Regarding energy usage, as Japan’s nuclear power plants have had to be taken offline in succession for testing and inspections since the Fukushima Dai-ichi Nuclear Power Plant accident on 11 March, 2011, with power generation at all 54 nuclear power plants (including the four defunct Fukushima nuclear power plants) suspended on 5 May, 2012, the country is still faced with the need to greatly suppress its energy demands. Saving power in the diverse household sector is complex, but policy measures that take account of differences among age groups, household sizes, and other unique characteristics of energy consumption, as well as consideration of effective local government measures

and assessment of any policy that is implemented will be key issues Japan will have to face.

Although this study focused on mechanisms for mutual support witnessed in the one year period following the Great East Japan Earthquake, there is a need to further consider mechanisms that are not influenced by the conditions of each group long-term for aid that represents a growing burden on the aid provider as well. There are also support issues, which couldn't be covered in this paper, that are relevant in Japan and overseas, stemming from the experiences of the Great East Japan Earthquake. For instance, as the role played by local governments is limited in terms of financial assistance under the existing system, it will be very important to consider initiatives to respond to urgent

funding demands in the future. It is also preferable to spread cooperation and partnerships abroad as well as domestically (regional governments, employers, medical groups, NGOs, etc.) going forward. Moreover, there are likely cases in developing countries where international organisations and international NGOs have the potential to support mutual aid.

It is hoped that Japan's experiences in the Great East Japan Earthquake, the earthquake research of IGES in light of Japan's experiences, and the recommendations based on these will reach as wide an audience as possible. It is also hoped that this research will be a notable addition toward building a sustainable society that is resilient in the face of disasters and that incorporates disaster mitigation and prevention measures.

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