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DISCUSSION BRIEF

Energy security should have more weight in low carbon scenarios

Introduction

Energy security is an important pillar of energy policy, yet it generally gets only superficial treatment in low carbon scenarios and roadmaps. To illustrate this point, this brief focuses on how energy security is dealt with in the EU's Energy Roadmap 2050 (European Commission, 2011a). We observe that the roadmap charts only a few aspects of energy security, such as import dependency and variable electricity production. Certainly, a more comprehensive analysis of security aspects would have made the roadmap even more useful as a basis for developing comprehensive energy policy. Such an analysis would require more elaborate and detailed descriptions of energy scenarios, as well as broader and more sophisticated approaches to the concept of energy security.

Background

Low carbon transitions entail extensive changes to our energy systems. The most important changes include large improvements in energy efficiency, increased use of variable renewable energy sources (e.g. wind and solar power), electrification of transport and industry, the use of carbon capture and storage and, in some countries, an expansion of nuclear power (see e.g. IEA, 2012; GEA, 2012). Existing future scenarios and roadmaps typically give serious treatment to resources, technologies, emissions and economic implications, but they are generally weak on examining consequences for energy security. Alas, there is a risk that security aspects are overlooked when policies are formulated.

The Energy Roadmap 2050 was presented in 2011 by the European Commission, together with a thorough impact assessment (European Commission, 2011b). The roadmap sets out possible trajectories for the EU energy system for the period up to 2050. All the scenarios are consistent with the EU target of reducing greenhouse gas (GHG) emissions by 80% by 2050. (This is the same target that is set in the roadmap for a low-carbon society presented by the Commission earlier the same year) (European Commission, 2011c).

The three pillars of EU energy policy are: (1) *sustainability*, with a focus on climate change mitigation, (2) *security of supply*, and (3) *competitiveness*. Naturally, EU energy policy needs to be coordinated and integrated in order to effectively implement the three pillars. However, the political priority given to each of the three pillars and their relative importance has varied over time and is also perceived differently by different member states. Climate change mitigation gained massive political momentum in the early 2000s, but has gradually lost ground, while energy security has become increasingly prominent on the political agenda since the mid-2000s (Nilsson, et al. 2009). The winds may well change again, but for long-term energy transitions to succeed, it is vital that all three policy pillars receive serious and consistent treatment.

Energy security is often used as a synonym for security of supply, or, even more narrowly, import dependency. But in reality, energy security is a multidimensional and complex concept that encompasses issues such as security of demand, and economic, social and political risk. Such issues are associated with, for example, affordability; energy poverty and revenues from energy; geopolitical considerations (connected to security, defence and political implications); livelihoods; human security; and political stability in exporting countries. Moreover, there are technological and environmental risks associated with the concept of energy security (see e.g. Johansson, 2013).

Although a few of these issues are included in strategies presented by the EU, such as the second strategic energy review (European commission, 2010), the feature of energy security most discussed in EU policy documents is security of supply. Policy-makers thereby can miss important security aspects of alternative energy strategies, which increases the risk of incoherence between policy frameworks in the broader EU policy arena (including security policy, foreign policy, protection of critical infrastructure, civilian and military crisis management, economic and environmental policy, etc.). Conversely, the integration of a broader energy security frame into key policy documents and impact assessments could enable more coherent policy-making.

Below, we briefly present the Energy Roadmap 2050 and its scenarios, followed by a short description of how the relation between energy and security could be framed. Then we discuss how and to what degree security aspects of the EU energy system have been presented in the roadmap and its accompanying impact assessment. Finally, we discuss if and how a broader and more sophisticated analysis of security aspects could be

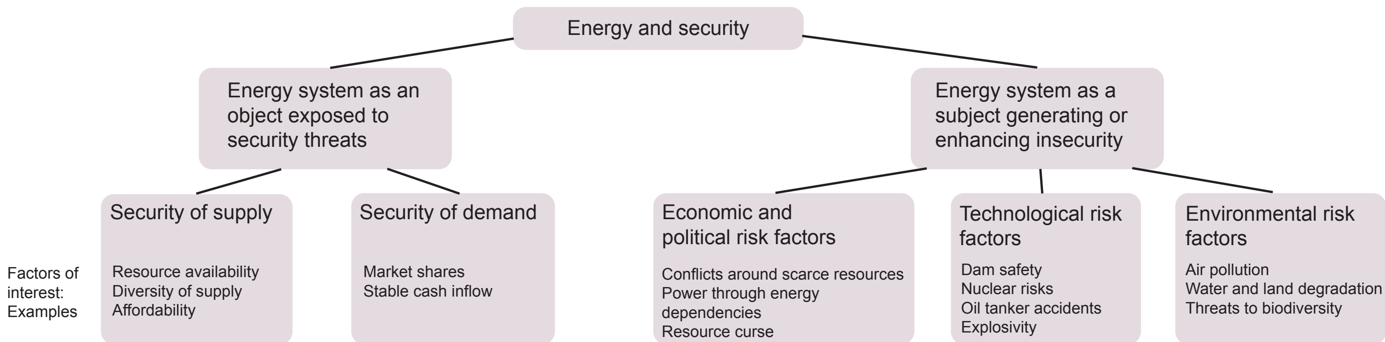

Figure 1: The analytical structure used in this brief to study the relations between energy and security

Developed from Johansson (2013)

Table 1: Characteristics of Energy Roadmap 2050 scenarios. All values are for 2050.

	Current trend scenarios		Decarbonization scenarios				
	Reference scenario	Current policy initiatives	High Energy Efficiency	Diversified Supply Technologies	High Renewables	Delayed CCS	Low Nuclear
Primary energy demand (% reduction compared with 2005)	-3.5	-11.6	-40.6	-33.3	-37.9	-32.2	-37.7
Electrification (% of total)	29.1	29.4	37.3	38.7	36.1	38.7	38.5
Renewables in gross final consumption (% of total)	25.5	29	57.3	54.6	75.2	55.7	57.5
CCS in power generation (% of total)	17.8	7.6	20.5	24.2	6.9	19	31.9
Nuclear energy in primary energy (% of total)	16.7	13.5	13.5	15.3	3.8	17.5	2.6
Import dependency (% of total)	57.6	58.0	39.7	39.7	35.1	38.8	45.1

Based on European Commission, 2011b, p. 38

developed from the scenarios and what further information would be necessary in order to do so.

The EU's Energy Roadmap 2050 and its scenarios

The roadmap itself is a rather short document (20 pages), while the accompanying impact assessment is rather long (110 pages). The impact assessment is dominated by a detailed description of a group of scenarios. These are: a reference scenario with a number of sensitivity analyses, a current policy initiative scenario, and five emission mitigation scenarios that lead to emission reductions in accordance with EU climate policy goals.

In the roadmap the Commission "explores the challenges posed by delivering the EU's decarbonisation objective while at the same time ensuring security of energy supply and competitiveness" (European Commission, 2011a, p. 2). More specifically, the roadmap is expected to provide more certainty for investors about possible future policy orientations at the EU level, show trade-offs among objectives as well as among different decarbonization scenarios, and set milestones after 2020 in order to mobilize stakeholders (European Commission, 2011d).

The five mitigation scenarios are labelled High Energy Efficiency, Diversified Supply Technologies, High Renewables, Delayed CCS and Low Nuclear. The scenarios are quantitative and based on calculations using the PRIMES model, which finds the most cost effective system under various boundary conditions and technology assumptions. The scenarios are developed by varying the assumptions made about various policy instruments and technology options. Some parameters vary considerably between the scenarios but others, such as the level of primary energy required, differ only marginally (Table 1).

While the impact assessment does include calculations of energy balances for various sectors, it does not give details on infrastructure development, geographic positioning of energy plants, or resources used. Thus, this lack of transparency means that several security implications cannot be adequately evaluated or taken into account.

Energy and security

The interaction between energy and security policy objectives can be viewed from many different angles, and in recent years several studies have presented analytical frameworks and indicators in order to capture the essence of the concept (see e.g. Ciută, 2010; Chester; 2011; Sovacool and Mukherjee, 2011; Cherp and Jewell, 2011; Winzer, 2012). As argued above, a broad approach is necessary to give serious treatment to the security aspects of energy policy, and should include both risks and threats to a well-functioning energy system (energy as an object) and situations when the energy system contributes to or enhances broader security threats to society (energy as a subject).

In this brief we apply a similar approach, shown in Figure 1, to our analysis of how security issues are treated in the Energy Roadmap 2050. The "energy as an object" part of our approach includes a focus on both security of supply and security of demand, depending on from whose perspective the analysis takes its starting point. The threats to a functioning energy system can have technological, natural and human causes and depend on, for example, intentional attacks, low investment in capital and human resources, and poor governance. The "energy as a subject" part includes circumstances where energy contributes to or enhances insecurity or conflicts. These might be a consequence of energy's economic value and the potential to use it as a weapon, either via political pressure at the international level or through other antagonistic threats (e.g. terrorism). Energy technologies can also be a risk factor due to their physical and chemical properties (e.g. risks associated with radiation, toxicity, or fire and explosions) and can also increase environmental risks (besides emissions of GHGs these include pollution to air, land and water, water consumption and land use).

Energy and security in the EU's Energy Roadmap 2050

The roadmap does not set out to exhaustively analyse the effects of energy policy on security issues: Climate change mitigation is its central concern, which limits the possible trajectories that the energy system can take. The accompanying impact assessment introduces four risks to security of supply, i.e. import dependency, depleting fossil fuel resources, more variable electricity production, and low resilience to natural and man-made disasters. However, only effects on import dependency and more variable electricity production are actually discussed.

Import dependency

The impact assessment quantifies import dependency for each scenario and compares between them. Import dependency varies little among the decarbonization scenarios, and is much lower in all of these than in the reference scenarios. However, there is an assumption in the decarbonization scenarios that renewable energy will be domestically produced, but the underlying reasons for this are not clear. Furthermore, this assumption is not fully consistent with the main text of the roadmap, which argues that renewable and low-emission sources in the Southern Mediterranean should be encouraged, facilitated and developed, and states an interest in importing renewable energy from non-EU countries, such as Russia and Ukraine (European Commission, 2011a, p. 11). It is also stated that natural gas is the fossil fuel with the lowest carbon content (and thus preferable from the perspective of GHG mitigation) but that it is a fuel that poses a challenge to security of supply, especially for countries with few supply routes. There is, however, little analysis of whether the present low diversity of gas supply will remain until 2050.

How relevant is the question of import dependency for energy security? Analysts argue (e.g. Yergin 2013) that diversity of suppliers and global market conditions are of central importance. However, neither of these factors is really dealt with in the roadmap. Moreover, import dependency is presented as a percentage of total supply, while import (and consumption) levels in absolute terms are not discussed, and it is important to do so because absolute levels are relevant to sensitivity in fuel prices and volatility.

The scenarios High Energy Efficiency and High Renewables are less dependent on depletable fossil resources than those in which fossil fuels, combined with CCS, play an important role. Although coal can increase supply diversity, its continuous use in the Low Nuclear scenario is assumed to require CCS, which has negative effects on resource efficiency due to the reductions in plant efficiency that follow from the use of CCS.

Variable electricity production

The roadmap at least partly deals with the risks associated with increased use of variable electricity production (e.g. wind and solar power). It does so because adequate grid stability is a precondition for the modelling in the scenarios, and investments in interconnection (i.e. the linking of electricity transmission systems across borders) are assumed to be made in a way that increases security of supply. Other balancing requirements are assumed to be met by increased pumped storage, the development of flexible-gas units, higher imports and exports, and hydrogen-based balancing.

Other factors relevant to energy security

Other factors presented in the roadmap that are potentially relevant to energy security include the share of fixed costs in total electricity costs, and the fraction of total electricity production that is decentralized. However, the report does not include a thorough analysis that clearly shows what aspects of energy security these factors would affect and how.

Furthermore, the security aspects of nuclear energy are not dealt with at all in the roadmap. It is only assumed that in those cases where nuclear energy is used, security problems are solved. This is a similar approach as that taken for renewable energy, where it is simply assumed that investments in transmissions infrastructure are adequate for securing supply.

Discussion – towards a broader security frame

So, the EU's Energy Roadmap 2050 focuses on only a few aspects of energy security, mainly in the area of security of supply, which is largely discussed in terms of import dependency and the stability of the electricity system. It does not deal at all with other technological factors, or political risks, such as security of demand and revenue, and social and political conditions in exporting countries. It is worth noting that other EU documents do take a broader perspective, but usually with much shorter time frames than those used in low carbon roadmaps (European Commission, 2010; European Commission, 2011e).

Many aspects of energy security depend on specific characteristics of the technical system, as well as on conditions in various sectors of the economy and on how energy markets develop globally. All these things are outside the scope of the roadmap, however, and it is necessary to include them in order to develop a deeper understanding of the security implications of different transition trajectories and the robustness of future energy systems.

Vulnerability

Vulnerability is one security aspect that certainly requires more detailed analysis, but it is difficult to assess on the EU or even the national level since it varies between sectors and even between individual businesses and consumers. A vulnerability assessment would have to dig deeper into how energy systems are designed in terms of technical details and actual regulations. For example, both biofuels and electrification are important options for decarbonizing the transport sector, but the characteristics of the respective systems (e.g. in terms of infrastructure, markets and actors) differ considerably and consequently they are associated with different vulnerabilities.

Quantitative and qualitative factors

The impact assessment shows a preference for quantifiable factors at the expense of qualitative ones (which is also the case for a majority of contemporary research efforts on climate change mitigation and energy security; see Jonsson et al. 2013). However, this preference is not justified and the relevance of quantifiable factors is questionable in some cases, for example where energy security is equated with import independence. In fact, this tacit assumption – that decreased import dependency is associated with positive security outcomes – runs counter to liberal thinking on international relations, which views mutual dependence (or interdependence) as something that enhances security (e.g. Keohane & Nye 1997). Furthermore, the impact assessment treats relations with countries neighbouring the EU as an exogenous factor. But, as a major regional energy importer, the EU can influence how security and foreign relations develop in the regions around it (e.g. Northern Africa and Eastern Europe) and actively pursue policies that increase, or decrease, interdependence. A Eurocentric perspective with the main focus on security of supply for the EU does not capture these aspects adequately. To do so, one option would be to take a perspective that more explicity focuses on actors – that is, to assess the security implications for different categories of actors that are pursuing the scenarios in the roadmap, such as households, power companies, industries, municipalities and nations. This may require a reorientation from an objective approach defined in material terms to a more subjective one, which would examine how social contexts shape perceptions of security and how these contexts evolve over time.

Implicit assumptions

The previous section pointed out that there are implicit assumptions in the scenarios, specifically that the electricity grid will be expanded to cover some potential imbalances in the system and that security risks associated with nuclear power will be dealt with. These assumptions serve to hide potential energy security challenges in low-carbon transitions because there is no guarantee that changes in one field, such as the expansion of a certain energy source, will be matched with appropriate infrastructure, adequate institutions or regulations to enhance security. Potential security problems should not be concealed in this way; rather they should be uncovered and exposed.

More transformative change?

Despite the fact that the alternative future systems in the roadmap vary as a consequence of policy and a few technological assumptions, they are still rather similar. They do not span the effects of more transformative system changes, for example getting close to 100% renewables as suggested by WWF in *The Energy Report* (WWF, 2011). Exploring such transformative scenarios may be a way to more clearly identify energy security implications, positive or negative, that may be overlooked in more incremental change scenarios.

Conclusion

The EU's Energy Roadmap 2050 deals with a number of aspects of a low carbon energy transition, and does also deal with energy security. However, only a few aspects of it are treated in any detail, such as import dependency and the consequences of variable electricity production. Given the political importance of energy security in the EU and globally, a broader and more sophisticated approach to energy security is needed. If the scenarios in the roadmap are to deal properly with a larger set of energy security issues they need to be developed in more detail, focus more on effects on various sectors, actors and consumer groups, and analyze energy systems under a variety of political and economic developments external to the EU. Finally, the mainly quantitative approaches to evaluating energy security must be complemented with qualitative approaches.

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Authors:

Bengt Johansson[a,b], Daniel K Jonsson[a,c], André Månsson[b], Lars J Nilsson[b], Måns Nilsson[d,c]

[a] FOI, Swedish Defence Research Agency, SE-164 90 Stockholm, Sweden

[b] Environmental and Energy Systems Studies, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden

[c] Environmental Strategies Research, School of Architecture and the Built Environment Royal Institute of Technology (KTH), SE-100 44 Stockholm, Sweden.

[d] Stockholm Environment Institute, Linnégatan 87D, SE-104 51 Stockholm,Sweden.

Published by:
Stockholm Environment Institute
Linnégatan 87D, Box 24218
104 51 Stockholm
Sweden
Tel: +46 8 30 80 44

Author contact:
Bengt.H.Johansson@foi.se,
+46 855 503379
Media contact:
Tom Gill, SEI Communications
tom.gill@sei-international.org

sei-international.org
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Twitter: @SEIresearch, @SEIclimate