

## EXTENDED ABSTRACT

### **Energy security in Japan in the context of a planned energy system transition**

BY

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The purpose of this thesis is to assess the impact of energy policies and institutions on Japan's energy system in order to identify current energy security issues as well as assess the outlook for energy security in the future. A major premise is that energy security is a function of policy, technology/infrastructure and institutions. While many studies of energy security have examined policies and technologies, relatively few have systematically examined the influence of institutions on energy security. Yet institutions exert a strong influence on how policies are articulated, interpreted and implemented and how the energy system itself evolves and changes.

This thesis uniquely combines an energy security assessment with an institutional analysis to provide the most comprehensive assessment of energy security and change in Japan's energy system since the Fukushima disaster. A novel analytical framework for energy security assessment is developed based on three properties (i.e.: robustness, resilience and adaptability) of a secure energy system. This study also provides the first in-depth analysis of the government's 2014 Strategic Energy Plan arguing that it represents a plan for a major energy transition. A framework for analysis of Japan's energy institutions integrates various institutional and related theories to provide a detailed analysis of the institutional structure for energy and to explain recent changes and the implications for Japan's energy security. Unique insights into the development of Japan's strategic energy plans and energy policymaking were made possible by supplementing the analysis with primary data gathered from interviews with senior government officials.

Energy security has been the fundamental driver of Japan's energy policy since the oil shocks of the 1970's and plays a central role in Japanese energy policy. The Japanese government has historically taken a strong role in regulating the energy sector given the importance placed on stable and reliable supplies of energy to support economic development and trade. Japan views itself as facing a wide range of potential threats to its energy security and virtually no other industrialized economy is as dependent on imports of energy resources as Japan. The shock of the Great East Japan Earthquake, tsunami and nuclear disaster of March 11, 2011 dealt a severe blow to Japan's energy system with far-reaching consequences for Japan's energy security. This "triple disaster" provoked a fundamental review of Japanese energy policy and energy institutions, resulting in a series of policies and plans that are reshaping the structure and future evolution of Japan's energy system.

The central research question for this thesis is: **how do energy policies affect energy security in Japan?** This question can be further broken down into the following related issues:

- in terms of vulnerabilities to threats and risks facing the energy system;
- in terms of strategies to reduce vulnerabilities;
- in terms of the relationship with other policy objectives;
- in terms of institutional change;
- in terms of the potential impact on energy security in the future.

This thesis therefore seeks to fill a gap in scholarly studies of energy security regarding the impact of energy policies and institutional change on Japan's energy security.

The research questions are answered by assessing policies and institutions in both the pre-Fukushima and post-Fukushima periods through an analytical framework that incorporates a systemic, integrated and comprehensive approach to the analysis of Japan's energy system. It is systemic because the energy system is conceptualized as a socio-technical system that co-evolves with its environment and related systems. It is integrated because an interdisciplinary approach is employed in this study, drawing from systems theory, engineering, economics, risk studies, ecological and sustainability studies, political economy, governance theory and institutional theories. It is comprehensive because it goes beyond narrow definitions of "security of supply" to include analysis of the entire energy supply-demand chain and a broader range of factors impacting on energy security. Such approaches are rarely applied in the energy security literature, which generally tends toward more deterministic conceptions of the energy system and narrow definitions of energy security.

The analytical portion of this thesis is divided into two main sections. The first section is focused on assessing energy security and energy policy in Japan between 2000 and 2013. It consists of three sub-chapters that take quantitative and qualitative approaches to analyzing Japan's energy system in order to evaluate Japan's past and current energy security situation. This analysis is presented in terms of energy security over two distinct periods: the period from 2000 to 2010 leading up to the triple disaster, and the period after the disaster between 2011 and 2013.

*Energy Security Vulnerability in Japan* focuses on identifying and assessing vulnerabilities to the threats and risks facing Japan's energy system. The results show that between 2000-2010, Japan's overall energy security situation steadily improved in all segments of the supply chain, as measured by a broad suite of indicators of vulnerability. However, the triple disaster

made some critical vulnerabilities worse and exposed new ones that posed significant challenges to Japan's long-term energy security and held important implications for policy.

*The Impact of Japanese Energy Policies on Energy Security* is focused on understanding the extent to which Japanese energy policies served to reduce vulnerabilities through their impact on energy system resilience and adaptability. The results show that between 2000 and 2010, policies and strategies served to strengthen energy system resilience and adaptive capacity, allowing the energy system to recover quickly after the triple disaster. However after the triple disaster, several indicators of energy system resilience and adaptability degraded and Japan's energy system shifted to a less desirable state with overall poorer performance and increased vulnerability.

*Energy Security and Sustainability in Japan* focuses on examining the government's energy security and sustainability (i.e.: climate change) goals and targets and evaluating the extent to which they were met. Over the 2000-2010 period Japan attempted to balance the "3-E's" of energy security, economic efficiency, and environmental suitability and aimed to achieve both energy security and sustainability objectives simultaneously. Over this period, the findings show that Japan's energy security situation generally improved but a number of key policy targets and objectives were not met. The triple disaster dealt a major blow to the balanced approach to energy policy as energy security and economic efficiency concerns took precedence over sustainability goals as the government sought to protect the economy.

The *Outstanding Issues and Vulnerabilities* sub-chapter summarizes the impact of Japanese energy policies on energy security up to 2013 and identifies and discusses ten energy security vulnerabilities and concerns that remain outstanding in the post-Fukushima period. These include issues related to nuclear power adequacy, low levels of renewables generation, lack of competition in electricity and gas markets, decline in support for nuclear power, inadequate inter-regional electricity and gas interconnections and exchange, electricity frequency conversion bottlenecks, weak demand-side management strategies, regulatory quality issues, and over-investment in electricity and gas infrastructure capacity.

The second section in this thesis consists of two sub-chapters that analyze institutions and institutional change in order to assess the potential impact on Japan's energy security in the future. The first sub-chapter, *Japan's 2014 Strategic Energy Plan: A Planned Energy Transition*, is focused on analyzing and evaluating the government's 2014 Strategic Energy Plan (SEP) in order to understand the nature and magnitude of the changes planned for Japan's energy system and related institutions. The analysis demonstrates that the shock of the triple disaster opened up a window of opportunity in Japan's policy environment for fundamental changes in Japan's energy policies, allowing for major reforms to the energy

industrial structure and energy institutions. Given the nature and magnitude of the potential changes implied in the SEP, it is concluded that the 2014 SEP represents a major planned transition of the Japanese energy system.

The second sub-chapter, *An Institutional Analysis of the Japanese Energy Transition*, examines the institutional structure of Japan's energy sector, the changes that have been taking place within it, and the impact of Japanese government policy reforms on the energy sector. The analysis shows that while Japan's energy institutions evolved and changed incrementally between 2000 and 2010, the triple disaster represented a critical juncture in the path of Japan's energy system development, overturning several policy paradigms and provoking major institutional and structural changes in Japan's energy sector. The empirical evidence in this section demonstrates that these changes are consistent with the objectives of the 2014 SEP and suggests that government commitment to fundamental change appears strong. It is therefore concluded that the major energy transition implied in the 2014 SEP has already begun.

The period immediately following a critical juncture is crucial in terms of determining the future path of energy system development. The Japanese energy transition is still in a very early stage as the impacts of various policies and reforms gradually work their way through the energy sector. Developments over the 2016-2020 period are seen as crucial to setting the course and deepening the path of the transition. As momentum for change has accelerated and the effect of more dramatic market and structural reforms have become more evident, energy sector governance in post-Fukushima Japan is evolving to reflect the growing influence of competitive markets and a broader array of energy actors and institutions.

The analysis in this thesis strongly suggests that the policies and institutional changes that have been proposed for reforming Japan's energy sector in the post-Fukushima period are likely to help further reduce energy security vulnerabilities and address outstanding issues as long as they are fully and effectively implemented. Japan appears to be moving toward a more robust, reflexive form of energy governance that prioritizes adaptability and economic efficiency over the emphasis on predictability and stability of the past. While the future is uncertain and unexpected events and developments are sure to occur, the results presented in this thesis suggest that Japan has taken firm steps toward enhancing its energy security for the future.