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The four 'R's of energy security[1]

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Abstract

Energy can be a confusing issue to the general public, policymakers, and politicians. Adding energy security to the lexicon has not provided any clarification. To assist in explaining some of the concepts associated with energy security and to show how an individual or organization can improve energy security, this paper introduces the "four 'R's of energy security": review (understanding the problem), reduce (using less energy), replace (shifting to secure sources), and restrict (limiting new demand to secure sources).

Keywords: Energy education, energy services, climate change.

1. Introduction

It is generally agreed that energy and energy policy are poorly understood by most members of the general public and many politicians (McKeown 2007). This is due to a variety of reasons, including the ongoing debates over nuclear power, oil company profits, and misconceptions regarding renewables (Brown 2007). For many people, the lack of understanding extends to the fundamentals associated with many energy services (Smith 2002).

Energy security, the reliable supply of energy at an affordable price (IEA 2001), is becoming an important issue in many jurisdictions, as a result of the volatility in world energy markets, the growing competition for energy resources, and the need for economic development and poverty reduction (World Bank 2005). Not surprisingly perhaps, energy security, like energy, is also often misunderstood. Indeed, in the United States, energy security and energy independence are often mistakenly used interchangeably (Bryce 2008).

This paper presents a methodology that can be used to explain energy security and how it can be improved to the general public, policy analysts, and politicians. The methodology consists of four 'R's: review (understanding the problem), reduce (using less energy), replace (shifting to secure sources), and restrict (limiting new demand to secure sources). It can be applied to the

energy services used by individuals and organizations and can also be employed as a method for developing a jurisdiction's energy policies and improving its energy security (Hughes 2007).

2. Understanding the problem: Review

The state of a jurisdiction's energy security is dictated by its energy supplies, the infrastructure required for producing, distributing, and possibly storing the energy, and the associated costs to the consumer.

The first 'R' of energy security is a review of the following:

- Existing sources, suppliers, and supplies of energy. This part of the review examines the state of the jurisdiction's energy sources. Energy sources are ranked in terms of how secure they are deemed to be (Hughes and Sheth 2008).
- Existing infrastructure, energy services, and energy intensities. The review should be done by sector as deeply as possible; for example, rather than simply "residential demand", the sector's energy services, such as heating, cooling, hot water, appliances, and lighting, should be considered individually.
- Potential secure energy supplies. The final part of the review examines the various secure energy supplies that are available to the jurisdiction, an analysis of the infrastructure needed to support these energy supplies, and the cost of embracing them.

The relationship between supply and infrastructure leads to two corollaries: first, the lack of infrastructure will exclude the consumer from accessing those forms of energy that rely on it, and second, the absence of affordable supply, regardless of the availability of infrastructure, will mean the consumer is unable to benefit from that energy source.

3. Using less energy: Reduce

Actions that lead to a reduction in energy demand can have an impact on energy security. Energy reduction, the second 'R' of energy security, can be accomplished through energy conservation or energy efficiency, or both. In energy conservation, less energy is available for a

particular energy service, meaning that the same service is not performed to its previous levels, whereas energy efficiency allows the same level of service to be achieved with less energy.

Of the two approaches to reduction, conservation measures can be introduced rapidly and, typically, with little cost; for example, lowering room temperatures, reducing roadway speeds, and turning off unnecessary lighting. However, because of reduced levels of service and potential changes to lifestyle, conservation has the undeserved reputation of being a virtuous rather than a practical activity (Kettle, Brown and Milner 2001).

Energy reduction through energy efficiency measures generally take more time and money to implement than does conservation; however, it can offer greater reduction potential. Examples of this approach include insulating a building to reduce heat loss, purchasing a vehicle with an improved fuel economy, and replacing incandescent bulbs with lower wattage compact fluorescents bulbs or light emitting diodes.

There are limits to how far conservation and energy efficiency can improve energy security. With energy conservation, consumers can return to their previous habits; for example, in 1972, to reduce gasoline consumption in the United States, President Nixon lowered highway speeds to 55 miles-per-hour (Woolley and Peters 2007a)—however, by 1977, President Carter noted that average interstate highway speeds had returned to 65 miles-per-hour (Woolley and Peters 2007b). The benefits of energy efficiency are often overstated by their proponents (Gottron 2001) and there is evidence of consumers parlaying savings into other energy intensive activities, offsetting some of the expected benefits, resulting in the rebound effect (Sorrell 2007).

Rising energy prices may induce energy reduction, as individuals and organizations look for ways to reduce their energy costs. Reduction can be allowed to occur through market forces resulting in demand destruction (Gue 2008), or it can be addressed through government policies that encourage reduction before rising energy prices make serious impacts on society.

There are a number of ways in which reduction can be measured, perhaps the most common being energy intensity or the amount of energy consumed per activity (USDOE 2008). Lowering energy intensity does not necessarily lead to an overall reduction in physical consumption, as

increasing the level of activity (population growth, house size, distances travelled) can result in an increase in consumption despite a decrease in intensity.

Reducing energy consumption does not automatically mean an improvement in energy security. If the reduction measures target secure sources, there may be an overall reduction in energy consumption, but the reliance on insecure sources may remain unchanged.

4. Shifting to secure sources: Replace

Although reduction is an important component in any energy security policy, its impact is limited by the fact that any system (be it household, industry, or country) requires a minimum level of energy to function. Therefore, in addition to reducing demand, improving energy security also requires the replacement of insecure energy supplies with secure ones—the different energy sources and their related services can be identified during the review process. In general, replacement, the third 'R' of energy security, is achieved by either diversifying energy supplies or changing infrastructure to allow alternative energy sources.

In diversification, the same form of energy is used the meet the demands of the energy service, but the supplier changes, ideally from less secure to more secure. One of the earliest references to the need for diversification is attributed to Winston Churchill in 1910, when, after overseeing the conversion of the Royal Navy to potentially insecure sources of Persian oil, he stated, "Safety and certainty in oil lie in variety and variety alone" (Yergin 2006). A more recent example of diversification was caused by the oil embargos of the 1970s, after which the United States replaced much of its Middle Eastern oil imports with supplies from Canada, Venezuela, Mexico, and Nigeria (EIA 2008).

Alternative energy sources differ from the existing energy source but perform the same or similar task, often using different infrastructure. One such example is the worldwide switch from oil to coal and nuclear for electrical generation in the late 1970s due to rising oil costs, driven in part by the first oil shock in 1970s (Gue 2008). The move from coal to natural gas and nuclear in the UK for electrical generation is another; driven largely by the coal miners' strike in the UK which threatened supply in the early 1980s (Parker and Surrey 1995). Iceland's plans for a hydrogen economy would allow it to replace imported oil (Blanchette 2008).

Given the energy requirements of the transportation sector, significant replacement programs have been established in most major economies. The EU's biodiesel program (EU 2006) and the US's renewable fuels program (Energy Independence and Security Act 2007) are examples of replacement policies intended, in part, to improve energy security.

5. Limiting new demand to secure sources: Restrict

Jurisdictions, such as those that are undergoing industrialization, economic growth, or increasing affluence, will often experience an increased demand for new supplies of energy. Since replacement refers to existing demand, a fourth 'R', restriction, is introduced with the intention to limit new demand to secure sources. Restricting energy sources to ones that are secure may be easier said than done as the jurisdiction may not have sufficient secure energy sources or infrastructure, or both, to meet the new demand. Short of curtailing growth, in these cases, the best available option is to have the jurisdiction maximize its use of secure sources, leaving the remainder in an insecure state.

A number of US states have enacted RPS (Renewable Portfolio Standard) legislation, for emissions reduction or energy security, or both. Connecticut's RPS is an example of restriction in that it requires its electricity providers to meet a percentage of their total retail load from renewable sources (Connecticut 2007). The percentage starts at 4.5 percent in 2005, increasing to 27 percent by 2020. Since the legislation allows intermittent renewables, a portion of the supply will require a secure backup.

6. Climate change and the four 'R's

Given the relationship between energy and climate change, it should not be surprising that the four 'R's can also be applied to energy-related climate change policies. By developing energy policies that address both energy security and climate change together, potentially costly and counter productive programs can be avoided. For example, with respect to energy reduction, security and climate policies can be identical as both can lead to a reduction in the consumption of fuels that are responsible for greenhouse gas emissions. However, energy replacement and restriction may not permit the same advantage—a jurisdiction may be faced with a shortage of insecure natural gas, forcing it to replace natural gas with secure supplies of coal for its

electrical generation. In this case, replacement and restriction may be more secure, but the results may be detrimental to the climate.

7. Summary

Increasing concerns over energy security and the environmental impact of anthropogenic energy consumption have highlighted the shortcomings of energy knowledge in the public, some policymakers, and many politicians. Increasing public understanding of energy issues will be essential to the health and well-being of any economy and society in the twenty-first century.

This paper has presented a concise and versatile methodology that can be applied to any energy security problem. The four 'R's of energy security explain the actions needed to improve energy security, beginning with understanding the problem (review), using less energy (reduce), shifting to secure sources (replace), and limiting new demand to secure sources (restrict).

The method can be used as an educational tool or more formally, to initiate the development of improved energy security policies. The four 'R's concept has already been employed as a means to explain energy security and climate issues to members of the general public, and provincial and federal politicians in Canada (Hughes 2008). Commercial and community organizations have incorporated the tool into their strategic planning efforts and it has been applied to develop energy policies in several jurisdictions.

We believe the four 'R's can be made even more successful by incorporating measurement and visualization tools to assist in identifying a jurisdiction's current energy security status and indicating pathways to improved energy security. Research in this area is ongoing.

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