Energy (in)security: world-making in an age of scarcity

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Abstract

'Energy security' has quickly assumed a significant place in the lexicon of policy. Like other handy couplets for characterizing socio-natural relations (such as carrying capacity and resource scarcity), energy security is a powerful framing device: it constructs worlds, normalizes certain practices of resource use, and establishes grounds for intervention. In this paper, I explore some of the different ways in which energy (in)security is now being used, and reflect on the political work it currently performs. I highlight the historical conditions under which energy and security have become combined, the close association of energy security with crude oil imports, and the imprint that oil has left on the concept. Although geography has tended to interpret practices of security through either a territorial or biopolitical perspective, in this paper I consider how energy's securitisation proceeds through a set of imaginative and calculative practices (referred to here as 'geo-metrics'). I use the language of 'world-making' to draw attention to the techno-political practices associated with securitising energy, and their capacity for constituting political ecological relations. I illustrate this with reference to a growing body of knowledge and expertise in the calculation and design of energy security indicators.

Introduction

'Energy' when conjoined with 'security' creates a potent discursive couplet that is reductive and performative in equal measure. Although the term is not new, 'energy security' has recently proliferated across public policy and popular debates, exemplifying a logic of securitisation that now permeates thinking within OECD economies about many of the biophysical conditions necessary for reproducing social life (other notable examples include food, water and climate). Successive policy reports in the UK, for example – such as the Wicks Report (2009), National Security Strategy (2010) and the Department of Energy and Climate Change's Energy Security Strategy (2012) - elevate the disruption of oil and gas supplies to a 'priority risk' for government, placing the interruption of hydrocarbon imports on a par with terrorism, cyber-attacks and organised crime. At EU level energy security has emerged a major policy concern in the context of high (and rising) levels of import dependence for primary fuels, and also underpins regional initiatives such as the EU-Russia Energy Dialogue (Mañé-Estrada 2006; Aalto and Temel 2014; Kuzemko 2014). Russia put energy security on the G8's agenda in 2006, and the St Petersburg Summit that year agreed seven Global Energy Security Principles; energy security also had a central place in the inaugural summit of the G20 in Washington D.C. in 2008 (G20 2008; van de Graaf and Westphal 2011). In the US, the Energy Independence and Security Act (2007) – signed into law by President Bush –framed vehicle fuel economy standards and the energy efficiency of public buildings as national security issues in a context (at the time) of growing dependence on imported oil and gas. Although domestic oil and gas production have surged in the last five years, energy security remains central to the Obama Administration's 'all of the above' approach to building a 'clean and secure energy future' (Whitehouse 2014; Winzer 2012; Bang 2010). Similar concerns can be seen outside the OECD too. In China, for example, energy security has recently evolved from an historic and primarily ideological concern with self-sufficiency. Rapidly rising energy demand, growing oil and gas import dependency, and the country's changing geo-economic and geo-political significance mean that energy security is now a central goal of national policy (reflected in the establishment of the National Energy Administration in 2008, for example), pursued via a combination of overseas resource acquisition, domestic resource development and energy conservation initiatives (Zhang 2011; Leung et al. 2014).

These brief examples illustrate a broad process of securitisation currently taking place around energy: securitisation here refers to the social processes by which matters of energy become framed as matters of security, an interpretation that draws on the Copenhagen School of International

Relations and its constructivist account of security as a 'speech act' that elevates the object of security above everyday politics (Buzan et al. 1998; Buzan and Wæver 2009; Williams 2003; McDonald 2012). Together the examples above illustrate how energy is being cast as a threat to national and international security and a matter strategic concern. In what follows I explore some of the different ways in which 'energy (in)security' is now being used, and reflect on the political work it currently performs. A primary objective is to pry open the contemporary association between energy and security to better understand the contingency of this coupling. I situate the *contemporary* securitisation of energy as a re-emergence of an older idea under particular historical conditions, rather than something new. I show how the concept of 'energy security' in circulation today has been shaped in significant ways by historical anxieties experienced by oil importing states. For many OECD countries these anxieties were consequent to the emergence of a new geopolitical economy of oil in 1970s, although similar existential crises around oil imports have been experienced at different times in other countries (the Soviet Union in World War Two and China in the 1960s, for example). Like a number of other discursive political-ecological couplets that have emerged at times of wrenching geopolitical and geo-economic change - such as carrying capacity, resource crisis and overpopulation- energy security produces new objects of concern that subsequently become means for assessing and managing uncertainty. My primary goal is to take seriously this *performative* quality of energy security. Accordingly I focus on how energy security seeks to fashion political-ecological relations in the here and now and, in particular, on the calculative techniques through which energy becomes rendered as a matter of security: I refer to these processes by the short-hand of 'world-making' (Delaney 2010; Robertson 2012). Whereas geographers have tended to interpret security/securitisation through either a territorial or biopolitical perspective, I consider here the ways in which energy's securitisation proceeds through a set of imaginative and calculative practices, what one might term a set of 'geo-metrics' (see Elden 2013). The somewhat quixotic term 'world-making', then, draws attention to the techno-political practices associated with securitising energy and their capacity for constituting political ecological relations. I illustrate this by reference to a growing body of knowledge and expertise in the calculation and design of energy security indicators.

Understanding energy's securitisation

At a rhetorical level, the resonance and political efficacy of 'energy security' arises from its *existential* character. The term draws on popular understandings of energy as an essential and animating force in the 'metabolism' of social life, linking personal worlds of social reproduction with

those of community and nation. Securitisation suggests these forces and material flows, to which society has become accustomed, are now placed at risk. Mason and Zeitoun (2013, 294) refer to these risks as the 'collapsing conditions for life' associated with climate change, the depletion of conventional oil, and biodiversity loss – in each of which energy production and consumption are extensively implicated. Such risks imply significant restrictions on established norms (of personal mobility and thermal comfort, corporate profitability, or national foreign policy, for example): indeed, policy makers frequently perceive energy insecurity as "a restriction of policy space" (Löschelet al. 2010, 1666). The term also draws some of its political efficacy from an instinctual – even primal - notion of securing as an effort to reproduce prevailing conditions against change and uncertainty (although it frequently conflates different scales of action and responsibility). Energy security has wide social resonance, therefore, because the referent – 'energy' –is popularly understood to be central to the reproduction of daily life; and because securitisation suggests that profound social achievements (wealth, warmth, food provisioning etc.) that have been won over the *longue durée* against the vicissitudes of nature, and in a context of international rivalry and competition, are now under threat.

The social resonance of 'energy security', however, is inversely related to its definitional precision, with numerous commentators noting how the concept is "rather vague" (Löschel et al. 2010, 1665). Sovacool (2013) recognises 45 different definitions, and Winzer (2012, 36) emphasizes how a lack of clarity over a definition makes energy security "hard to measure and difficult to balance against other policy objectives". Paradoxically, then, a defining characteristic of the term, then, is its plasticity (Hildyard et al. 2012, 5): it is generally acknowledged that this lack of definition affords security a wide range of political possibilities, including its capacity as a political 'trump card'. Others have gone further to suggest that affixing energy to security makes security threadbare as a concept: the totality of energy – its saturation of economic, social and environmental life – "has the potential to normalize security and render it politically unexceptional" (Ciută 2010, 124). The multiplicity and flexibility of meaning– what Chester (2010) terms energy security's 'polysemic' character - derives from the abstraction inherent to *both* parts of the couplet.

First, the modern usage of 'energy' is a 19th century invention intended specifically to enable the commensuration of radically different material forms, so that their efficacy for heat and power might be determined (Smith 1998). It is, then, a product of the reductionism of physics (Hildyard et al. 2012) which effectively strips/dematerialises energy from its material forms: wind, water, biomass, fossil fuels are all made equivalent under the banner of 'energy,' ignoring the different affordances that each of these distinctive materialisations of energy provides. This unifying capacity

of energy as a concept has occasional echoes in the contemporary policy landscape: the UN's *Decade of Sustainable Energy for All* (2014-24), for example, positions energy as a "golden thread" linking issues of equity, economy and sustainability; while 'secure, low-carbon and affordable' energy is an explicitly articulated holy grail of energy policy in a number of countries, including the UK (see NAO 2012).

Second, security is a similarly abstract formulation from which the particularities of form and causation – of what, for whom, at what cost? – are lost (an observation underpinning critical security studies, e.g. Buzan and Waever 2009; Mutimer et al. 2013). Conjoining 'energy' and 'security', then, effectively squares the 'plasticity' and produces a very potent concept indeed: lacking specification, a broad range of actions and clusters of technologies may be licensed by appealing to the term, from wind farms to nuclear power, from curtailing public access and rights of way to withholding the right to protest/strike. Approached as a *discourse*, then, energy security is a classic 'empty signifier': a concept considerably more concrete than the object to which it refers.[1] However, to see it only in these terms – as a (highly mutable) discursive representation - is to overlook the way in which securitisation is simultaneously a set of acts and practices. Not only is the language of security/securitisation performative – in the sense that the words 'do things' (such as suturing together disparate ideas and positions, or enfranchising one set of actors over another); securitisation also depends on knowledge practices (definitions, measurements, assessments, technologies of visualisation) that do not so much disclose a world of political-ecological relations as actively constitute those relations.

Securitisation is one of several administrative logics that now cleave the energy policy landscape. Energy transition, energy access and energy poverty, for example, have rather different objectives to securitisation: whereas energy security seeks to preserve established norms and to safeguard the status quo –through strategies of infrastructure 'hardening' or the development of social resilience – the logic of energy transition is a socio-technical engineering of change over time. Energy security and energy transition, then, are rather different objectives and efforts to achieve one can undermine the other (Cherp et al. 2013). By contrast, energy poverty and energy access are less structured by temporal logics of anticipation (securing against or enabling change) and, instead, they draw attention to social logics of allocation and exclusion in the here and now: these terms acknowledge the importance of access mechanisms, and how one can be surrounded by high-value energy flows but not have access to them. While the security, poverty, transition and access agendas share a general critique of the market's failures to deliver socially desired objectives (variously secure, low-carbon or affordable energy), they also pull in different directions and license different forms of

action. I turn now to consider the conditions under which the securitisation of energy has (re)emerged as a particularly powerful logic in an increasingly crowded energy policy landscape.

Contextualising energy security's re-emergence as a policy objective

Energy security came to political prominence in OECD economies in the context of the 'new international economic order' that emerged around the global oil trade in the 1970s (a full genealogy would affirm the term's formative associations with oil, although trace the roots further back to the British Navy's strategic decision in the early 20th century to switch its fleet from coal to oil (Yergin 1988)). The re-appearance and proliferation of 'energy security' in the contemporary political-economic moment reflects the conjuncture of four elements.

First, in many national policy contexts the securitisation of energy is occurring in the wake of energy market liberalisation (and economic deregulation more broadly). An important characteristic of the logic of securitisation is the way it discursively and institutionally positions its object (energy in this case, and more specifically energy supply) as a focus and tool of statecraft. The Wicks Report in the UK, for example, opens by noting that "the time for market innocence is over" (Wicks 2009, 1). More colloquially there is evidence that some of neoliberalism's chickens may be coming home to roost, in the form of electricity brownouts/blackouts and predicted 'capacity gaps' associated with under-investment by market actors in new generating and transmission capacity; the failure of price signals in the oil market to generate a sufficient supply side response in the face of rising demand; and the insufficiency of market mechanisms (such as the EU ETS) for governing emissions of greenhouse gases. Securitisation, then, licenses renewed state oversight of, and involvement in, decisions about the production, transportation and consumption of energy in countries (like the UK) where the state has historically unwound itself from ownership and administration of the energy system. The adoption of a policy language of energy security is frequently associated with a parallel process of institutionalisation, as various components of the state's 'security apparatus' engage with energy, from foreign policy and the military, to the state's interest in particular forms of consumption behaviour (such as work on energy efficiency by the UK's 'nudge unit', more properly known as the UK Government Behavioural Insights Team). The re-emergence of energy security, then, reflects a generalised failure of markets for allocating resources in ways that deliver important public goods, and a re-enchantment with the state's potential in the face of significant market failure.

Second, significant shifts in the centre of geo-economic and geo-political power at the world scale have brought into question the control, effectiveness and sustainability of conventional energy

provisioning systems (Bradshaw 2009, Mitchell 2010). This is particularly the case for oil and, to a lesser extent, for gas. The underlying cause here is a rapid growth in energy demand outside of the OECD, notably in China but also in a number of major oil and gas exporting countries so that their 'exportable surplus' is reduced, and flat or declining demand in the OECD.[2] One effect of these new geographies of oil demand has been to erode the OECD's influence in world oil markets. The historic emergence of energy security as a significant policy concern was linked to the loss of access by major oil importing countries to the reserves, production capacities and output of oil-producing states; its re-emergence in the last decade is associated with a further erosion of these same countries' 'call' on global oil, in the form of their declining control over oil demand and an increasing prevalence of bi-lateral deals (particularly those associated with Chinese oil investment) that effectively remove oil from market channels (Bridge and LeBillon 2013; Mitchell and Mitchell 2014). Both moments have raised challenging questions for oil importing states about their ability to secure flows of oil in their direction.

Third, in countries that have become accustomed to significant domestic oil and gas output (like the UK), declining domestic production has created a growing dependency on imports (Mitchell et al. 2013). This has simultaneously highlighted the limits to sovereignty as means of securing sufficient resources, and exposed a reliance on extra-territorial trade networks and non-domestic actors for provisioning. Declining domestic production has given rise to a new form of *geo*-politics centred on depletion and the threat of 'running out' in a context of physical scarcity and increased international competition. These politics find expression, for example, around claims for 'peak oil' as the moment in which nature "begins to show her hand" (Association for the Study of Peak Oil 2008, 3; Bridge and Wood 2010). The notion of planetary limits is articulated more generally around a 'perfect storm' of food, water and energy shortages (Beddington 2009), one that can be (too) easily assimilated with a realist, zero-sum view of the world in which states compete over a dwindling resource base. Invoking an existential threat to the body of the nation, securitisation readily conforms with a view of geopolitics as an international "race for what's left" (Klare 2012).

Fourth, and at the broadest level, the proliferation of energy security has been enabled by a general expansion in the terms of reference for security in the post-Cold War period and, specifically, the shift from military security to an engagement with a more flexible understanding of 'human security' (Dalby 2001). As Dalby articulates at length, this more capacious understanding has allowed for the securitisation of a range of environmental threats and concerns, from water quality and biodiversity loss to climate change. While the securitisation of energy has specific historical roots (as outlined above), a more expansive understanding of security as human security has led to energy being

increasingly included among several new objects of security policy, such as food, water and climate change. This is important because the multiplication of security's objects has shifted the meaning of security (Ciută 2010, 125) and created a small yet significant space in which to question what is being secured. Recent conceptual work on energy security reflects this trajectory towards a more expansive understanding, acknowledging the plurality of objectives and values underpinning securitisation.[3]

To what does 'energy security' refer within energy policy?

In unpacking the way securitisation is being applied in contemporary energy policy, it is useful to distinguish between a dominant or core geopolitical framing and a number of others that either build upon it, or which sit obliquely to it. As a first cut, I draw here on Lakoff's (2008, 36) examination of securitisation around public health to identify three different logics of energy securitisation: sovereign state security (focussed on external threats to national space), population security (centred on regular domestic events and the distribution of risk within a given territory) and vital systems security (aimed not at "the national territory or the population but rather the critical systems that underpin social and economic life"). These three logics represent different approaches and imply different subjects and objects of securitisation: and, as in Lakoff's original formulation, they are not to be understood as a chronological sequence, but as interacting logics that are more or less present at any one time (for a related, although distinct perspective, see Cherp and Jewell (2011) who parse energy security into three different perspectives – sovereignty, robustness and resilience – which they note have historically been considered separate policy problems; see also Ciută 2010).

In most policy documents, energy security primarily refers to the first of Lakoff's categories: that is, threats to national energy supply and, more specifically, to geopolitical risks of *short-term disruption* to international (i.e. cross-border) flows of oil and gas, reflecting the significant role of these fuels in transportation, domestic heating and electricity production. The dominant articulation of security, then, problematizes the "interaction between the domestic and the international" (Ciută 2010, 127), and centres on managing perceived threats to the state associated with interruptions in cross-border flows of fuels. Framed this way, energy security is primarily a concern of countries that are net importers of oil and gas (the proportions of these fuels that are traded internationally is much higher than for coal or for electricity). Cherp and Jewell (2011) similarly characterise this focus the

international movement of oil and gas as a 'sovereignty' perspective on security, while Mason and Zeitoun (2013, 294) see a distinctive *territorial* imaginary at work in the way such risks "supplement traditional threats to the state." The Wicks Report (2009), for example, identified the UK's growing energy import dependence (particularly for gas) and warned of "a global grab for energy" in which "nations flex their muscles in the pursuit of energy resources". Such formulations express energy security as deriving from prevailing geopolitical relations, or what Ciută (2010) describes as a "logic of war." Exemplifying this perspective, the UK's National Security Strategy (2009) places energy security as a defining concern of the 'age of uncertainty': the preamble to the Strategy observes, for example, how "the security of our energy supplies increasingly depends on fossil fuels located in some of the most unstable parts of the planet." The EU, as the world's largest energy importer, has adopted a number of initiatives that seek to rescale security of supply from a national concern of member states to a regional level in an effort to achieve the goal of 'secure, sustainable and competitive energy'. Its 2030 framework for Climate and Energy, for example, builds on earlier initiatives linking climate change targets and energy security objectives to the development of a single energy market, including the Energy Community Treaty (2005) that associated increased 'security of supply' (and socio-economic stability) with the extension of energy market liberalisation to states in SE Europe and the Black Sea region.

A secondary application of the 'sovereignty' framing - which shares a focus on threats to national space associated with international flows of fuels – highlights the concerns of fossil fuel exporters around the security of demand. It reflects a view from the 'other end' of the commodity chain to that of importing countries. The focus here, however, is typically not on the short term but on *longer-term changes in demand* associated with structural shifts in the energy intensity of production and/or with policy approaches to address the environmental insecurities associated with the combustion of fossil fuels. Security of *price* is particularly significant for fossil fuel exporting states which have extended state spending on the back of resource revenues, and which accordingly have seen the 'break-even' price (of oil and gas) necessary to finance annual state expenditure rise over time. For countries like Saudi Arabia, Venezuela or Qatar which are major fossil fuel exporters, any reduction in revenue flows – as a result of demand destruction and/or falls in price – will have significant consequences for regime stability. The core point here is that security is scaled to the nation, derives from prevailing geopolitical relations, and centres on physical cross-border flows (mainly oil and gas). The task of achieving energy security is understood as the responsibility of national governments and, conversely, insecurity derives from the actions (or in-actions) by states.

Over the last few years, this traditional understanding of security as uninterrupted national supply has become hitched in policy discourse to additional concerns about the affordability and acceptability of specific fuels, and the environmental and social consequences of their use. From an economic perspective, for example, energy insecurity may be defined as "a loss of economic welfare" which can arise from changes in either the availability and/or price of energy (Bohi and Toman 1996, 1; cited in Löschel et al. 2010, 1665).[4] As Ciută (2010) points out, the incorporation of affordability and acceptability dimensions changes the logic of energy security: no longer is it about 'survival' in the face of existential threats but it has expanded into a 'logic of subsistence' (i.e. economic functioning) that involves profoundly moral and ethical questions about what level of energy provision is acceptable. Indeed, the environmental consequences of energy choices and the exclusionary effect of rising prices for energy have taken on a growing salience in debates over the meaning and scope of energy security policy. The UK's energy policy, for example, seeks not simply to secure energy, but to secure "clean, affordable energy to combat climate change." In a similar way the International Energy Agency, founded in the early 1970s as a club of oil importers specifically to address supply disruptions associated with action by OPEC members (and an institutional expression of energy security as a 'logic of war'), now defines energy security as "the uninterrupted physical availability at a price which is affordable, while respecting environment concerns" (IEA 2014).[5]

Expanding the scope of security to include the reproduction of social and economic life has the effect of enrolling a broader range of actors (and actions) in energy's securitisation. Significantly, it modifies the object of security: it contextualises the circulation of energy in relation to the welfare of national population, adding to a quantitative concern with rate of flow (barrels of oil/cubic meters of gas per day) a series a series of qualitative assessments of the socio-economic and environmental consequences of those flows. Here Lakoff's notions of 'population security' and 'vital systems security' are particularly useful: applied to energy, population security directs attention towards the routine interactions and daily practices *within* states that define national profiles of energy use, and which create a series of internal vulnerabilities; while vital systems security draws attention to critical infrastructures, and to networks and scales of organisation not necessarily congruent with those of national populations (see Baldwin 2013 for a related point regarding 'vital ecosystems security'). Conceptually, this enlarged understanding of security shifts the focus from an upstream interest in supply to consider its relation to downstream practices and expectations around the consumption of energy services, such as mobility, heating, power and light. Cherp and Jewell (2011) highlight how contextualising energy flows in relation to the services they provide promotes a view of energy security-as-resilience, and directs strategy towards improving the flexibility and diversity

of energy systems and their ability to adapt in the face of both supply uncertainties and multiple social demands. This framing of energy security is currently less embedded in policy, although there are moves in that direction. For example, the Global Energy Assessment (IIASA 2012) – which sought to understand common energy security concerns in over 130 countries - adopted energy services as its analytical object in order to reflect the contribution of energy to human welfare and social development (Cherp et al. 2012). In the UK context, for example, improving domestic energy efficiency (of housing stock, in particular) has become understood as part and parcel of a response to energy security, energy poverty and climate change.

Emerging from oil's long historical shadow

The previous section identifies the diversity of energy's securitisation. It also suggests, however, that policy framings of energy security continue to be shaped in significant ways by its formative application to the 'oil shocks' experienced by major oil importing countries in the 1970s. True, discourses of energy security now refer as much to gas as they do to oil (Cherp and Jewell 2011) but the imprint of this historic association remains visible in three ways. First, energy security is understood as the geopolitics of internationally-traded oil and gas, played out between *countries* positioned at the two ends of the commodity chain (producers vs. consumers). This perspective not only obscures from view the role of transnational corporations and corporate political economy – increasingly significant in the UK given the internationalisation of its energy system (Bridge and Bradshaw 2014) - but it also territorialises difference at the scale of the state. For example, it draws a sharp distinction between importing states and exporting states, but reveals very little about the vast differences within these economic spaces. Invocations of 'rising powers' and the figure of 'Chinese demand', for example, scale energy demand to the nation rather than considering important internal differences associated with the distribution of wealth and power. They also overlook the way territorial demands for energy are structured by the way particular places are embedded in global production networks and the re-export of goods (see Davis and Caldeira (2010), for example, on the extent to which China's territorial emissions are linked to the re-export of finished products). More generally, the mobilisation of energy security in energy policy tends to reproduce a national imaginary of consumption that conflates market economies with citizens (see Hildyard et al. 2012), that flattens inequalities in access and power within countries, and that inserts national distinctions as a primary axis of differentiation.

Second, we can also see traces of the 1970s concern with oil import security in how the logic of securitisation places at stake nothing less than the *conditions of social life.* As Huber (2009) has demonstrated, the cultural politics of the 'American Way of Life' were forged in the crucible of the

OPEC oil embargo. Carter's description of a disruption to the flow of oil as the 'moral equivalent of war' is significant not only for its confirmation of the high stakes involved, but also because ensuring 'victory' required state action and inter-state co-ordination (such as Carter's National Energy Policy (1977) or actions of OECD member states to set up the IEA). Indeed, from the vantage point of the present, the 'energy crisis' of the 1970s highlights how energy security can be understood as an effort to secure the status-quo, locking in historically specific modes of production and social reproduction (for example, forms of automobility or patterns of urban development, see Paterson 2007; Huber 2013).

Third, in seeking to secure the status quo (against disruptive change), some forms of insecurity are normalised/obscured as part of the 'good life' that is to be secured, while still other forms of insecurity are actively produced for others in the act of ensuring security. Hildyard et al. (2012, 69) for example interpret securitisation as a form of dispossession and enclosure, in which the welfare of private corporations and wealthy elites is secured at the cost of others: what is being secured, they argue, is "not an economy organised around the right of all to live but one of automobilised private householders, exclusionary politics and the structural production of waste". They go onto highlight the lack of a consideration of human rights in the context of the EU's Energy Security Strategy and the way it overlooks the human rights record of Azerbaijan, Turkmenistan, Uzbekistan and Kazakhstan.

In summary, then, although energy's securitisation takes a variety of forms contemporary policy formulations of energy security are dominated by a 'sovereignty' perspective (Lakoff 2008; Cherp and Jewell 2011). A number of other minor 'modulations' are emerging that loosen securitisation from its close association with sovereignty and geopolitics and, in so doing, highlight more complex geographies of energy. These are not exclusively centred on national territories but extend to the infrastructural networks of energy conversion, transmission and distribution, and the global production networks of inter- and intra-firm relations that govern how and where energy moves. These alternative perspectives not only change the objects and subjects of securitisation, but they also introduce alternative territorialities to those of the state while also problematising relations among different organisational scales (for example, between community livelihoods, energy services at the scale of the household and body (e.g. thermal comfort) and the responsibilities of central and local state; see, for example, Butler et al. 2013, Brown and Walker 2008). Furthermore, they highlight the topologies of connectivity and (potential) disconnection associated with energy infrastructure, and the ways in which sources of insecurity arise from the way domestic energy networks are configured and managed. While they are comparatively minor figures in contemporary

policy, these framings nonetheless indicate the plurality and openness of the logics of securitisation as they relate to energy.

The science of energy security: geo-metrics

The re-emergence of energy security at policy level has been paralleled by a growing interest in the social sciences in producing the 'objects' of policy: the tools and devices through which states of energy security/insecurity may be diagnosed and rendered governable. As discussed above, the couplet 'energy security' conjoins two different and abstract domains and, while rhetorically rich, it lacks the specification required of a 'tool' capable of doing the work of governance. However, significant research effort in the social sciences has targeted this governance problem over the past few years. This work seeks to create new metrics and indices that are able to transform contextual descriptions of energy flows (e.g. measures of import dependency, fuel prices and intensity of vehicle use) into assessments of (in)security (see Stepputat (2012) for a reflection on similar knowledge production work aimed at the 'security-development nexus'). We can term these 'geometrics,' in the sense of the earthly political arithmetics described by Elden (2013): they involve technologies of calculation, visualisation and manipulation that seek to disclose the dimensions of energy security in order to render them governable. This emerging 'science of energy security' is oriented towards inventorying, assessing, and anticipating energy flows, energy access, and the dependencies and (environmental) consequences associated with patterns of energy consumption.[6] Social science, then, is implicated in the contemporary conjoining of energy with security through efforts to develop standardized metrics and objects that can simultaneously assess 'energy security' and enable its governance. In the parallel context of climate security, Dalby (2013) has commented on the 'new mathematics of global security' and how the geometrics of carbon are "calling all sorts of new ecological entities into existence as matters for geopolitical calculation" (see also Bridge 2011). A striking feature of the emerging science of energy security is its constitutive relationship to energy policy, and to political relations more broadly. Ongoing work to move forward the science of energy security, with the objective of providing a robust underpinning to this growing area of policy concern, exemplifies the notion of "co-production" described by Jasanoff (2004, 2) wherein "the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (see also Chilvers and Evans 2009). Drawing on this insight we can consider recent academic work on indicators and metrics of energy security as a creative practice of 'world-making': the knowledge practices involved do not simply disclose existing states of energy (in)security but, through processes of technical measurement, calculation and the production

of new scientific objects by which energy security is made visible and governable, they constitute new political-ecological orders.

Calculation, quantification, visualisation: energy security as a metrological project

A key task has been that of calculation, the production of quantitative knowledge about energy security in ways that can make heterogeneous threats to security commensurable for decision makers. Quantification performs 'energy security' as a measure: it both sutures the two components of the couplet, and simultaneously makes possible comparisons (across space and time). Elsewhere these techno-political processes of quantification have been referred to as *metrology* because of the way they centre on developing common forms of measurement that "open up new objects and sites of disagreement" (Barry 2002, 274). Their effect is to render energy security as a tractable problem – to transform a weakly-defined notion into a practical decision-space - and so bring energy security into the domain of management, modelling and scenario analysis (Kruyt et al. 2009, 2013). Indeed, measurement and calculability serve as important definitional criteria in recent work so that logics of measurement and quantification are now driving how energy security is becoming understood. For example, Kruyt et al. (2013, 291) argue that quantification is needed to "make the concept less vague" while Winzer (2012, 36) argues for a narrow definition of energy security as supply continuity because it "can be measured more precisely" than alternatives.

A good illustration of this metrological project within work on energy security is the recent effort to develop quantitative 'indicators' of energy (in)security (Scheepers et al. 2007; Gupta 2008; Cherp and Jewell 2011; Jewell et al. 2014a, 2014b; Kruyt et al. 2013). These formulations either build upon or explicitly depart from (see Jewell et al. 2014a) what has come to be known as the 'four As' approach (APERC 2007) which considers threats to energy security associated with the availability, accessibility, affordability, and acceptability of specific fuels. A diverse range of simple indicators have been proposed, extending beyond long-standing metrics like reserve/production ratios or the Shannon-Wiener index of diversity (Stirling 1998, Jansen et al 2004) to include measures of import dependence, political stability, energy price and the sensitivity of certain sectors (like transport) to changes in price or supply (Kruyt et al. 2013). However, it has been to the development of aggregate indicators that most researchers have turned their expertise. In an early example of the process, Sovacool and Brown (2010, 87) compiled an energy security index for 22 countries in the OECD. Their index is made up of ten indicators that describe the availability and affordability of fuels, energy and economic efficiency, and environmental stewardship. Availability, for example, refers to "diversifying the fuels used to provide energy services as well as the location of facilities using those fuels, promoting energy systems that can recover quickly from attack or disruption, and minimizing

dependence on foreign suppliers": indicators here are measures of oil import dependence, natural gas import dependence, and dependence on petroleum transport fuel. Similarly affordability "refers to providing energy services that are affordable for consumers and minimizing price volatility" and its indicators are retail prices for electricity and petrol.[7]

Producing aggregate indicators like these is data-intensive and involves a series of transformations through which existing contextual measures (e.g. trade flows, energy intensities of GDP) are combined and re-interpreted as meaningful indicators of security. For example, Sovacool and Brown (2010) assembled data on 10 indicators of energy use across 22 countries (a process they describe as "tedious and difficult") and then carried out two different aggregation approaches. First, they scored the relative progress over time of each country on each indicator using values between -1 and +1, and these values were then aggregated to produce a 'final score' (which ranged from +3 in Denmark to -6 in Spain and Portugal). Second, to assess the relative magnitude of change, the authors created z-scores, which indicate the extent to which a particular country deviates from the group mean. By calculating z-scores for different time periods, they were able to assess change over time in the degree of energy security: comparing the early 1970s with 2007, for example, they note how "some metrics, such as energy intensity and fuel economy for passenger vehicles, have almost universally improved, while others, such as electricity consumption per capita, electricity prices, and gasoline prices have almost universally deteriorated". This second set of aggregated figures show that UK saw the greatest improvement, with Spain, Ireland, France, Italy, Sweden improving the least. Significantly these two methods produce quite different results, highlighting one of the challenges of selecting aggregation techniques.[8]

There are now a number of similar indicators projects that seek in different ways to capture the various dimensions of energy security. Löschel et al (2010, 1670), for example, argue against a single, aggregated index and propose a suite of indicators accompanied by a "meaningful discussion addressing trade-offs of different dimensions of the issue". Cherp and Jewell (2013) outline an assessment framework for delineating 'vital energy systems,' identifying vulnerabilities and selecting indicators. They emphasise the calculative process involved in assembling indicators and the trade-offs around degree of aggregation and, like Löschel et al. (2013), they highlight the importance of expert judgement and narrative processes of reasoning in making sense of indicators. A good example of how emerging indicators of energy security are being combined to generate scenarios and visualisations for planning purposes is the Model of Short-Term Energy Security (MOSES) developed by Jewell (2011) through her work with the IEA. MOSES uses 30 indicators of energy security and its technical methods allow for their combination and interpretation "in a systematic,

transparent and policy-relevant way". The model is based on assessment of different vulnerabilities and provides a measure of both the "risks of energy supply disruptions; and resilience**,** or the ability of a national energy system to cope with such disruptions." The model considers risk and resilience as they relate to both domestic and external factors so that the assessment of indicators generates an energy security profile of individual countries: communication and visualisation are primary objectives of the model which is designed to "convey holistic stories" about countries (Cherp and Jewell 2013, 166). In this way MOSES is illustrative of the leading edge of an emerging 'energy security science'.

These brief examples illustrate how a core goal of work on energy security indicators is to craft a set of measures that can provide a basis for operational decisions: in some cases the objective is a quantitative metric that could perform the role of a target (in the context of national energy policy, for example) and in others it is render energy security compatible with formal simulation models describing national or global energy systems. More often, however, metrics provide an "heuristic role - capturing a particular aspect of energy security and indicating a relative position or direction of change" (Kruyt et al. 2013, 293). The significant point about this work, however, is that it does not simply disclose a world of relations, dependencies and consequences: the practices of measurement and calculation involved produce a world that can be subjected to calculation and, in so doing, create new forms of political capacity and agency. The emerging suite of energy security indicators, then, should be thought of as political technologies: knowledge practices informed by social science that are constitutive of political relations. In other words their political significance goes beyond the production of new knowledge: there is a largely unacknowledged performative dimension to the way energy security indicators (and associated representational devices) constitute a world in which certain forms of strategic action are possible. The narratives of vulnerability and interconnection that energy security indicators and scenarios allow are potentially 'disruptive,' in the sense of being capable of generating of new modes of understanding and forms of securitisation. In his work on public health and biosecurity, Lakoff (2008, 35) comments on how the introduction of scenario-based exercises enabled new ways of thinking about disease to emerge, which in turn created a new norm of planning and preparedness rather than prevention: in this way scenarios "generate an affect of urgency in the absence of the event itself." The object of scenario planning, according to Lakoff, is the security of 'vital systems' such as critical infrastructure (rather than state sovereignty or population) and "the event whose probability cannot be calculated, but whose consequences are potentially catastrophic" (p. 36). Recent work on energy security indicators by Cherp and Jewell (2011, 2013) effects a similar redefinition of the object of security, arguing that its focus should not be states or economies but 'vital energy systems' such as the nuclear fuel cycle, electricity grids, and

transportation. It is not yet clear to what forms of political action recent work on vital energy systems and energy security scenarios will give rise; however, following Lakoff (2007), it is likely to be different to work on quantitative indicators alone, and to target preparedness and resilience as forms of intervention.

Conclusion

'Energy security' has quickly assumed a significant place in the lexicon of policy. In this paper I have sought to understand what is at stake in the *securitisation of energy* - the claim that energy is first and foremost a matter of security as opposed to, say, human development, social justice, or environmental sustainability. The paper has highlighted the material conditions under which energy and security have become combined, and the imprint the close historical association of energy security with crude oil imports has left on the concept. It is easy for critical geography to be dismissive of the already large and rapidly growing literature on energy security: to caricature it as the new face of an old 'geopolitics,' shot through with a realist perspective on international relations, tied to military concerns about supply and conflict, and whose 'pragmatism' "promotes a response that has little to do with ensuring that everyone has the energy to meet their basic needs andeverything to do with creating new sources of accumulation" (Hildyard et al. 2012, 21). The long historical shadow cast on the concept by its formative association with inter-state oil conflicts in the 1970s means energy security is readily conformable with an eco-scarcity narrative, signalling inter-state competition over a dwindling resource base (see, for example, Peters 2004). However, rather than read energy's securitisation in this way, I have drawn attention to how the concept of energy security is more open and variegated than such a reading allows. Energy security remains a 'roomy category' whose meaning is unsettled (Goldthau 2012) and I have explored some of the different ways in which energy (in)security is now being used and reflected on the political work it currently performs.

Through the creative efforts of social science to develop forms of knowledge for inventorying, visualising, and planning energy flows, energy security is fast becoming a political technology and tool of governance. These modes of governance are emergent and there is, of course, every possibility that energy security becomes yet another 'colonial' form of resource management, a tool for extra-territorial state-craft with which to secure the flows of energy required for national and corporate systems of accumulation. However, I have sought here to read the growing literature on energy security differently, highlighting its reflexivity and internal attentiveness to problems of

boundaries and definition. Within this literature there is a reflexivity about 'what is being secured' and where the territorial and sectoral boundaries of securing may lie: in the discussion over securitisation vs. transition, for example, there is recognition that to secure energy is also to foreclose certain energy futures (Mitchell et al. 2013); in work on resilience and robustness, insecurity emerges not as an exogenous threat but as a system-property or 'network effect'; and in work which emphasises practices and spaces of consumption (e.g. around energy services), there is recognition of how policies oriented towards energy's 'securitisation' intersect with livelihoods (and how, by extension, logics of securitisation may produce new forms of insecurity).[9]

I have focused on the emergence of 'energy security indicators' as a particular objective of the growing social science research on energy security, and drawn attention to the political work performed by emergent techniques of securitisation such as quantification, calculation and visualisation. This research is at an interesting moment, as the frameworks, criteria and indicators created in the laboratories of social science are now being let loose on the world and are beginning to shape it in their own image. Research on the geo-metrics of energy security emerges from several different geographical centres of thought and there is, as yet, no consensus or standard set of indicators. Indeed, much of what is interesting conceptually about the securitisation of energy is that it is an unsettled project that has not (yet) consolidated into a 'metrological regime' (defined by Barry (2002) as a context in which "measurement has come to take on a relatively standardised form"). Currently the securitisation of energy is a creative and contested project in which the various techniques for energy's securitisation exceed the goals of policy. Understanding what is at stake in these metrological practices is important: energy security may be doubly reductive as a discursive couplet, but as a way of knowing and acting in the world it shows itself to be highly generative.

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References

Aalto P and D K Temel 2014 European Energy Security: Natural Gas and the Integration Process *Journal of Common Market Studies* 52(4): 758-74.

APERC 2007*A Quest for Energy Security in the 21st Century* Asia Pacific Energy Research Centre.

ASPO 2008Association for the Study of Peak Oil Newsletter No. 87 Available online at http://www.aspo-ireland.org/contentFiles/newsletterPDFs/newsletter87_200803.pdf

Baldwin A 2013 Vital ecosystem security: emergence, circulation, and the biopolitical environmental citizen. *Geoforum* 45: 52-61.

Bang G 2010 Energy security and climate change concerns: Triggers for energy policy change in the United States? *Energy Policy* 38 1645-53

Barry A 2002 The anti-political economy *Economy and Society* 31(2) 268-84

Beddington J 2009 Food, Energy, Water and the Climate: a perfect storm of global events? Speech to the Sustainable Development UK Conference. Available online at http://www.bis.gov.uk/assets/goscience/docs/p/perfect-storm-paper.pdf

Bohi D and Toman M1996*The economics of energy security* Boston, Dordrecht and London, Kluwer Academic Publishers

Bradshaw M 2009 The Geopolitics of Global Energy Security*Geography Compass* 3(5) 1920-37

Bridge G 2013 Territory: now in 3D! *Political Geography* 34 55-7

Bridge G and Bradshaw M 2014Deepening globalisation: economies, trade and energy systems in **Ekins P** (ed)*Global Energy: Issues Potentials and Policy Implications* Oxford, Oxford University Press

Bridge G and Le Billon P 2013 *Oil* Cambridge, Polity Press.

Bridge G and Wood A 2010 Less is More: specters of scarcity and the politics of resource access. *Geoforum* 41(4) 565-576

Bridge G 2011 Resource geographies 1: making carbon economies, old and new. *Progress in Human Geography* 35(6): 820-834.

Brown S and Walker G 2008 Understanding heat wave vulnerability in nursing and residential homes*Building Research and Information* 36(4) 363-72

Buzan B and Wæver O 2009 Macrosecuritisation and security constellations: reconsidering scale in securitisation theory *Review of International Studies* 35 253–76

Buzan B, Wæver O and de Wilde J 1998 *Security: a new framework for analysis.* Boulder, CO: Lynne Rienner.

Butler C Darby S Henfrey T Hoggett R and Hole N 2013 People and Communities in Energy Security in **Mitchell C Watson J and Whiting J***New Challenges in Energy Security: The UK in a Multipolar World***,** 116-36

Cherp A Adenikinju A Goldthau A Hernandez F Hughes L Jansen J Jewell J 2012. Chapter 5 – Energy Security, in *Global Energy Assessment: toward a more sustainable future.* Cambridge University Press, Cambridge UK and New York, and the International Institute for Applied Systems Analysis, Laxenburg, Austria; pp. 325-83.

Cherp A and Jewell J2011 The three perspectives on energy security: intellectual history, disciplinary roots and the potential for integration*Current Opinion in Environmental Sustainability* 3 202–12

Cherp A and Jewell J 2013 Energy security assessment framework and three case studies. In **Dyer H and Trombetta M** (eds) *International Handbook of Energy Security*Cheltenham, Edward Elgar 146-72

Cherp A Jewell J and Goldthau A 2011 Governing Global Energy: Systems, Transitions, Complexity. *Global Policy* 2 75–88.

Chester L 2010 Conceptualising energy security and making explicit its polysemic nature *Energy Policy* 38(2) 887-95

Chilvers J and Evans J Understanding networks at the science-policy interface *Geoforum*40(3) 255-62

Ciută F 2010 Conceptual notes on energy security: total or banalsecurity? *Security Dialogue* 41 123–44

Dalby S 2001*Environmental Security* Minneapolis, University of Minnesota Press.

Dalby S 2013 The geopolitics of climate change *Political Geography* 37 38-47

Davis S and Caldeira K 2010 Consumption-based accounting of CO2 emissions *Proceedings of the National Academy of Sciences.*

Delaney D 2010*The Spatial, the Legal and the Pragmatics of World-Making: Nomospheric Investigations* New York, Routledge

Elden S 2013 Secure the volume: Vertical geopolitics and the depth of power*Political Geography* 34 35-51

European Commission 2011 *Key facts and figures on the external dimension of the EU energy policy* Commission Staff Working Paper. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52011SC1022:EN:NOT

G20 2008 Declaration, Summit on Financial Markets and the World Economy, November 15. Available at http://www.treasury.gov/resource-center/international/g7-g20/Documents/Washington%20Nov%20Leaders%20Declaration.pdf

van de Graaf T and K Westphal 2011. The G8 and G20 as Global Steering Committees for Energy: Opportunities and Constraints. *Global Policy* 2 (Special Issue): 19-30.

Gupta E 2008 Oil vulnerability index of oil-importing countries *Energy Policy* 36(3) 1195-1211

Hildyard N Lohmann Land Sexton S 2012*Energy Security ForWhom? ForWhat?* Sturminster Newton, Dorset, The Corner House

Huber M 2009 The use of gasoline: value, oil and the 'American way of life' *Antipode* 41(3) 465-86.

Huber M 2013. *Lifeblood: oil, freedom and the forces of capital*Minneapolis, University of Minnesota Press.

IIASA 2012 *Global Energy Assessment: towards a sustainable future.* Cambridge, Cambridge University Press.

IEA 2014 *Energy Security* Available online at http://www.iea.org/topics/energysecurity/
Jansen 2004

Jasanoff S 2004 The idiom of co-production in Jasanoff S (ed) *States of Knowledge: the co-production of science and social order*New York and London, Routledge 1-12

Jewell, J 2011. *The IEA Model of Short-term Energy Security (MOSES): Primary Energy Sources and Secondary Fuels* OECD/IEA Working Paper. Paris.

Jewell J 2013 *Energy security and climate change mitigation: the interaction of long-term global scenarios* Doctoral Dissertation, Central European University, Budapest, Hungary.

Jewell J Cherp A and Riahi K 2014a Energy security under de-carbonization scenarios: an assessment framework and evaluation under different technology and policy choices. *Energy Policy* 65: 743-60.

Jewell J Cherp A Vinichenko V Bauer N Kober T McCollum D van Vuuren D and van der Zwaan B 2014b Energy security of China, India, the E.U. and the U.S. under long-term scenarios: results from six IAMs. *Climate Change Economics* 4(4)

Klare M 2012 *The Race for What's Left: the global scramble for the world's last resources* New York, Metropolitan Books

Kruyt B van Vuuren D de Vries H and Groenenberg H 2009 Indicators for energy security *Energy Policy* 2166-2181

Kruyt B van Vuuren D de Vries H and Groenenberg H 2013 Indicators for energy security, in **Sovacool B** (ed) *The Routledge Handbook of Energy Security* Routledge, London and New York, pp. 291-312.

Kuchler M 2012 *Fields of Gold: The Bioenergy Debate in International Organizations* Doctoral Thesis, Linköping University, Sweden.

Kuzemko C 2014 Ideas, power and change: explaining EU–Russia energy relations. *Journal of European Public Policy* 21(1) 58-75

Lakoff A 2008 From Population to Vital System: national security and the changing object of public health. In *Biosecurity Interventions: global health and security in question*. Eds. Lakoff and Collier, Columbia University Press, pp. 33-59

Löschel A Moselenr U and Rubbelke D 2010 Indicators of energy security in industrialised countries *Energy Policy* 38(4) 1665-1671

Mañé-Estrada A 2006 European energy security: towards the creation of the *geo-energy* space *Energy Policy* 34 3773-86.

Mason M and Zeitoun M 2013 Questioning environmental security *The Geographical Journal*179(4) 294–297

McDonald M 2012 The Failed Securitization of Climate Change in Australia *Australian Journal of Political Science* 47(4): 579-92

Mitchell J 2010 *More for Asia: rebalancing world oil and gas.* Chatham House.

Mitchell J and Mitchell B 2014 Structural crisis in the oil and gas industry *Energy Policy* 64 36-42

Mitchell C Watson J and Whiting J(eds) 2013*New Challenges in Energy Security: the UK in a multipolar world* Palgrave Macmillan

Mutimer D Grayson K and Beier J 2013 Critical Studies on Security: an introduction *Critical Studies on Security* 1(1) 1-12

National Audit Office 2012*The Government's Long-Term Plans to Deliver Secure, Low Carbon and Affordable Electricity*London, UK.

Pasqualetti M 2013 The competing dimensions of energy security in **Sovacool B**(ed)*The Routledge Handbook of Energy Security* Routledge, London and New York 275-90

Paterson M 2007 *Automobile Politics: Ecology and Cultural Political Economy*Cambridge University Press

Peluso N and Watts M (eds) 2001 *Violent Environments* Ithaca, Cornell University Press.

Peters S 2004 Coercive western energy security strategies: 'resource wars' as a new threat to global security *Geopolitics* 9(1) 187-212

Robertson M2012Measurement and alienation: making a world of ecosystems services *Transactions of the Institute of British Geographers* 37 (3) 386-40

Scheepers M Seebregts A de Jong J and Maters H2007 *EU Standards for Energy Security of Supply: updates on the crisis capability index and supply/demand index quantification for EU-27* Netherlands, Energy Research Centre

Smith C 1998*The Science of Energy: a cultural history of energy physics in Victorian Britain* Chicago, University of Chicago Press

Sovacool B and Brown M 2010 Competing dimensions of energy security: an international perspective*Annual Review of Environment and Resources* 35 77-108

Sovacool B 2013 Introduction: defining, measuring and exploring energy security in **Sovacool B** (ed) *The Routledge Handbook of Energy Security* Routledge, London and New York 1-42

Stepputat F 2012 Knowledge production in the security-development nexus: an ethnographic reflection *Security Dialogue* 43 (5) 439-455

Stirling A 1998 On the Economics and Analysis of Diversity. Brighton, Science Policy Research Unit, University of Sussex

Wicks M 2009 *Energy Security: a national challenge in a changing world* London

Williams M 2003 Words, images, enemies: securitization and International Politics. *International Studies Quarterly* 47(4): 511-31.

Winzer C 2012Conceptualizing energy security *Energy Policy* 46: 36-48

[1] For a discussion of bio-energy as an empty signifier, see Kuchler, M. (2012).

[2] Indonesia's transition from an oil and gas exporter to an oil and gas importer illustrates this phenomenon, although the growth of energy consumption in major oil and gas exporting countries and the erosion of exportable surplus is a more general dynamic.

[3] Thanks to an anonymous reviewer for making this connection.

[4] Löschelet al. (2010, 1666) also advance this economic definition with the view that "energy security exists if the energy sector does not cause (major) welfare-reducing frictions in the economy at national or global levels."

[5] The IEA (2014, no page number) has developed a comparatively nuanced view of energy security: it recognises, for example, how security involves a consideration of temporality (over what time horizon will things be secured?) and that "long-term energy security is mainly linked to timely investments to supply energy in line with economic developments and environmental needs (while) on the other hand, short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance."

[6] Several initiatives in the past few years have focused on developing metrics and indices of energy security, and some of this work is referred to in the text. Pasqualetti (2013) reports on an international meeting in Singapore funded by the MacArthur Foundation that brought together a series of experts for the express purpose of developing metrics of energy security: his account also highlights some of the challenges involved, including the tension between universal and contextualized indicators. A theme issue of *Energy Policy* 38(4) was devoted to concepts and indicators of energy security in 2010. Cherp and Jewell (2013, 344) refer to the "current proliferation of energy security indicators".

[7]Efficiency involves improving the performance of energy equipment and altering consumer attitudes: indicators here are energy intensity, per capita electricity use, on-road fuel intensity of passenger vehicles; stewardship consists of protecting the natural environment, communities and future generations; indicators are emissions of sulphur dioxide and carbon dioxide.

[8] I am grateful to an anonymous reviewer for this observation.

[9] There is common cause here with researchers in political ecology on the vulnerabilities and uncertainties created through strategies to secure access to resources and the 'normal violence' associated with global provisioning systems (see, for example, Peluso and Watts 2001).