

Annex II: Defining Energy Security Factors

Energy security is not straightforward to assess. Changes in any given factor may help or hurt energy security, depending on the specific circumstances. Often it is a combination of factors that determines the overall impact on energy security. The simplifications made in this paper are meant to address the dominant concerns of energy security, but as the discussion below indicates, each evaluation is more complicated than it might appear. Recognizing these challenges, the authors propose eleven factors as components of an energy security lens.

Diversity of suppliers

Over-reliance on any one supplier or group of suppliers can be an energy security risk if supplies from that region are disrupted. Security of supply is also influenced by the relative security of a given region: political instability, economic risk, and violence are often cited as sources of supply risk, especially in places that are large reserve holders and major exporters. There is no magic number signaling adequate diversity of suppliers, but more diversity is generally thought to be better for energy security. The relative risk of depending on a supplier also depends on how easy it is to find a replacement for the fuel being supplied – fungibility and surplus capacity are key factors.

Level of Imports

No country is energy self-sufficient. Minimizing reliance on imports is generally believed to improve energy security since the reliability of the portion of energy needs that must be imported is beyond the importing country's control. However, the issue is not quite so straightforward. Imports can also be beneficial, providing resources for which there is no readily available alternative, and to the extent that they are bought and sold on a global market, there are additional security benefits because the resource can often be easily replaced by fuel from other suppliers. Global trade in energy is widely regarded as increasing global energy security. It is therefore difficult to determine an optimal level of import dependence. In addition, different suppliers present different levels and types of risks. Energy sources from regions with significant political risk, instability, or conflict may be regarded as less secure than resources from places without such risks. Moreover, countries linked by extensive physical infrastructure, such as the United States and Canada, arguably operate as a seamless market and these "imports" may be virtually indistinguishable from domestically produced products.

Security of Trade Flows

For any country reliant on energy imports, as well as for the overall security of global supplies, secure trade flows are critically important to overall energy security. Approximately 50 percent of the inter-regional global oil trade passes through only five narrow channels. If a supply disruption should occur, a functioning global energy trading system allows customers to find replacement supplies quickly. As cross-border energy trade has become more prevalent the energy transit countries (countries with energy transport infrastructure passing through their territory) have become more significant. Security of supplies and the ability to bring supplies to market depend upon the capacity and willingness of these countries to ensure energy transit across their borders.

Geopolitics and Economics

International economic and political factors in a nation or region are increasingly important when discussing the flow of money from energy- (mainly oil-) consuming nations to energy-exporting nations, and raise additional concerns regarding the rise of major new economies with growing appetites for energy. The geopolitical dynamics of energy pit countries which control energy resources against countries which need energy resources (and increasingly regions whose territory serves as a thoroughway for energy supply infrastructure). The implications of the trends are not straightforward. In particular, it is difficult to identify what leverage producer nations have over consumer nations (given their mutually dependent but possibly asymmetric relationship) and what relative gains in economic strength mean in political terms. For the past twenty-five years, major global energy consumers have advocated the Western-based principles of a free market system for governing energy development and trade. To the extent that major global producers and consumers act in ways that are contrary to the long-held principles of open and efficient markets, their actions may undermine global energy security.

Nuclear Proliferation

In general, proliferation risk is measured by who has access to fissile material or the means to produce it, and the capability to create nuclear weapons. It is impossible to forecast whether the world's future non-proliferation system will be robust. However, next-generation nuclear technologies may be less prone to proliferation. For the purposes of analyzing this factor, we will interpret an increase in the absolute quantity of nuclear in the overall energy supply mix to indicate an increased proliferation risk, and discuss in detail the policies and technologies needed to manage this risk in the findings and conclusions section.

Diversity of fuels

Over-reliance on any one source of fuel, even those that are renewable or domestically produced, increases the chance of widespread economic impact in the event of a shortage or disruption in supply. However, over-diversification without possibility for supply substitution or the existence of infrastructure capable of handling a diverse fuel supply can also be problematic and costly.

Market/Price Volatility

Price volatility discourages long-term investment due to the uncertainty of the long-term direction of the market. Volatility is critically important and a potentially troublesome aspect of energy security going forward. To the extent that the energy system is undergoing a transformation both in terms of physical structure and market dynamics, energy reliability and energy price volatility could be increasingly problematic.

Affordability/Economic Impact

The relative affordability of energy is a critical component of energy security. While costs of technologies are relatively straightforward to assess, the overall impact of their deployment

on consumers and the economy is less clear. For the purposes of this exercise, affordability is measured in total cost of the scenario (undiscounted) in 2035.

Energy Intensity

If demand reduction is accompanied by strong levels of economic growth, this would indicate that the economy is more insulated from the negative effects of energy price fluctuations. In particular, improvements in oil and natural gas intensity indicate a decrease in the economy's reliance on those fuels. However, it should be noted that a decrease in energy consumption due to demand reduction driven by high prices would not reflect an overall improvement in security.

Reliability

Energy reliability is often measured in terms of outages or shortages in electricity availability, but concepts of reliability vary widely around the world. Developed country expectations for reliability are fundamentally different than in places where energy is routinely only available during certain times of day or under special circumstances. Aging, neglect, disruptions to physical infrastructure, or mismanagement have adverse impacts on energy reliability. Anticipating future levels of reliability is difficult, especially when new infrastructure and technologies are expected to be brought on line.

Feasibility

Future technology growth plans may require technological improvements or deployment levels that seem difficult, if not impossible, to achieve. These perceptions are based on current information regarding constraints on resources, materials, and human capital, as well as expectations about the feasible pace and scale of deployment and historical rates of technological improvement. It is difficult to assess the feasibility of different scenarios without knowing what might be possible in the future. Without pushing the envelope, society may never reach what is ultimately possible, but pushing too hard for certain technology outcomes without proper contingency plans could lead to unaffordable and unreliable energy supplies. For instance, power sector planners are counting on advances in waste management technologies in order to deploy significant amounts of nuclear power. If policy makers push for these advances but fail to hedge this strategy adequately by investing in advances in renewables, CCS, and other low-carbon power generation options, the low-carbon power technologies deployable in the event that these advances do not materialize may be inadequate to meet growing energy demand.