A New Method of Using Energy Security Risk as a Decision-Making Tool

Bo Kim
Rice University, Undergraduate, Economics Department
Corresponding author: bsk2@rice.edu

Executive Summary: Policymakers have traditionally crafted energy policy with the end goal of increasing energy security. This proposal suggests a change to this line of thinking by outlining a method that quantifies the projected impact of various policies on energy security to inform the policy decision-making process. This method allows policymakers to compare the impacts of policies on energy security using a standardized methodology across different policy cases. Specifically, this involves quantifying the effects of the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook 2014* policy case scenarios on U.S. energy security risk and weighing these effects against other long-term policy goals considered in the model runs, such as CO2 emission reduction and GDP growth. This method allows policymakers to more clearly visualize the relative effects of different policies on the economic and energy landscape. The Institute for 21st Century Energy's *Index of U.S. Energy Security Risk* is used as a concrete example of the proposed method. Though this proposal is concerned with the general idea of quantifying energy security, the proposal does not advocate for any one specific quantification method.

The main policy prescriptions in this proposal are to calculate and to utilize a quantified measure of energy security. The proposal shows an example of how this can be calculated and how this measure can be practically utilized to help policymakers weigh other policy considerations. Finally, by assigning hypothetical, relative importance to the policy goals of energy security, economic growth, and CO2 emission reduction, this proposal outlines specific policy recommendations to best meet these goals. In light of these goals, this proposal firstly recommends the recovery of unconventional fossil fuels. Secondly, this proposal recommends reducing electricity demand, potentially by improving energy efficiency.

I. Introduction

Energy security is defined by the International Energy Agency as the "uninterrupted availability of energy sources at an affordable price" and has become increasingly relevant in the rapidly shifting energy landscape of a globalized and interconnected world (IEA). Despite different opinions about the exact definitions of the idea of energy security, policymakers almost universally consider energy security as one of the most important long-term goals of energy policy. Increases in energy security allow nations to more easily withstand sudden, unpredictable events that affect the global energy market. For example, the U.S. in the 1970s saw skyrocketing domestic energy prices and fuel shortages created by various international events that affected the world energy market. Low U.S. energy security and a consequent inability to respond to world market fluctuations were largely responsible for the magnitude of the impacts of these oil shocks (Yergin, 2006). In turn, these shocks contributed to a prolonged period of economic stagnation. Energy security further directly affects the consumer by mitigating the negative impact that energy market fluctuations can have on gas and electricity prices.

While the concept of energy security in the abstract can be easily understood, quantifying energy security is much more difficult. The idea of energy security encompasses a number of different metrics across the energy landscape. As a top consumer and producer in the global energy market, the U.S. energy system firstly includes domestic metrics, such as energy consumption per capita. Secondly, one must consider global metrics such the amount of oil imported from foreign sources or the political security of oil reserves worldwide. It is difficult to coherently quantify these metrics, to assign them individual weights, and to produce a single measure of energy security. Given the complexity of these data, it is almost impossible to analyze these numbers without making assumptions that are necessarily subjective.

Attempts to quantify a measure of energy security exist. The Institute for 21st Century Energy, an affiliate of the U.S. Chamber of Commerce, has led this effort through their publication of the *Index of U.S. Energy Security Risk* (U.S. Index), an annual report that measures current, past, and future U.S. energy security using quantitative data, historical trends, and U.S. government projections (the methodology of this index will be discussed further in a later section). Although a measure of energy security exists, there has not been a wide-scale attempt to systematically utilize this measure in policy decision-making.[1]

There are infinitely many ways to weigh the different metrics utilized in the calculation of energy security. While the U.S. Index's weighing of metrics is fair and informed, there are simply too many other potential combination of weights for this policy proposal to completely endorse the U.S. Index's particular combination. This process of distilling and weighing large amounts of data and projections into a handful of useful figures is potentially subjective. However, in utilizing a systematic, clear, and transparent methodology based on publicly available data, mainly from the U.S. Energy Information Administration (EIA), the U.S. Index is relatively objective in its methodology. Furthermore, given the lack of similar indices and measures of energy security, the U.S. Index is the best available concrete example to understand the general methodology of this policy proposal. Most importantly, the U.S. Index bases its projections off of publicly available EIA modeling runs. These models include a "business as usual" reference case that models the short-run state of the U.S. energy landscape without significant changes in energy policy or unexpected energy market shocks. The impact of potential events deviating from the reference case, such as a significant increase in electricity demand or unexpectedly high oil prices, are projected by using the same statistical model with different assumptions. This allows one to forecast various aspects of U.S. energy security risk under different policy case scenarios until 2040. Predictions beyond this year are not modeled by EIA, ostensibly due to the inability of models to usefully forecast beyond this date.

Policymakers have traditionally crafted energy policy with the end goal of increasing energy security. Under this framework, it is not particularly difficult to imagine whether a policy would increase or decrease energy security. Increased domestic energy production, for example, would increase energy security while an increase in the price of oil worldwide would decrease it. A more difficult task is to quantify the magnitude of these effects and to calculate the final impact on energy security that encompasses all of the negative and positive impacts of different metrics. For example, what is the net effect of an increase in domestic energy production coupled with an increase in worldwide oil prices? Quantifying energy security aims to answer these and similar questions by outlining a method for utilizing a quantifiable, projected impact on energy security during the policy decision-making process. Policymakers can explicitly compare the relative impacts of energy policies on energy security using a standardized methodology across different policy cases.

Additionally, this proposal aims to quantify the effects of each of the policy cases modeled in EIA's <u>Annual Energy Outlook 2014</u> on U.S. energy security risk and to weigh these effects against other long-term policy goals considered in the model runs. Two goals are considered and analyzed in this proposal as examples: gross domestic product (GDP) growth and carbon dioxide (CO2) emission reduction. This analysis allows policymakers to more clearly visualize the relative effects of different policies on

[1] The latest edition of the U.S. Index, published during the editing process of this paper, briefly outlines the predictive decision-making methodology described in this proposal as it relates to GDP versus energy security concerns. This proposal, however, expands upon this this analysis and methodology to include environmental considerations and consequently arrives at slightly different policy recommendations.

the economic and energy landscape. For example, a policymaker could find that enacting a certain policy increases energy security but weakens the economy significantly. A comparable policy might only slightly increase energy security but generate strong economic growth. In this example, a policymaking decision can be made and numerically justified depending on how much policymakers choose to weigh energy security versus economic growth.

This proposal uses the methodology followed by the U.S. Index as an example of a method of weighing energy security versus other long-term considerations. The merits of the specific weighing of metrics by the U.S. Index are beyond the scope of this proposal, which instead proposes a different application of the general method exemplified by the U.S. Index. This general method could easily be adapted to formulate a different measure of energy security that weighs certain metrics differently than the U.S. Index.

II. Methodology: measuring energy security risk

The importance of the U.S. Index methodology is not in its specific choices of metric weights. As previously mentioned, the U.S. Index's particular combination of weights is a good but not definitive example of the proposed general methodology. Instead, the U.S. Index's importance comes from the use of the weighing process itself as a way to compare impacts of disparate metrics on energy security. The exact methodology of the U.S. Index's weighing process is described below to provide a more concrete example for this thought process.

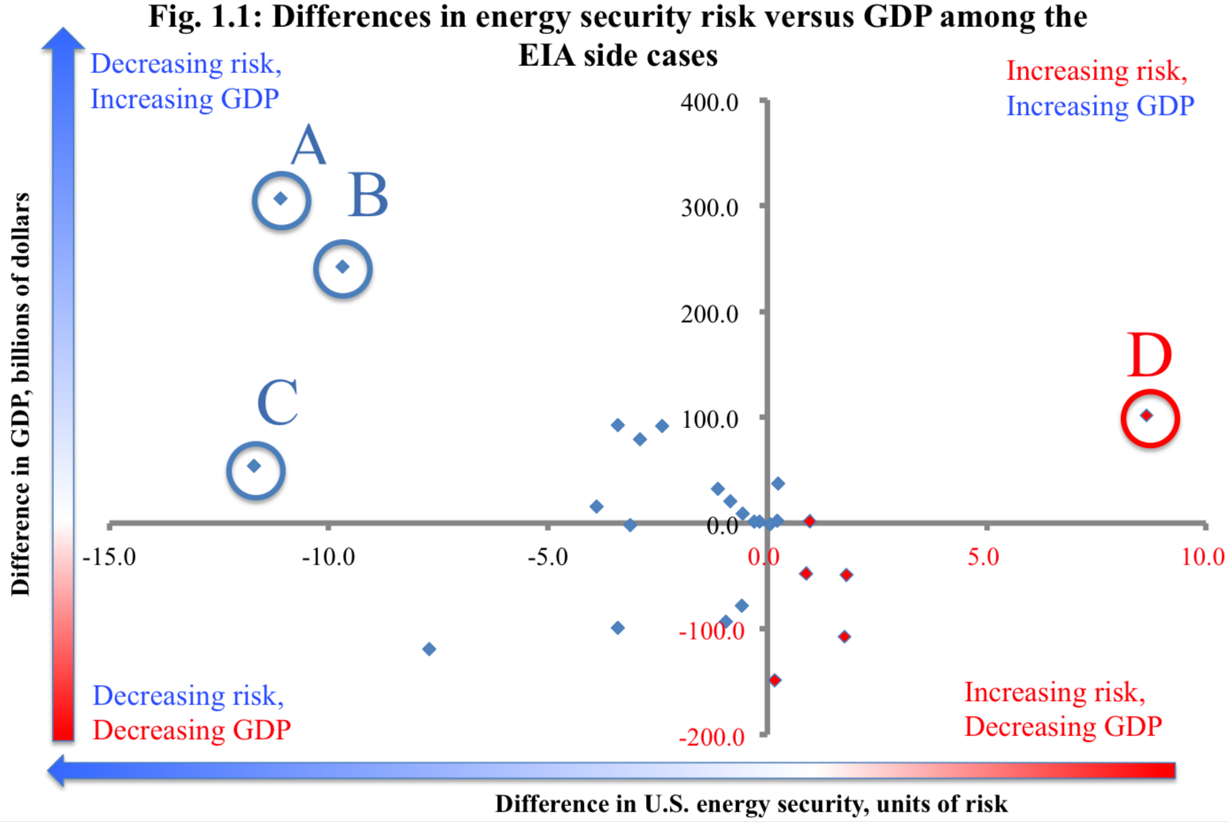
The U.S. Index measures energy security risk as a weighted index of four sub-indexes that represent areas of risk to American energy security. These four sub-indexes measure geopolitical, economic, reliability, and environmental risk. Each of these sub-indexes are generated through the evaluation of publicly available data and subsequently weighed to create a single number that represents U.S. energy security. An increase in energy security is equivalent to a decrease in energy security risk, and vice versa.

In evaluating the data, the U.S. Index uses 37 metrics such as the security of world oil reserves, crude oil prices, and energy expenditures per household. This section will examine the calculation of two metrics to shed light on the general thought process. These metrics are the security of world oil reserves and energy consumption per capita.

To measure the security of world oil reserves, the U.S. Index weighs global proved oil reserves by using two measures. The first is a measure of a country's freedom, defined by Freedom House as a measure of a country's political rights and civil liberties (Institute for 21st Century Energy, 2014, Freedom House, 2014). The second is a diversity index applied to global oil reserves that measures the size of each country's oil reserves relative to global reserves. By combining these two metrics, one can then determine the political security of world oil reserves. This number is then normalized for easier comparison, meaning that this and all other metrics are converted to the same numerical index that allows one to meaningfully compare changes in different metrics against each other. For example, the normalized impact of a change in barrels of oil imported could then be compared to the normalized impact of an increase in energy efficiency. On this normalized scale, a baseline score of 100 assigned to 1980 due to the dim prospects of energy security in that year. Consequently, a number close to 100 represents a large risk in energy security. This is a measure of the risk associated with the average barrel of crude oil reserves. Certain metrics, including the security of world oil reserves, are not possible to meaningfully forecast. In this case, it is impossible to meaningfully predict future political freedom rankings and oil reserves. Therefore, for neutrality's sake, the U.S. Index extends current measures of only these particular, unpredictable metrics in forecasts for years in the future (Institute for 21st Century Energy, 2014). These measures, like all of the others, are still converted to a normalized scale using 1980 as the baseline year.

Other metrics are easier to meaningfully forecast. One example is energy consumption per capita. Using EIA forecast data, the 2014 version of the U.S. Index notes that energy consumption per capita is predicted to steadily decrease (Institute for 21st Century Energy, 2014). This is likely due the post-industrialized U.S. economy continuing to move away from energy-intensive manufacturing towards less energy-intensive service industries (Medlock, 2009).

Fig. 1.1: Differences in energy security risk versus GDP among the EIA side cases



The end result is a series of historical measures of particular metrics, ranging from energy expenditures per GDP to energy-related CO2 emissions (Institute for 21st Century Energy, 2014). These measures have also been weighed and converted into the same scale to allow for comparisons between metrics with different units of measures. Historical and current measures of each metric have essentially been converted to an index.

The current index score of each of these metrics is then considered in the calculation of one or more sub-indexes, depending on which sub-indexes that a metric is relevant to. For example, energy consumption per capita directly affects the economic and environmental sub-indexes but would have little direct impact on the reliability and geopolitical sub-indexes. As such, this metric is not weighed in the latter two sub-indexes. The exact process of assigning relevancy to various sub-indexes is up to the policymaker. Given the large number of metrics, questions of whether to assign just one metric to a sub-index is not likely to have significant impacts on the final energy security index. In each sub-index, the component metrics are each assigned a weight that reflects each metric's proportional share of the sub-index. Certain metrics with a potentially larger impact on geopolitical risk would be weighed more heavily in that sub-index than a metric with a smaller effect. These weights are potentially subjective, but because they are based partly on historical trends, the U.S. Index manages to create a relatively realistic weighing of sub-indexes and their metrics.

After each of the individual metrics and sub-indexes are calculated, each of the impacts on the four sub-indexes is combined to generate a single number representing U.S. energy security. A score of 100 here represents the low energy security (high energy security risk) of the baseline 1980 year, meaning that anything close to 100 represents an insecure U.S. energy landscape. This proposal will only use this final combined number, but in theory any of the sub-index numbers could be used to measure more specific impacts. All of the numbers used in this proposal will be calculated as differences in energy security from the reference case to isolate the specific impacts of different policy cases.

III. Methodology: energy security risk as a decision-making tool

Every year, the EIA produces the *Annual Energy Outlook*, which contains a number of projections and model runs for potential policy cases. These potential policies are modeled as EIA's 'side cases.' Examples include the 'High Oil Price' case, which evaluates the impacts of lower global supply of oil and higher demand in non-member Organization for Economic Co-operation and Development (OECD) states. Another example is the 'GHG25' (Greenhouse gas) case, which evaluates the impacts of a \$25/metric ton tax on carbon that rises 5% yearly from 2015 to 2040 (EIA, 2014).

By plugging in projection data from these model runs into the established method of calculating energy security, one can project the impact of each side case on U.S. energy security. Comparison of projected energy security numbers with projected CO_2 emissions or GDP, for example, allows a policymaker to generate a much more informed cost-benefit analysis through which one can compare policies. For example, policymakers can decide between the following two policies. The first is a policy that has a very strong positive effect on energy security despite only moderate reductions in CO_2 emissions. The second is a policy with a small positive effect on energy security and a large reduction in emissions. Without an ability to quantify the magnitude of these impacts, policymakers are left with policies that both seem to increase energy security and reduce emissions, a simplifying assumption that does not communicate the tradeoff between emissions and energy security that exists in both policies.

The clearest way to show this tradeoff is by creating a scatter plot that charts both a policy's impacts on energy security and on another policy goal based on their projected numbers in 2040, the last year of the EIA projections. A plot of energy security versus GDP is shown in Fig. 1.1, which plots the differences between various side cases[2] and the EIA's reference case, with each data point representing each side case's unique trade-off between GDP and energy security. Thus, a business-as-usual policy is by definition represented by the reference case at the (0,0) origin point, indicating no change. Note that on the x-axis, a higher energy security risk score means more energy insecurity. As such, the portions of the axes that represent lower GDP or and energy security have been labeled red, while the opposite changes are labeled blue. Policymakers should generally try to avoid policies that delve too far into the red portion of an axis without strongly considering the relevant trade-offs. Exceptions to this rule exist. For example, an economy in severe recession might choose to increase GDP growth even if this comes at the cost of large increases in CO_2 emissions. In the other figures, the red portions of axes similarly represent a negative effect on that particular policy metric. A more in-depth analysis is described below.

IV. Applications of the method: weighing energy security versus singular policy goals

This section generates a number of graphs similar to Fig. 1.1 in order to demonstrate the method of weighing energy security versus GDP and CO_2 emissions. It should be noted that this analysis could be easily expanded to include other policy goals, such as minimizing energy expenditures per household.

Energy security versus GDP. Fig. 1.1 shows the example case of energy security weighed against GDP. The EIA cases with the largest impacts are circled and labeled. A decrease in energy security risk and an increase in GDP would ideally be goals of U.S. energy policy that is focused on the two variables of energy security and GDP. Therefore, the best policies, based on this graph, would be in quadrant II, where cases A, B, and C are located. Quadrant IV would be the worst-scenario cases, but Case D has been singled out due to its unique combination of a sizable growth in GDP and a significant decrease in energy security. An examination of the economic impacts alone would not depict the magnitude of this policy's detrimental effects on energy security. Fig. 1.2 summarizes the details of each labeled case and resulting impacts on energy security and GDP. The descriptions for the other cases can be found in the EIA's *Annual Energy Outlook 2014* but have been left out of this proposal for the sake of brevity.

From examining Figs. 1.1 and 1.2, one can see visually and numerically that, in terms of improving energy security and GDP, the 'High Oil and Gas Resource' case, labeled as Case A, is an ideal combination of an increase in both energy security and GDP. While other cases, including the 'Electricity: Low Nuclear' and 'Low Oil Price' cases labeled as Cases B and C similarly generate improvements in both categories, it is Case A that

[2] All of EIA's cases were included except for the 'Low Economic Growth' and 'High Economic Growth' cases. As severe outliers, these were left off to enhance the readability of the graphs.

has the most significant overall impact. Policymakers who want to improve both energy security and GDP should tailor policies to drive the U.S. towards the circumstances modeled in Case A. More specific policy recommendations are in a later section.

Fig. 1.2: Selected EIA case descriptions, energy security versus GDP

Case label	EIA case name	EIA case description	Energy security risk impact	GDP impact
A	High Oil and Gas Resource	Estimated ultimate recovery per shale gas, tight gas, and tight oil well is 50% higher and well spacing is 50% lower (or the number of wells left to be drilled is 100% higher) than in the Reference case. In addition, tight oil resources are added to reflect new plays or the expansion of known tight oil plays and the estimated ultimate recovery for tight and shale wells increases 1%/ year to reflect additional technological improvement. Also includes kerogen development, tight oil resources in Alaska, and 50% higher undiscovered resources in the offshore lower 48 states, Alaska, and shale gas in Canada than in the Reference case.	-11.1	306.6
B	Electricity : Low Nuclear	Begins with the Accelerated Nuclear Retirements case and combines with assumptions in the High Oil and Gas Resource and the No Sunset cases.	-9.7	242.1
C	Low Oil Price	Low prices result from a combination of low demand for petroleum and other liquids in the non-Organization for Economic Cooperative Development (non-OECD) nations and higher global supply. Lower demand is measured by lower economic growth relative to the Reference case. On the supply side, the Organization of the Petroleum Exporting Countries (OPEC) increases its market share to 51%, and the costs of other liquids production technologies are lower than in the Reference case. Light, sweet crude oil prices fall to $70/ barrel in 2017 and rise slowly to $75/barrel in 2040.	-11.7	54.4
D	High Oil Price	OECD nations and lower global supply. Higher demand is measured by higher economic growth relative to the Reference case. OPEC market share averages 37% throughout the projection. Non-OPEC petroleum production expands more slowly in the short to middle term relative to the Reference case. Crude oil prices rise to $204/barrel (2012 dollars) in 2040.	8.6[3]	101.8

[3] Note that an increase in energy security risk reduces overall U.S. energy security

Fig. 2.1: Differences in energy security risk versus CO2 emissions among the EIA side cases

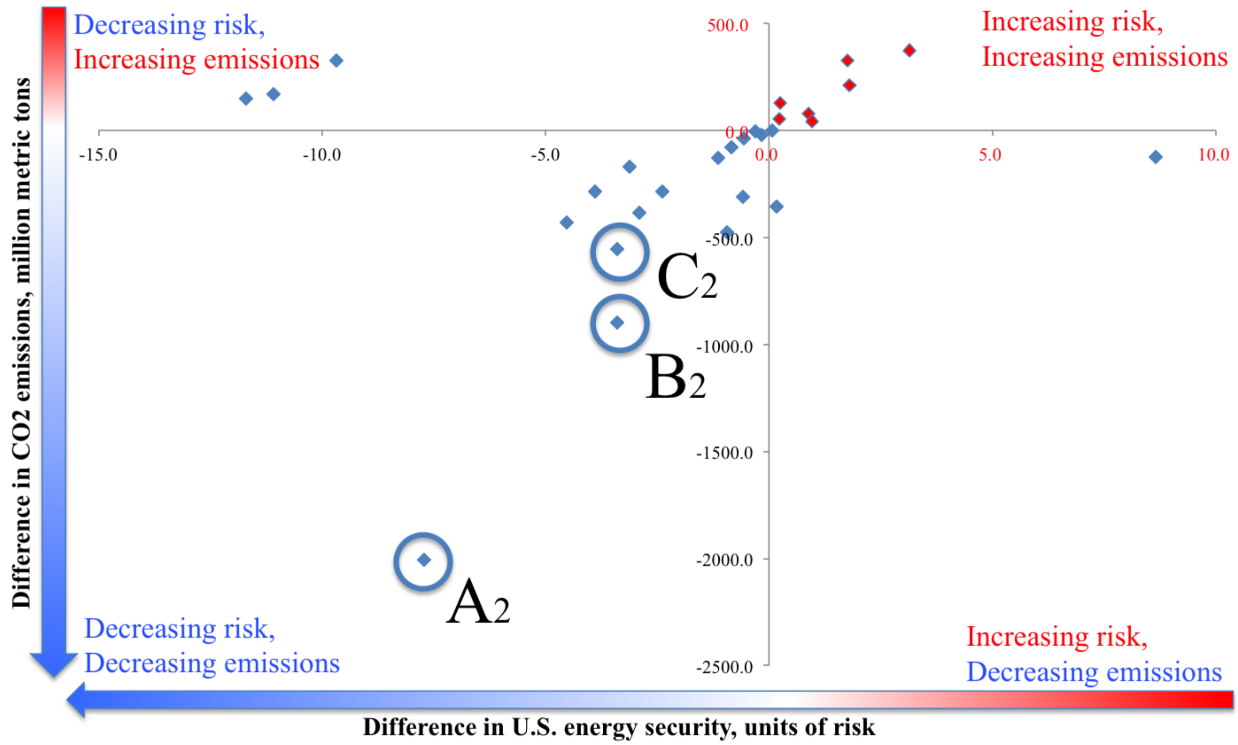
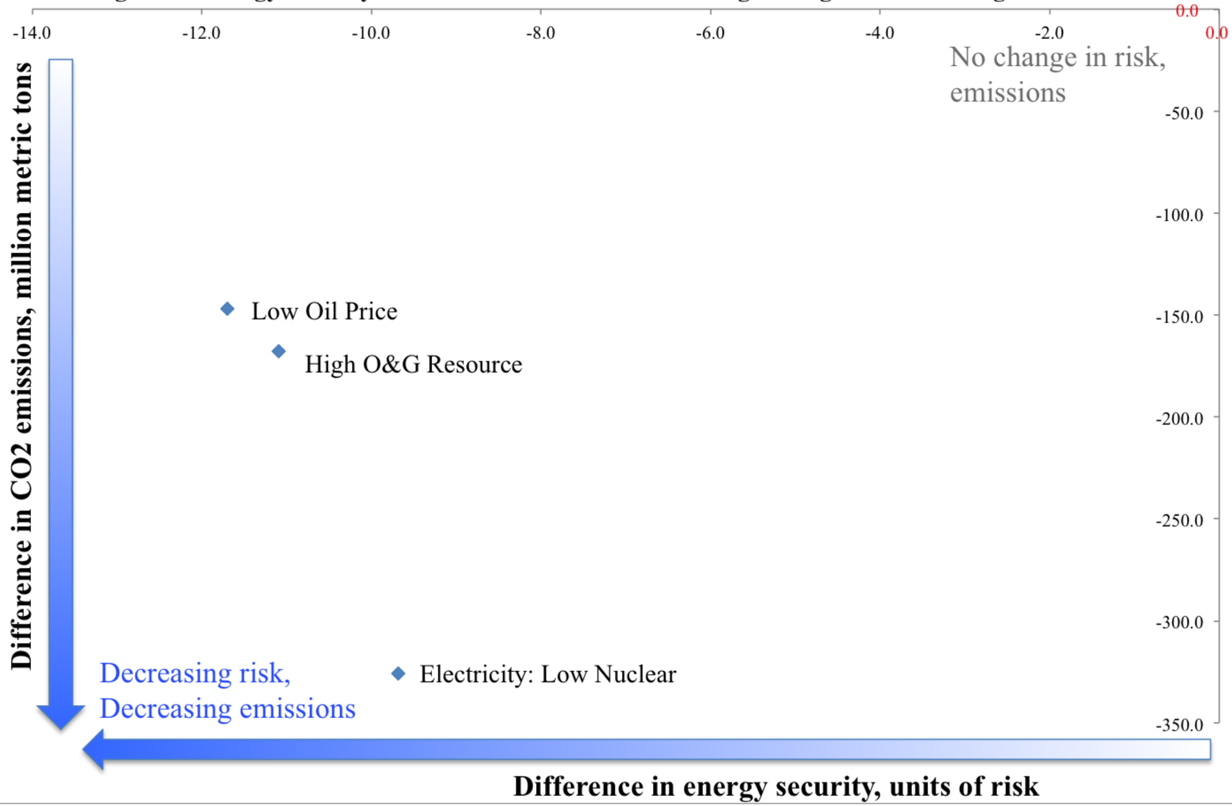


Fig. 2.2: Selected EIA case descriptions, energy security versus CO2 emissions

Case label	EIA case name	EIA case description	Energy security risk impact	CO2 emissions difference
A_2	GHG25 ($25 CO2 tax)	Applies a price for CO2 emissions throughout the economy, starting at $25/ metric ton in 2015 and rising by 5%/year through 2040.	-7.7	-2007.7
B_2	GHG10 ($10 CO2 tax)	Applies a price for CO2 emissions throughout the economy, starting at $10/ metric ton in 2015 and rising by 5%/year through 2040.	-9.7	-895.9
C_2	Low Electricity Demand	This case was developed to explore the effects on the electric power sector if growth in sales to the grid remained relatively low. Begins with the Best Available Demand Technology case, which lowers demand in the building sectors, and also assumes greater improvement in industrial motor efficiency.	-3.4	-556.2

Figure 3: Energy security risk versus CO2 emissions among the highest economic growth cases



Energy security versus CO2 emissions. Fig. 2.1 shows energy security weighed against CO2 emissions. Potential policies would ideally increase energy security (a decrease in energy security risk) while decreasing CO2 emissions. These policies, including the cases labeled A–C, are in quadrant III, while the policies in quadrant I that decrease energy security and increase CO2 emissions should be avoided if at all possible. Fig. 2.2 summarizes the details of each case and resulting impacts on energy security and CO2 emissions.

From Figs. 2.1 and 2.2, a tax on carbon (Cases A_2 and B_2) seems to be the most effective way of increasing energy security while reducing CO2 emissions. Policymakers who are solely focused on energy security and reducing CO2 emissions should promote policies similar to the two carbon taxes modeled in the EIA's side cases. Case C_2, a 'Low Electricity Demand' case, is also a relatively good policy option. Again, more specific policy recommendations are in a later section.

V. Applications of the method: weighing energy security versus multiple policy goals

The method laid out in this proposal simplifies the process of evaluating and generating worthwhile policies by directly comparing energy security and other long-term policy goals. However, there are often multiple policy goals that a policymaker attempts to address. Regarding the three policy goals examined, an ideal policy would increase energy security and GDP growth while reducing CO2 emissions. It is unlikely that one policy most effectively accomplishes every individual goal without trade-offs with other goals. For example, while a $25 carbon tax is extremely effective at reducing CO2 emissions and increasing energy security, such a policy would reduce GDP by 113.4 billion dollars compared to the reference case[4]. Some level of trade-off is therefore unavoidable.

An 'ideal' policy is dependent on the relative weight that one assigns to different policy goals. The example used here is a policymaker in a struggling economy that would prioritize GDP growth and energy security over choosing a policy for a maximum amount of CO2 reductions. Using a list of

[4] Derived from EIA numbers using the U.S. Index's methodology

the top three policies that maximize GDP growth and increase energy security (Cases A–C from Figs. 1.1, 1.2), one can then plot these policies on a graph measuring energy security versus CO2 emissions to pick the best policy for CO2 emission reductions out of the three highest GDP growth cases. An example is given below in Fig 3. Given that Figs. 1.1 and 1.2 show that the 'High Oil and Gas Resource' and 'Electricity: Low Nuclear' cases generate significantly more economic growth than the 'Low Oil Price' case, policymakers in this example should craft policy that pushes the U.S. towards one or either of the two former cases. Both of these policies increase CO2 emissions compared to the reference case. The 'Electricity: Low Nuclear' case increases emissions significantly more than the 'High Oil and Gas Resource' case, meaning that policymakers seeking to minimize CO2 emissions should be wary of the former case.

VI. Policy recommendations

The first and foremost recommendation for this proposal is that policymakers should quantify an index or metric of U.S. energy security to use as a consideration in crafting energy policy.

This proposal outlines one method of creating such an index. Different metrics and different weights of metrics could potentially be utilized, but the general methodology of the proposal in quantifying and weighing metrics should remain the same. The value of having a systematically quantified number representing U.S. energy security should be clear. A measure of U.S. energy security should ideally use publicly available data and a transparent methodology of weighing different metrics. Quantifying energy security allows policymakers to more accurately compare the long-term effects of different energy policies on a number of different goals. Furthermore, policymakers can quantify the impacts of policies after implementation on energy security.

To best utilize this proposal's method, policymakers should have clearly defined, ordinal policy priorities. Energy security, economic growth, and environmental concerns are top priorities in energy policy debates today (Medlock, 2009). The top priority as examined in this section is energy security, with GDP growth and CO2 emissions being secondary and tertiary considerations, respectively.

We will briefly consider a hypothetical scenario in which a policymaker might have these issues in mind. In this scenario, a moderately sized industrializing economy, Country A, exists in the 21st century. Cognizant of the economic shocks caused by low energy security in the U.S. in the 1970s, Country A decides that avoiding these economic dislocations is the top priority of its energy policy and aims their top focus on energy security. However, as a developing economy, Country A would also like to maintain steady economic growth. GDP growth then becomes Country A's second priority. Finally, climate change is becoming a more pressing issue for the coastal regions of Country A. Consequently, policymakers would like to minimize CO2 emissions but not at the cost of energy security and economic growth. This could mean choosing a policy that increases CO2 emissions slightly as long as this is accompanied by a significant increase in energy security and GDP growth.

With these same priorities in mind, policymakers should implement policies that move the country towards the most net-beneficial EIA side cases. In the scope of this proposal, this means scenarios where energy security and GDP growth increase and CO2 emissions increases are minimized. Using EIA's future modeled data plugged into the U.S. Index's method, the following are specific policy recommendations to move the U.S. towards these modeled side cases. As the EIA data are U.S.-specific, these recommendations are designed to be implemented in the U.S. with the assumption that the U.S. shares policy priorities with Country A.

1. Actively pursue recovery of unconventional fossil fuels

This would move future U.S. policy towards a scenario more consistent with the 'High Oil and Gas Resource' case modeled by EIA. From an evaluation of the policy goals of energy security, economic growth, and reduction of CO2 emissions, recovering unconventional fossil fuel resources creates significant benefits in energy security and economic growth with a relatively moderate increase in CO2 emissions compared to other high economic growth cases.

2. Pursue policies to reduce electricity demand, such as improving energy efficiency

Lowered electricity demand decreases CO2 emissions while generating a moderate increase in energy security and GDP growth.[5] While these increases are not as significant as the growth in some of the other cases, they are nevertheless an improvement on the reference case. Furthermore, increased recovery of unconventional fossil fuels in combination with lowered electricity demand would moderate the increases in CO2 emissions the former case would cause while generating better energy security and higher GDP growth compared to just the latter case.

These policy recommendations are nothing new in the energy policy world. The fact that EIA bothered to model these specific cases reveals the prominence of these policy scenarios. It is tempting to evaluate the merit of these policy scenarios from the framework of environmental or economic costs. For example, increased unconventional fossil fuel production is often criticized because of an accompanying increase in CO2 emissions, while carbon taxes are criticized for hurting the economy. These concerns are incorporated into EIA's modeling predictions and consequently into this proposal's method.[6] This proposal's method allows one to quantitatively analyze the tradeoff between these negative impacts and the positive impacts that these policies have on energy security, CO2 emissions, and economic growth. Policymakers can now quantify how much the benefits might exceed the costs within specific policies and across different policy scenarios.

VI. Limitations and further research

Several limitations exist in regards to this proposal. First, there are limitations in forecasting, particularly when it comes to a multifaceted goal such as increasing energy security. EIA's forecasts assume no drastic changes other than the policies that each case models and as such do not account for unexpected events and developments in energy policy.

The second limitation is more specific to this proposal. There is ultimately no definitive, foolproof way to objectively forecast and measure something as complex as U.S. energy security. All indices and measures of energy security, including the U.S. Index, weigh metrics in an inherently approximate and subjective way. The purpose of this proposal is to suggest a general method of calculating and utilizing a measurement of energy security that policymakers can use to evaluate how policies' effects on energy security trade off with effects on other policy goals.

VII. Conclusion

Despite its importance as a goal for energy policy to strive towards, quantifying energy security is a relatively underdeveloped area of energy policy. Policymakers looking to mitigate the impact of energy supply disruptions on energy prices would like to increase energy security through various policies. Not utilized in the current decision-making process is a quantification of the impacts of these policies on energy security. Policymakers looking to increase energy security cannot compare the relative magnitude of benefits to energy security between multiple policies. Furthermore, the accompanying trade off between energy security and GDP or CO2 emissions should further be an element in the decision-making process. As beneficial as energy security is, it would not be in a policymaker's interests to increase energy security at the cost of reduced economic output and drastically increased CO2 emissions.

By using methods similar to the outlined process and methodology described in this proposal, policymakers can now quantify energy security in a way that allows them to weigh benefits to energy security as one of many factors in crafting energy policy. This would allow policymakers to get a more complete understanding of the effects of different policies on energy security, GDP, and CO2 emissions. As the energy world undergoes massive changes and remains inextricably tied to national interests, this kind of multifaceted understanding of energy policy becomes increasingly vital to policymakers, the energy economy, and the country as a whole.

[5] GDP would increase by 92.7 billion dollars as compared to the reference case

[6] For example, EIA's 'GHG25' carbon tax case shows a decrease in GDP of 119.4 billion dollars when compared to the reference case. The 'High Oil and Gas Resource' case shows an increase of 167.6 million metric tons of CO2 emissions (EIA, 2014).

References

EIA. *Annual Energy Outlook 2014*. Rep. U.S. Energy Information Administration, 7 May 2014. Web. 25 July 2014.

Freedom House. "Freedom in the World." Freedom House. January 1, 2014. Web. 21 December 2014.

IEA. "IEA- Energy Security." *International Energy Agency*. International Energy Agency, n.d. Web.25 July 2014.

Institute for 21st Century Energy. *Index of U.S. Energy Security Risk, 2013 Edition*. Rep. Institute for 21st Century Energy, 2013. Web. 25 July 2014.

Institute for 21st Century Energy. *Index of U.S. Energy Security Risk, 2014 Edition*. Rep. Institute for 21st Century Energy, 2014. Web. 5 January 2015.

Medlock III, Kenneth B. "Energy Demand Theory." In International Handbook on the Economics of Energy, 89-111. 2009.

Yergin, Daniel. "Ensuring Energy Security." In Foreign Affairs, 69-82. March/April 2006 ed. 2006.

Author Biography

Bo Kim is a third-year undergraduate student at Rice University in Houston, Texas, where he studies Art History and Economics. His research interests include energy policy and asylum policy. After graduation, he plans on attending law school. The author worked as a fellow for the Institute for 21st Century Energy at the U.S. Chamber of Commerce in the summer of 2014. During this period, he helped to collect and analyze data for the 2014 edition of the Institute's Index of U.S. Energy Security Risk. The author greatly appreciates the guidance and help of Steve Eule and Karen Harbert in formulating the idea for and assisting in the creation of this proposal.