

## Energy Security: Applying a Portfolio Approach

By *Kevin D. Stringer*\*

With oil prices skyrocketing to new levels, and the demand for energy increasing at a pace commensurate with the rapidity of globalization, energy access and supply take on a critical dimension for the national security of all states. The topic of energy access is also closely linked to climate change issues through the release of carbon dioxide (CO<sub>2</sub>) gas into the atmosphere and the aspirations of developing countries to achieve economic growth through increased consumption levels. Given its weighty consequences for the future, the subject of energy security now finds itself as a common theme on the curricula, research menus, and agendas of most military institutions of higher learning, international security think-tanks, and ministries of defence.

Teaching or discussing this topic with military officers or diplomats requires a simple methodology to conceptualize energy security at the state level as well as to provide a basic understanding of the key concepts and definitions. With such an approach, non-energy experts can then derive general ideas or conclusions for new directions in energy policy.

With such a goal in mind, this article explores the topic of energy security education by: defining energy security; highlighting the trends and challenges that will vex countries in the next few decades; and proposing a portfolio approach from the banking and finance world for conceptualizing this issue at the state level. Within the portfolio approach, the principles of both source and supplier diversification are explained, and then applied to case examples taken from Asia and the Baltics to illustrate how this simple model can aid in the discussion and development of policy options and ideas for national decision-makers. The conclusion shows that while the portfolio model is useful for a general overview to energy security, the approach does have limitations for addressing the theme comprehensively.

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## 1. Energy security defined

The modern idea of “energy security” emerged in the nineteenth century as warfare became mechanized and began to require substantial fuel inputs, first as coal for warships and trains (Bucholz, 1994:53-70). The decision of the British Admiralty prior to the First World War to switch from coal-fired to oil-fired vessels marked the start of the now traditional link between petroleum and security (Yergin, 1991). Since then the concept of “energy security” has taken on wider dimensions. No longer does it mainly encompass just the flow of oil, as central as that has been for more than six decades. It now extends to the entire infrastructure of energy supply that supports the global economy (Yergin, 2005).

With globalization, the issue of energy is relevant to the security boundaries of a state. A security boundary is the extent and contours of a nation’s interests. Wherever a country’s interests lead, there too must follow capabilities to protect those interests. And as a nation’s economic interests expand into the global market, it must consider the problem of safeguarding its global and regional interests (Wenmu, 2006:22). Logically, as the world economy globalizes, the national engines of commerce are fuelled by increasingly global sources of energy. A chief national interest therefore becomes access and security for a nation’s energy supply from often cross-border locations and suppliers.

Today, energy security can be broadly defined as an umbrella term that covers many concerns linking energy, economic growth, and political power. The energy security perspective varies depending upon one’s position in the value chain. Consumers and energy-intensive industries desire reasonably-priced energy on demand and worry about disruptions. Major oil producing countries consider security of revenue and of demand integral parts of any energy security discussion. Oil and gas companies consider access to new reserves, ability to develop new infrastructure, and stable investment regimes to be critical to ensuring energy security. Developing countries are concerned about the ability to pay for resources to drive their economies and fear balance-of-payment shocks. Power companies are concerned with the integrity of the entire network. Policymakers focus on the risks of supply disruption and the security of infrastructure due to terrorism, war, or natural disaster. They also consider their security margins – the amount of excess capacity, strategic reserves,

and infrastructure redundancy available (New Energy Security Paradigm, 2006:9).

For this article on the portfolio approach to energy security, the state and its security policymakers are the focal point. Energy security does not stand by itself but is lodged in the larger relations among nations and how they interact with one another (Yergin, 2006:69-82). This perspective of energy security focuses on politically and economically motivated supply interruptions to a state. For states, energy security contains three essential goals: the availability of energy needed for stable economic and social development; freedom from interruption of the energy supply; and the affordability of energy prices. As such, thinking about possible instruments for achieving energy security does not have to begin by merely assessing a nation's military options.

In fact, considerations of energy and security have more to do with broader geopolitical factors and the combined national elements of policy affecting the control of energy development and transportation around the world. Distinguishing between these two ideas is more than an academic exercise. Energy security, as defined above, goes more to the heart of realizing a nation's well-being, even as it takes into consideration the separate issues involving energy and security (Daojiong, 2006:3). Achieving this well-being depends both on a nation's own energy policies, and on the role of other international actors in a state's search for energy security. Energy security is not simply the combination of energy and security. This distinction is particularly relevant when international factors come into play (Daojiong, 2006:2). Therefore when viewing a nation's energy sources through the prism of a portfolio, policymakers must consider all the national elements of power – military, diplomatic, informational, and economic – in addressing this interplay with international actors, not all of them being states.

## **2. Current and future energy challenges**

Before defining a portfolio approach to energy security, some important energy trends and challenges for the future need to be highlighted. Global energy needs are likely to continue to grow steadily for at least the next two and a half decades. More than two-thirds of the growth in world energy use will come from the developing countries, where economic and population

growth rates are highest (Birol, 2006:190; International Energy Agency, 2005). The impact of growth in China and India on the global demand for energy has been tremendous, but the rest of Asia has also shown rapid growth in energy consumption. In the 1970s, North America consumed twice as much oil as Asia. In 2005, for the first time ever, Asia's oil consumption exceeded North America's (Yergin, 2005).

Although alternative energy sources are widely touted, in reality, fossil fuels will likely continue to dominate energy supplies, meeting more than 80 percent of the projected increase in primary energy demand. Oil remains the single largest fuel, with two-thirds of the increase in oil use coming from the transport sector. Oil dominates transportation fuel simply because it is the most economical way currently known to derive liquid fuel; which, in turn, is the most economical means of running a multi-node, randomly-changing, multi-geography transportation system. Physics and economics conspire to make this so.

Natural gas demand is likely to grow faster than oil demand, driven mainly by power generation. Gas is projected to overtake coal as the world's second-largest primary energy source before 2015 (Birol, 2006:190; International Energy Agency, 2005); but increasingly coal may be turned into gas, as prices and environmental concerns support use of the transformation technology which is already available.

Over time, consuming countries are likely to grow increasingly reliant on oil and gas imports from a small group of suppliers – notably Russia and the big Middle East producers – but including Brazil, Australia, and Canada. Those suppliers are increasingly likely to have concerns of national pride, cultural identity, and pace of development which push aside the commercial basis of the old concessionary system. National oil companies now control over 80% of the oil and gas resources in the world (Treverton, 2007:9; Esteruelas, 2007:4-5). As a result, supply arrangements are not simply a matter of price and contracts; but a matter of politics, culture, and international balances of trade. Expanding trade is welcomed, as it binds suppliers and customers in mutually beneficial relationships. But, at the same time, the risk of a major supply disruption – whether from terrorism, piracy, accidents, severe weather, political tensions, or war – will undoubtedly increase (Birol, 2006:193).

Likewise, increasing integration and long-term supply agreements improve efficiency, reduce uncertainty for investments in infrastructure, and encourage cooperation. Yet, as the energy value chain has become more integrated, the vulnerability of any one component, and the effects of its failure, have been magnified. A recent case in point was in August and September of 2005 when Hurricanes Katrina and Rita delivered the world's first integrated energy shock, simultaneously disrupting flows of oil, natural gas, and electric power (Yergin, 2005). This first integrated energy crisis of the 21<sup>st</sup> century contributed to changing the way that energy security is viewed. The integrated energy industry – in which a break at any point in the supply chain can reverberate throughout the system – has far reaching implications (The New Energy Security Paradigm, 2006:4).

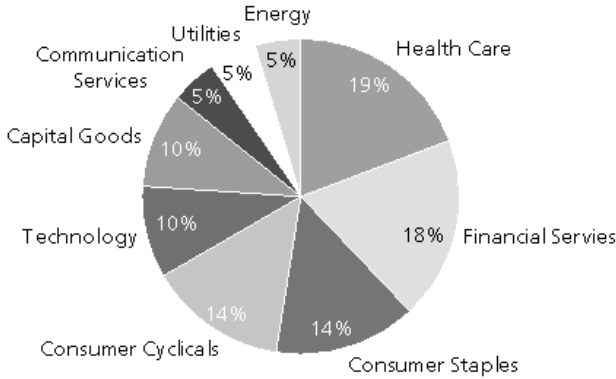
In another instance, for the commodity of natural gas, the underinvestment in production facilities and transmission pipelines in Russia and Central Asia threatens to create a supply crunch in the next few years. This situation is compounded by the lack of competition in the Russian gas sector which is an impediment to the efficient and timely development of Russian and Central Asian gas resources (Birol, 2006:193; International Energy Agency, 2005). Russian political imperatives have prevented the solution of this problem by the technical and economic means which would have been expected in a purely commercial system. Given the above challenges, the reduction of risk and an expansion of supply choice become paramount goals for energy policymakers.

### **3. Portfolio approach for energy security**

One of the challenges when discussing the topic of energy security is finding a framework that allows policymakers and others to conceptualize the status of a nation's current energy arrangements, then analyze the risks and take appropriate measures to correct deficiencies. There are a number of frameworks that can be applied to energy security, with most revolving around various risk assessment and diversification models. This article proposes a simple portfolio approach taken from the banking and finance world as a basic framework for conceptualizing the issue of energy security at the state level.

In its financial context, a portfolio is simply a group of investments held by an investor. This term can apply to other themes like skills, art,

components, and energy sources. Portfolios are commonly used in banking to describe a collection of investments held by private or institutional investors (see Figure 1).



**Figure 1: Sample stock portfolio**

One of the most important and influential economic theories dealing with finance and investment is modern portfolio theory (MPT) which was developed by Harry Markowitz and published under the title “Portfolio Selection” in *The Journal of Finance* in 1952. MPT says that it is not enough to look at the expected risk and return of one particular stock. By investing in more than one stock, an investor can reap the benefits of diversification, which is both observed and sensible (Markowitz, 1952:77-91).

MPT emphasizes the principle of diversification. Under the concept of diversification, the idea is to create a portfolio that includes multiple investments in order to reduce risk. For example, an investment that consists of only the stock issued by a single company is a portfolio with high risk. If that company’s stock suffers a serious downturn, the portfolio will sustain the full brunt of the decline. By splitting investments among the stocks of ten different companies, potential risk to the portfolio is reduced, because the likelihood of simultaneous downturns is low. This portfolio approach to risk management states that rather than focus on the specific risk characteristics of each position or obligation in the portfolio, an asset or liability manager using a portfolio approach will analyze and aggregate risks by type and try to achieve an overall balance of risk and

return (Gastineau, 1992:175). Thus, the most critical issue for managing a portfolio is achieving the best return while minimizing the risk of the overall portfolio.

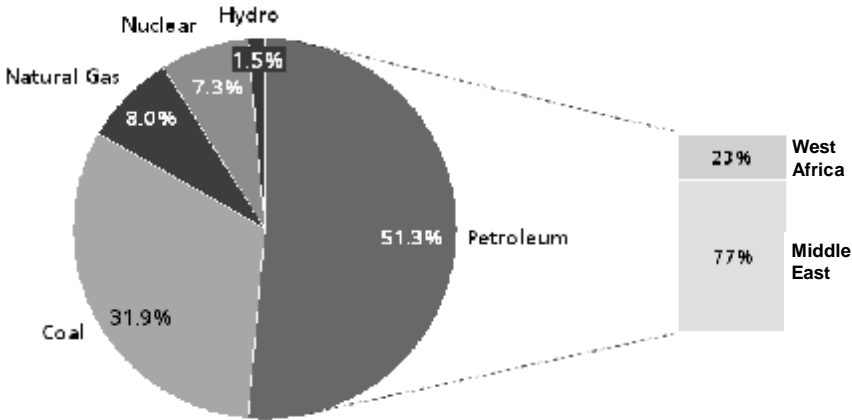
So how does this apply to energy security? By depicting a country's energy sources and suppliers in a portfolio, this conceptual approach provides a view to the current source and supplier dimensions of diversification, and enables decisions to be made concerning adjustment of the energy mix to achieve the optimal sourcing of energy while reducing risks in the failure of any one source or supplier. At a deeper level, a portfolio view also allows a further general assessment of the potential threats to a nation's energy sources or access to them, at the strategic and operational levels. In the end, diversity of sources, suppliers, and even energy transportation routes become the linchpins for national security. Naturally, like any model, the portfolio approach has its limitations in both the investment and energy security worlds. These constraints will be highlighted in the conclusion.

#### **4. The principle of diversification**

Since Churchill's day, the key to energy security has been diversification (Yergin, 2005). Churchill declared, "Safety and certainty in oil lie in variety and variety alone." With that, he was articulating the fundamental principle of energy security: diversification of supply. Churchill's maxim of ninety years ago continues to hold true – diversification of supply is one of the main guarantors of security and, indeed, is the starting point for energy security. In similarity to having a broad portfolio of stocks and bonds with different levels of risk and return, widening the sources of energy supply lessens the impact of any particular disruption and provides opportunity for compensating supplies (Yergin, 2005). Diversification can be approached in two dimensions – source and supplier.

Source diversification refers to the mix of different energy sources that potentially comprise a state's energy needs. These sources are well known and can be generally grouped as petroleum, natural gas, coal, nuclear, hydroelectric, wind, sun, and biofuels. A good case example is Taiwan. Taiwan is not blessed with abundant natural resources. Aside from the electrical power produced by its three nuclear power plants and a small contribution from hydropower, virtually all of its energy is supplied from imported oil, coal, and natural gas (The Energy Situation in Taiwan,

Republic of China, 2007) (see Figure 2). This mix has specific implications for the management of its future energy portfolio as well as its energy national security focus. These implications will be addressed in the first case study.



*Figure 2: Taiwan's energy supply structure*

Supplier diversification pertains to the mix of state providers of the commodities of petroleum, natural gas, and coal, and looks at which countries are the sources of the respective energy supply. Oil is particularly important, and the vast majority of the literature on energy security focuses on oil imports and on possible interruptions of petroleum supply (Bohi and Toman, 1996; Salameh, 2003:135-144; Muller, 2003:3-10). The current major suppliers of petroleum are Saudi Arabia, Russia, Norway, Iran, Venezuela, United Arab Emirates, Kuwait, Nigeria, Mexico, Algeria, Iraq and Libya. Since a majority of these countries suffer political instability or have a high potential for it, this places the importers at risk. A wise country seeks then to diversify its supplier mix among several so that the failure of any one does not cut off an adequate supply of petroleum.

The People's Republic of China's (PRC) quest for African energy sources is a classic example of supplier diversification. China's oil consumption, already the second largest in the world after the United States, is forecast by some to grow to 590 million metric tons in 2020 (up from 220 million tons in 2000), nearly three-quarters of which will be imported by that time

(Takahashi, 2004). In less than 10 years, China has secured oil production and exploration deals in a swathe of countries reaching across Africa from the Red Sea to the Gulf of Guinea. In its desire to diversify away from Middle East petroleum, China now relies on Africa for between one-quarter and one-third of its oil imports, with the trend rising (Money Flows to Oil, 2006:11). This amount is forecast to reach 40 percent of its total supply within the next decade. (Rogers, 2007:74). The PRC has achieved this diversification feat with a diplomatic offensive on the Dark Continent using the promise of soft loans, infrastructure development, and even military assistance (Mahtani, 2007:4).

For natural gas, a list of main producers would include: Russia, United States (U.S.), Canada, United Kingdom, Netherlands, Iran, Norway, Algeria, Indonesia, and Saudi Arabia. Again, potential political unrest is present or latent in a number of these states, and a savvy importer attempts to spread his risk among the overall group. However, natural gas imports have generally been limited to close regional neighbours because of the difficulty of transporting natural gas over long distances.

Natural gas is lighter than air, and has far less energy content than petroleum at atmospheric pressure. Compressing natural gas to transport it in containers requires that the compressed gas be shipped in thick-walled pressure vessels. The weight, expense, and handling of the containers reduces the economics of using natural gas; particularly for large-volume, continuous industrial processes. Therefore, to economically transport natural gas, it is easiest to send it via a pipeline. Yet, building pipelines long distances across oceans or mountains becomes expensive very quickly, and introduces a variety of physical challenges. As a result, natural gas has been mostly restricted to pipeline transport in specific regions; and has not been globally deliverable in the way that both coal and petroleum have been.

A technology which is changing these limitations is liquefaction. Supercooling natural gas to -240 degrees Fahrenheit turns it into a liquid (LNG) which can be transported in specialized tanker ships. A regasification terminal at a deepwater port turns the LNG back into its gaseous form, and feeds it into a pipeline like any other natural gas. Thus, markets greatly distant from a gas-producing region can still use natural gas as an energy source as long as they have a suitable port. Countries which do not have a suitable port may still benefit by purchasing regasified LNG

through neighbouring countries which do have a suitable port (but then relations with that neighbour become even more important).

LNG is emerging as a new global energy business. The major regional markets – Asia, Europe, and North America – will likely be linked through an increasingly flexible LNG industry. The world's proved natural gas reserves are as large as reserves of petroleum, but they have not been developed to the same degree because of the constraints on transportation; thus LNG offers significant supplies and an alternative set of suppliers.

Still, the use of LNG as an alternative energy supply requires that capital be committed to infrastructure projects for regasification, and pipelines for delivery to users. Until recently, LNG has been largely an Asian trade, based upon highly structured long-term contracts (Yergin, 2005). Those contracts provided the means to finance the LNG infrastructure and produced an environment of steady supply. Now, a spot market is developing, where LNG can be purchased on short notice; but this still requires the infrastructure to be in place in order to land the LNG. In practice, this requires that a facility be built and operated full time, but with sufficient excess capacity to handle emergency outages of other energy supplies. Of course, provision also needs to be made to pay the higher prices for LNG which would likely be faced if the market recognizes the sudden spike in demand caused by an outage in some other energy source. Still, the development of LNG has added significant flexibility to the arsenal of solutions policymakers now have for managing energy security. The LNG market, though, is a double-edged sword. The development of this new global LNG business has contrasting security dimensions. It contributes to further diversification of energy supply and energy sources. Yet, at the same time, it creates new global dependencies that are vulnerable to disruption (Yergin, 2005).

A further important point to energy resources is geological and environmental endowment, and geopolitical positioning. A country with oil reserves or abundant amounts of sun and wind has potentially a higher level of energy independence over those that do not. Correspondingly, energy security is also a factor of a state's geopolitical position and its neighbours. As an island nation, Taiwan for example needs unimpeded sea lanes as it gets most of its oil via the Strait of Malacca from the Middle East and West Africa. Conversely, for continental countries like the Baltics

and Eastern European countries, the relationships to their direct land neighbours, particularly Russia, are important since they receive their natural gas through pipelines extending from their Russian supplier directly or through adjacent countries. Good international relations with these counterparties are therefore critical for guaranteeing an uninterrupted national energy supply. Witness the case of Ukraine. Russia's decision to cut off gas supplies to Ukraine in early 2006 called into question its reputation as a reliable supplier, and raised doubts for other countries about its dependability and ultimate foreign policy and security intentions.

The conflict has continued to simmer in 2007. Ukraine is now seeking to bypass the Russian pipeline company Gazprom by purchasing gas directly from Turkmenistan, rather than allowing Gazprom to profit from resale of the gas to Ukraine. The dimensions of the relationship are instructive: Turkmenistan wants a higher price for its gas; Ukraine can ill afford to pay a higher price; Ukraine is dependent upon Gazprom to transport the gas from Turkmenistan; but Gazprom has to cross Ukrainian territory to sell gas to Europe.

## 5. Case example Taiwan

Figure 2 shows the energy portfolio of Taiwan. In assessing this current portfolio in a simplified manner, Taiwan depends on petroleum for almost half of its needs, with coal and other sources making up the remainder. While not unbalanced, this mix merits a closer look especially at the diversification among the suppliers of the main types of energy. For oil, its primary energy pillar, Taiwan is heavily dependent on the volatile Middle East for 77 % of its petroleum. In terms of reducing risks, an initial policy recommendation would be for Taiwan to increase its use of coal and simultaneously look for other sources of petroleum. These sources could include countries like Venezuela or Canada. Interestingly, coal was the main energy source before 1966 in Taiwan, but oil replaced it as the major energy source as of 1967. In 2006, Taiwan imported approximately 62 million metric tons of coal, mainly from Indonesia (38.5%), Australia (36%), and Mainland China (21%) (The Energy Situation in Taiwan, Republic of China, 2007).

In reviewing the Taiwanese energy goals for 2020, Taiwan aims on changing its energy supply structure in this fashion by increasing coal from

34% to 37% while decreasing petroleum from 49% to 32% (The Energy Situation in Taiwan, Republic of China, 2007). The result will be more balance between these two core types of energy. A further step might be to increase the use of natural gas, particularly by using more liquefied natural gas (LNG). Lastly, promoting and investing in renewable energy sources could contribute to greater self-sufficiency and reduced supplier risk. All of these measures would diversify the current energy portfolio and reduce the risks found in the current set-up.

In assessing the security implications and risks of the current portfolio at the strategic level, the maritime aspect comes to the fore coupled with Taiwan's international relations with the People's Republic of China (PRC). Taiwan depends heavily on free and unimpeded sea lines of communication for its energy access. Taiwan's oil must transit from West Africa and the Middle East through two choke points – the Strait of Hormuz, at the entrance to the Persian Gulf and the Strait of Malacca, linking the Indian and Pacific Oceans, through which passes about 80 percent of Japan's and South Korea's oil and about half of the PRC's. Coal coming from Australia and Indonesia travels a shorter distance and avoids these two passages, but still must come by ship. These lanes must be kept open either by the rather minor Taiwanese navy or more realistically through multilateral arrangements with larger maritime allies like the United States, the United Kingdom, and Japan. Otherwise its main supply lines are at risk.

Similarly, deteriorating diplomatic relations with the PRC could have heavy energy implications for the Taipei government. Maintaining a flow of energy to Taiwan through a PRC blockade would pose formidable challenges for Republic of China leadership (Grubb, 2007:88). Petroleum, coal, and LNG would be equally exposed to a PRC blockade. A related strategic concern in a China-Taiwan scenario would be the fact that a sizable portion of Taiwan's imported coal supply comes from mainland China (21 percent), the remainder primarily from Indonesia (38 percent) and Australia (36 percent). China could restrict shipments of coal unilaterally, without a blockade. This concern is partially offset by the overall strength of the global coal supplies; such large coal producers/exporters as Australia, Russia, Indonesia, and the United States could easily supply Taiwan's demand if supplies from the mainland were

cut. Thus, Taiwan must maintain strong diplomatic and economic ties to these suppliers to cover such eventualities.

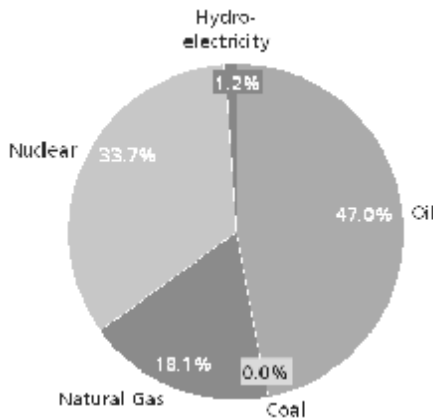
At the operational level, further concerns for Taiwan's energy access that can be derived from Figure 2 are in the areas of port and terminal security. Delving deeper, Taiwan has seven major ports: Kaohsiung, Keelung, Suao, Taipei, Taichung, Hualien, and Anping. Kaohsiung handles 67 percent of the total cargo volume, with Keelung second at 15 percent (Taiwan Government and Information Office, 2006). Kaohsiung is also the home of Taiwan's only shipyard capable of dry-docking large, deep-draft vessels, as well as its most productive oil refinery (Chinese Petroleum Corporation, Chinese Petroleum Corp., 2006:14-15). The proportionate concentration of facilities at Kaohsiung makes it an obvious target for terrorists or others desiring to disrupt Taiwan's energy supply. This threat implies mobilizing national assets to defend and protect such critical installations. Such steps require the cooperation of a number of government departments beyond the military. Naturally this portfolio analysis of Taiwan is a basic example to show how this model can simplify the energy security discussion and generate ideas concerning source and supplier diversification, and derive strategic or operational security implications. Changes to actual energy policy and the implementation of those changes would require much deeper analysis.

## **6. Case example Lithuania**

Shifting geographical zones, the energy situation in Eastern Europe merits consideration. Long-term forecasts by the International Energy Agency (IEA) suggest that natural gas will be the fastest growing component of world primary energy consumption, and globally, the IEA projects the highest increase of natural gas consumption for Eastern Europe and former Soviet Union countries. This implies that the region's dependence on gas deliveries from Russia – the prime source of energy – is likely to increase in the short and medium term, driven by rapid growth and relatively high energy dependency. These countries, in particular, are increasingly uncomfortable with their dependence on energy supplies from Russia. They see the early 2006 supply disruptions to Ukraine (which also affected European Union countries) as evidence that Russia is using its dominant position for political purposes. In looking specifically at the Baltic countries, energy consumption is projected to increase substantially,

in the range of 30-70 percent over the next five years, as opposed to 20-40 percent in the Central European countries (Tirpak, 2006). As such, taking the case example of Lithuania and applying the portfolio approach can provide useful insights that would contrast with those of the Taiwanese case.

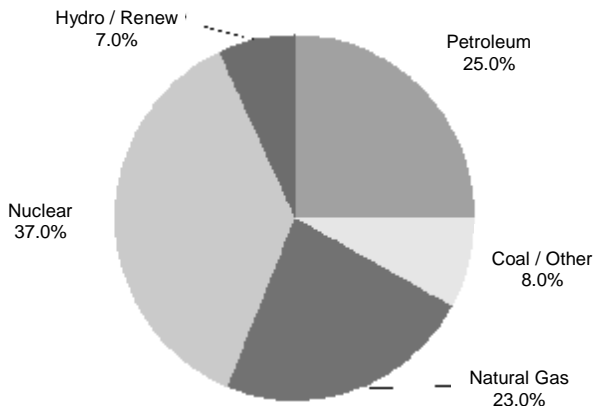
Lithuania, a country on the eastern shore of the Baltic Sea finds itself in a difficult situation with regards to energy security. The 2003 energy portfolio of Lithuania is depicted in Figure 3, and a similar view is provided for 2004 in Figure 4. From a superficial perspective, the portfolio looks balanced with a healthy portion of Lithuania's oil dependence offset by nuclear energy and natural gas. This picture though is deceptive and can only be the starting point of an analysis. Like with Taiwan, looking one level deeper at supplier diversification and at the state's unique energy infrastructure characteristics reveal a number of critical issues for the future.



*Figure 3: Lithuania's structure of energy consumption - 2003*

Until recently, approximately 90% of the country's oil supply came from Russia. Again, Lithuania is not alone among European Union (EU) states in this situation. Over the past few years, Russia has supplanted Norway to become the EU's single largest source of oil. Lithuania is unique though in that it is home to the only oil refinery in the Baltic States. For Lithuania, the majority of this Russian oil flowed via the Druzhba pipeline to this processing plant in Mazeikiu. Given this high risk situation, Lithuania opened the Baltic Sea Butinge terminal to receive oil deliveries by tankers

to reduce its dependence on the Druzhba pipeline (Bohlen, 2007). It was an important first step in diversification.



*Figure 4: Lithuania's structure of energy consumption - 2004*

In 2006, a reported leak on Russian territory caused the Russian pipeline monopoly Transneft to shutdown the Druzhba pipeline that supplied Lithuania with its oil. This blockage falls into a pattern of Russian behaviour beginning in 2002, when Transneft shut down a spur that shipped crude to the Latvian port of Ventspils. This was followed by Gazprom, Russia's natural-gas export monopoly, blocking gas supplies to the Ukraine in January 2006, and Transneft cutting oil to Belarus a year later over price and transit disputes. Forced into diversification, Lithuania now pays for tanker-delivered oil from countries like Venezuela, which has averted an energy crisis. This other source access is critical for its petroleum supply since in October 2007 Russia told the European Union (EU) it is unlikely to reopen the stretch of the Druzhba pipeline that had brought oil to Lithuania. The declaration was made by Russian Energy Minister Viktor Khristenko during a meeting in Brussels with EU Energy Commissioner Andris Piebalgs. "In response to Piebalgs' question, minister Khristenko said that reopening the pipeline was unlikely to be economically viable." Lithuania has said the closure was politically motivated by the sale of its Mazeikiu refinery to Poland's PKN Orlen rather than to a Russian bidder. The pipeline closure added to worries, notably among EU newcomers from central and Eastern Europe, that

Russia was using its energy resources as a foreign policy tool. Russia has denied such criticism (Reuters, October 16<sup>th</sup>, 2007).

Given the 37 percent nuclear energy portion of the energy portfolio, Lithuania could seemingly compensate for its petroleum problems with increased nuclear energy usage. Unfortunately, Lithuania faces an even larger energy crisis further down the road. The Ignalina nuclear power plant is scheduled to be decommissioned in 2009. This facility produced over 10.34 terawatt-hours (TWh) of electricity in 2005, more than 70 percent of Lithuania's total production that year (Baran, 2006:17). It expects to build a USD 5 billion nuclear reactor with Poland and the two other Baltic states by 2015, but nobody has a clear view yet on what would happen in the period after closure of the second unit in 2009 until the new reactor is built around 2015 at earliest. A logical step would be to fall back on the third energy pillar of natural gas which supplies approximately 23 percent of the Lithuanian energy portfolio. Regrettably here, Lithuania falls into the problem of overdependence on one supplier – again Russia, and reliance on pipelines from this neighbour. Russian gas, which accounts for 75 percent of Lithuania's heating fuel, poses a more difficult problem; when Lithuania closes its Chernobyl-style nuclear reactor at Ignalina in 2009, 75 percent of its electricity demand will be met by Russian gas, more than double the current 34 percent. As the Lithuanian Economic Minister, Vytautas Navickas, stated: "That is too much dependence on one gas supplier and on one state. It's like drugs. We have to have diversity" (Bohlen, 2007).

In summary, with its current portfolio, Lithuania faces considerable challenges to its energy security. These challenges are manifested in three principal ways. First, Lithuania is far too dependent on Russia for energy supplies. Second, when the Ignalina nuclear plant closes, Lithuania's dependence on external sources of energy (that is, Russian supplies) will increase. Third, Lithuania must seek multilateral solutions, not all of them easy to achieve, if it wishes to have an optimal energy portfolio. Potentially, the portfolio solution lies in a mixed approach of using renewable energy, diversifying sources and routes of supply of imported energy, and reducing demand.

To tackle the first two issues requires diversification alternatives away from oil and natural gas from Russia. From a source perspective, exploring alternate energy means might seem to be a logical step, but unfortunately

most types are rather unsuitable given Lithuania's location. Wind, solar, hydroelectric and geothermal power accounted for less than one percent of Lithuania's total energy supply in 2003. Renewable energy sources have little technical feasibility – let alone economic viability – in Lithuania. Since it is a relatively flat, low-lying country (only a few western areas rise above 200 metres), there is little potential for hydroelectric power. Nor is Lithuania a good candidate for wind power. According to the European Bank for Reconstruction and Development, the average wind speed in most areas of the country is around 15 kilometres per hour (kph). This is insufficient, as most wind turbines in operation today require speeds of 10-15 kph as a bare minimum for power generation. Lastly, Lithuania is an even less suitable candidate for solar and geothermal energy. The country's high latitude and climate conditions are particularly unfavourable for solar power generation. At the same time, Lithuania is part of a region that is geologically extremely stable, effectively eliminating the potential for employment of geothermal power (Baran, 2006:22). The only option remaining is biomass renewables, but this alternative has limitations given current technology and distribution challenges. It has grown though incrementally, between the snapshot years of 2003 and 2004. Given the aforementioned, Lithuania must remain with fossil fuels and nuclear power for the bulk of its energy needs.

In terms of oil and gas, Lithuania has, as an important transit point to the energy markets of the West and the Kaliningrad region of Russia, a state-of-the-art onshore terminal and offshore sea platform at the coastal village of Butinge, which has a capacity of 12 million tons of crude per year. Just twenty-five kilometres south of Butinge is Klaipeda, the country's only deep-water seaport (Baran, 2006:2). With this infrastructure, Lithuania can continue to import crude from other nations via tankers, and should work on the diplomatic front to increase the number of countries used as suppliers.

Similarly, LNG provides an excellent way to diversify its gas supplies away from Russia, and the port of Klaipeda provides a potential starting point for building an LNG terminal. In this direction, Prime Minister Gediminas Kirkilas has charged a task force with analysing the possibility of building a liquefied gas import terminal in Lithuania. According to a press release from the government's press service, Ignas Vegele, the head of the Mykolas Romeris University Department of EU Law, has been appointed

as chairman of the task force, which will have to present its proposals by January 15<sup>th</sup>, 2008. A liquefied gas terminal is important to a country seeking to ensure energy security (Baltic Business News, 2007:6). Interestingly, Latvia and Poland are also entertaining the prospect of constructing an LNG receiving terminal. This would allow these countries easy access to a much broader market since LNG is not limited to transmission by pipeline; like crude oil, it can be shipped via tanker (Baran, 2006:28). Given the costs of such energy projects, joining such a venture as a partner would be potentially more favourable for Lithuania's energy portfolio than going it alone.

Lastly, the simple measure of greater energy conservation and efficiency should not be overlooked. Conservation – energy efficiency – should be thought of as an energy source, and one with very large potential (Yergin, 2005). With a clear vision and multi-agency implementation plan, Lithuanian policymakers could reduce consumption substantially. Also, the principle of resilience or a "security margin" in the energy supply system can provide a buffer against shocks; and facilitates recovery after disruptions. Resilience can come from many factors, including sufficient spare production capacity, strategic reserves, backup supplies of equipment, adequate storage capacity along the supply chain, and the stockpiling of critical parts for electric power production and distribution, as well as carefully conceived plans for responding to disruptions that may affect large regions (Yergin, 2005). Creating storage facilities for crude or natural gas could offer a strategic reserve for this small Baltic country. Again, such a strategic reserve facility could be shared both in cost and usage by its Baltic or Polish neighbours.

Like Taiwan, in terms of the security implications of its current portfolio, Lithuania has both strategic and operational issues with its energy supply chain. Strategically, its main energy effort requires a strong weighting on the diplomatic and economic fronts to find multilateral solutions with its Baltic and European neighbours and to develop a stable of new oil and ultimately LNG suppliers. Simultaneously, it must exercise a nuanced diplomacy towards Russia given its dependencies and location. At the operational level the watchword is critical installation security. The port of Klaipeda, the refinery at Butinge, and the reactor at Ignalina are all single points of failure that must be guarded from asymmetric threats ranging from terrorist actions to cyber attacks. Like the example of Spain,

Lithuania's participation in the Middle East as a North Atlantic Treaty Organization (NATO) member does make its energy infrastructure a potential target for Islamic terrorists.

Using the portfolio approach to energy security provides a simple way to educate on a state's energy portfolio by providing a snapshot in time of its composition and the implications of such a setup. In thinking about the two sample portfolios of Taiwan and Lithuania, some common issues come to the forefront. First, energy security is a real concern for governments and their populations. With the two small countries analyzed, a large failure in the international energy supply chain could have catastrophic economic consequences. For example, a U.S. strike on Iranian economic infrastructure would take some 4 million barrels per day off the global oil market at a time when oil prices already are over USD 100 a barrel. Given its tenuous supply lines, Taiwan would feel a heavy impact. Although it must be noted that such a campaign is more likely to drive a wedge between the American people and the American government than between the Iranians and their government because of the energy consumption of the U.S. public.

Second, solutions for diversification, particularly for smaller countries hinge upon multilateral arrangements with like-minded partners. Energy security will greatly depend on how countries manage their relations with one another, whether bilaterally or within multilateral frameworks, and it is critical to build cooperative relations, based on common interests, with nations that produce and export energy. In Lithuania's case, a large number of future options such as an LNG terminal, larger storage capacities, and a new reactor rely upon European and Baltic partners for full success.

Third, energy security requires a holistic view to national defence where the military, diplomats, economists, tax officials, police, and others must all be involved. Long-distance, cross-border pipelines are becoming an ever-larger fixture in the global energy trade. There are also many chokepoints along the transportation routes of seaborne oil and, in many cases, liquefied natural gas (LNG) that create particular vulnerabilities: the Strait of Hormuz, which lies at the entrance to the Persian Gulf; the Suez Canal, which connects the Red Sea and the Mediterranean; the Bab el Mandeb strait, which provides entrance to the Red Sea; the Bosphorus strait, which is a major export channel for Russian and Caspian oil; and the Strait of

Malacca, through which passes 80 percent of Japan's and South Korea's oil and about half of China's. Ships commandeered and scuttled in these strategic waterways could disrupt supply lines for extended periods. Securing pipelines and chokepoints will require interagency activity as well as the development of multilateral rapid-response capabilities.

Last, at the operational level, critical installation security is of paramount importance. In the United States alone, there are more than 150 refineries, 4000 offshore platforms, 160000 miles of oil pipelines, facilities to handle 15 million barrels of oil a day of imports and exports, 10400 power plants, 160000 miles of high-voltage electric power transmission lines and millions of miles of electric power distribution wires, 410 underground gas storage fields, and 1.4 million miles of natural gas pipelines. None of the world's complex, integrated supply chains were built with security, defined in this broad way, in mind (Yergin, 2005). Attacks could take the form of physical assaults on port facilities, refineries, petrochemical plants, compression stations, dams, transmission lines, and substations. In thinking of Taiwan's ports, and Lithuania's three energy "single points of failure" – reactor, port, and refinery – national decision-makers must seek an efficient and optimal security solution for these facilities given the implications of an outage.

In the end, the portfolio model is simply one way to study and educate on the topic of energy security. Success in this endeavour ultimately depends heavily on a good and nuanced understanding of portfolio diversification, which in itself is more of an art than a science. Like any framework or model, the portfolio approach has limitations when applied to the investment and energy security worlds. In both fields, portfolio theory does not account for "low probability, high impact" market shocks such as the sub-prime crisis in the banking sector or a major oilfield disaster or conflict in the energy sector. Portfolio theory displays a weakness in both areas by relying wholly on historical data, which as a snapshot, may not depict the true risk and return realities of the current market. Especially in the energy sector, this results in an information lag, which could potentially affect current policy decisions. When applied solely to energy security, portfolio theory is an inexact method as the approach does not properly account for the production side of the equation; it focuses mainly on the energy consumption of the receiving nation. This narrow view limits a deeper risk assessment of the source countries of energy, as well as all possible transit risks.

Nevertheless, despite these caveats, by depicting a country's energy sources and suppliers in a portfolio, this conceptual approach provides a general view to the current source and supplier dimensions of diversification, and enables decisions to be made concerning adjustment of the energy mix to achieve the optimal sourcing of energy. This in turn can reduce risks caused by the failure of any one source or supplier. The iron rule for maximum portfolio efficiency always being, "spread the risk and never put all assets in one basket."

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