8. International Grid Interconnections and Energy Security

8.1. The Concept of Energy Security

One justification often noted for international electricity grid interconnection is that they can, depending on how they are configured, improve energy security in the interconnected countries. "Energy Security" has typically, to those involved in making energy policy, meant mostly securing access to oil and other fossil fuels. With increasingly global, diverse energy markets, however, old energy security rationales are less important, and other issues, including climate change, other environmental, economic, social, and political considerations are becoming increasingly important. As a consequence, a more comprehensive operating definition of "Energy Security" is needed, along with a workable analytical framework for assessing which of many possible energy paths or scenarios—including those both with and without grid interconnections or similar international projects—yield greater energy security for the areas considered[149].

Many of the existing definitions of energy security begin, and usually end with a focus on maintaining supplies of energy, particularly oil. This focus has as its cornerstones reducing vulnerability to foreign threats or pressures, preventing a supply crisis from occurring, and minimizing the economic and military impact of a supply crisis once it has occurred. National energy policies today are being challenged on multiple fronts. The substance of these challenges needs to be incorporated into a new, broader concept of energy security. Current National and international energy policies have been facing many new challenges, and have at their disposal new tools, that need to be considered as key components of new energy security concepts. At least five key components—environment, technology, demand side management, social and cultural factors, and post-Cold War international relations—are central additions to the traditional supply-side point of view.

Considering the addition of these concepts, a new definition of Energy Security is as follows:

A nation-state is energy secure to the degree that fuel and energy services are available to ensure: a) survival of the nation, b) protection of national welfare, and c) minimization of risks associated with supply and use of fuel and energy services. The five dimensions of energy security include **energy supply**, **economic**, **technological**, **environmental**, **social and cultural**, and **military/security** dimensions. Energy policies must address the domestic and international (regional and global) implications of each of these dimensions.

149 Some of the text for this Chapter was derived from D. Von Hippel (2004), "Energy Security Analysis, A New Framework", p. 4 to 7 in *reCOMMEND*, "A Newsletter of the Community for Energy, Environment, and Development", Volume 1, Number 2, December, 2004, available as *http://forums.seib.org/leap/reCOMMEND/reCommend2.pdf*. The summary provided here and included in the *reCOMMEND* article was based on work done as a part of the Nautilus Institute's "Pacific Asia Regional Energy Security" project (PARES), which had as its goals to propose a consensus definition of "energy security", develop an analytical framework to address energy security dimensions of choices in energy sector development, prepare illustrative medium-range energy "paths" for Japan (1995 to 2020), evaluate the energy paths against a suite of energy security criteria using the framework, and review the results for applicability to other countries of the region. Available from Nautilus Institute at *http://69.44.62.160/archives/pares/PARES_Synthesis_Report.PDF*.

What distinguishes this energy security definition is its emphasis on the need to consider extra-territorial implications of the provision of energy and energy services, while recognizing the complexity of actualizing (and measuring) national energy security. The definition is also designed to include emerging concepts of environmental security, which include the effects of the state of the environment on human security and military security, and the effects of security institutions on the environment and on prospects for international environmental cooperation.

8.2. Dimensions of Energy Security

Some of the possible dimensions, measures, and attributes of energy security, as broadly defined above, are summarized in Table 8-1. Grid interconnections will or can affect virtually any or all of these dimensions, as the discussion in the previous Chapters in this Report has shown. As a consequence, the identification of the overall energy security benefits of any given interconnection is a complex exercise, but one that typically begins with a comparison of alternatives for providing energy services with and without a proposed interconnection project.

Table 8-1: Dimensions and Attributes of Energy Security

Dimension of Energy Security	Attributes	Interpretation
Energy Supply	Total Primary Energy	Higher = indicator of other impacts
	Fraction of Primary Energy as Imports	Lower = preferred
	Diversification Index (by fuel type, primary energy)	Lower index value preferred
	Diversification Index (by supplier, key fuel types)	Lower index value preferred
	Stocks as a fraction of imports (key fuels)	Higher = greater resilience to supply interruption
Economic	Total Energy System Internal Costs	Lower = preferred
	Total Fuel Costs	Lower = preferred
	Import Fuel Costs	Lower = preferred
	Economic Impact of Fuel Price Increase (as fraction of GNP)	Lower = preferred
Technological	Diversification Indices for key industries (such as power generation) by technology type	Lower = preferred

Dimension of Energy Security	Attributes	Interpretation
	Diversity of R&D Spending	Qualitative—Higher preferred
	Reliance on Proven Technologies	Qualitative—Higher preferred
	Technological Adaptability	Qualitative—Higher preferred
Environmental	GHG emissions (tonnes CO_2, CH_4	Lower = preferred
	Acid gas emissions (tonnes SOx, NOx)	Lower = preferred
	Local Air Pollutants (tonnes particulates, hydrocarbons, others?)	Lower = preferred
	Other air and water pollutants (including marine oil pollution)	Lower = preferred
	Solid Wastes (tonnes bottom ash, fly ash, scrubber sludge	Lower = preferred (or at best neutral, with safe re-use)
	Nuclear waste (tonnes or Curies, by type)	Lower = preferred, but qualitative component for waste isolation scheme
	Ecosystem and Aesthetic Impacts	Largely Qualitative—Lower preferred
	Exposure to Environmental Risk	Qualitative—Lower preferred
Social and Cultural	Exposure to Risk of Social or Cultural Conflict over energy systems	Qualitative—Lower preferred
Military/Security	Exposure to Military/Security Risks	Qualitative—Lower preferred
	Relative level of spending on energy-related security arrangements	Lower = preferred

8.3. Potential Impacts of Grid Interconnections on Energy Security

International electricity grid interconnections can have impacts on—that is, provide costs and/or benefits in—each of the dimensions of energy security described in Table 8-1, and probably many additional dimensions as well. Table 8-2 provides just a few examples of how grid interconnections might provide benefits, and incur costs or risks, in each of the dimensions described. Note that these examples are neither exhaustive nor necessarily likely to occur in any given interconnection project. What is clear, as was noted above, is that the impacts of a grid interconnection on energy security may be quite complex, and that any given interconnection project, evaluated from a particular national point of view, will require trade-offs between the different dimensions of energy security. Further, a review of all of these dimensions is necessary to determine whether a nation and its people are likely to be more energy secure with or without the grid interconnection project.

Table 8-2: Examples of Potential Energy Security Benefits and Costs of Grid Interconnections

Dimension of Energy Security	Interconnection Benefits	Interconnection Costs/ Risks
Energy Supply	Improved electricity supply	Higher energy imports and increased import dependence
	Diversification of energy supply sources	Dependence on reliability in the interconnected system
	Diversification in fuel imports	Obligation to export resources
	Improved reliability of electricity supply	
Economic	Lower costs of fuel, capital expenditures for importing country (or both partners, in some exchanges)	Additional costs of infrastructure for interconnection
	Earnings from power sales through interconnection (foreign exchange)	Additional costs for generation and other infrastructure in exporting nation
	Indirect economic benefits of less expensive, more reliable electricity (education, jobs, health care, re-spending of cost savings)	Foreign exchange outlays and indebtedness for infrastructure investments
	Cost savings through substitution of electricity for other fuels (lamp oil, batteries)	Exposure to energy price volatility on international markets and/or to terms of "locked-in" contracts
	Economic interdependence	Economic interdependence
Technological	Improvement in power quality	Exposure to risk from poor power quality in interconnected nations
	Exposure to new technologies that can be replicated to improve power system	Exposure to risk from use of new technologies

Dimension of Energy Security	Interconnection Benefits	Interconnection Costs/ Risks
	Reliance on Proven Technologies for generation and transmission	Risk of being obligated to continue use of an older technology as newer, cheaper, more flexible technologies become available (lack of future adaptability)
Environmental	Reduced emissions of air pollutants of local, regional, and/or global significance	Increased emissions of air pollutants of local, regional, and/or global significance Lower = preferred
	Reduced water pollution, solid wastes due to avoided generation, fuel storage, other fuel cycle activities	Increased water pollution, solid wastes due to additional generation, fuel storage, other fuel cycle activities, construction impacts
	Reduced ecosystem and aesthetic impacts through avoided construction of new generation	Increased ecosystem and aesthetic impacts through construction of power lines, new generation plants, construction/ operation of facilities in previously isolated areas
	Reduced exposure to environmental risk through avoidance of need to build new generation with uncertain environmental impacts	Increased exposure to environmental risk through reliance on big projects with uncertain, potentially diverse environmental impacts
Social and Cultural	Increased availability of medical care, education, employment opportunities through extended and/or more reliable and/or less expensive electricity supplies	Risk of social conflict if benefits of interconnection project are not shared appropriately, or if graft or other preference is perceived
	Reduced exposure to risk of social or cultural conflict by bringing cultures together to share power resources	Increased risk of internal social and cultural conflict as isolated populations are brought into contact with construction teams and others associated with the interconnection project
	Improvement of social capacity to participate in complex decision-making	Isolation of populations from traditionally-used resources; "boomtown" impacts

Dimension of Energy Security	Interconnection Benefits	Interconnection Costs/ Risks
Military/Security	Reduced exposure to international military/security risks by increasing political and economic dependence between nations	Increased exposure to international military/security risk by tying economy to inputs from another nation, thus leaving both nations vulnerable to each others' internal conflicts
	Reduced need for internal security due to social benefits of improved electricity supply (reduced unemployment, greater education)	Increased need for spending on energy-related security arrangements, such as on securing power lines