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INTRODUCTION

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Energy research and energy-related policy making are informed by terms, ideas and stories that reproduce certain ways of thinking about problems and responses. As in other fields, phrases enter common usage, concepts become taken for granted, and shared vocabularies form. Disciplines and approaches build on these foundations, often forgetting that what seems like obvious, or common wisdom has a history: it is not set in stone nor is it uncontested or uncontroversial. The essays included in this collection explore different aspects of what we refer to as 'fables' in the energy world.

The phrases and sayings about which we write are not simply 'made up', or fictional in the sense of being products of the imagination alone. Rather, our point is that they act as orienting narratives; as tales that have conceptual foundations that have become invisible, worn smooth through use and submerged within familiar discourses in government, as well as in research and teaching.

In reviewing and revisiting a selection of terms that have this fable-like status we have two main goals. One is to introduce and also problematise the concepts we discuss – reminding old hands and newcomers alike that recurrent refrains (such as, 'first pick the low hanging fruit'), imperatives (to keep the lights on) and policy injunctions (engage with the energy trilemma) reproduce ideas that need not, and perhaps should not, be taken at face value. The second is to enrich the repertoire of concepts circulating in this field and to create opportunities for disciplines and approaches outside the realm of energy research to make useful contributions. On both counts, new 'stories' and vocabularies are needed.

The idea for this collection came from this double realisation.

Although approaches differ, the essays included here have certain features in common. Each sets out distinctive characteristics of the 'fable' or topic in question and each offers a critical analysis of the ideas on which the phrase or statement depends and of the challenges and issues that follow. The result is more than a glossary or index of key terms. In detailing what lies behind dominant discourses and sayings, contributors articulate and critique assumptions and conventions that have become embedded in the energy field. We do not push the analogy with Aesop's fables very far, but each chapter begins with an emblematic image and a short statement, making a link to this tradition. This is partly for fun, but also as a reminder of the power of metaphor and discourse.

Terms and languages are always changing, and we do not pretend to offer a final, rival or definitive lexicon. Instead, our purpose is to make the familiar strange again in order to generate and promote critical reflection about some of the core ideas around which energy and transport studies revolve. In detail, the collection examines eleven terms: energy demand; energy services; efficiency; rebound; elasticity; picking low hanging fruit; keeping the lights on; promoting smart homes; the energy trilemma; flexibility; and non-energy policy. This is not an exhaustive list, but in combination, these topics represent and exemplify dominant approaches in energy and transport policy and research.

Each 'fable' can be read as a stand-alone contribution and each is designed to inform and inspire students, teachers, policy makers or researchers with an interest in that topic. Reading them together gives a stronger sense of how related traditions and schools of thought 'hang together' and support each other. In designing the collection, we have sought to make some of these connections plain.

The first two chapters following this introduction (on demand and on services) show how energy is conceptualised as something that is abstracted from what people do, and from the histories, cultures and contexts in which energy demand is constituted.

The chapters in Part II (efficiency, rebound and elasticity) explore a series of linked ideas about the character of provision and consumption. All three terms are rooted in engineering and/or economics and all share a tendency to treat energy as a topic in its own right (as a resource, a component of an input-output equation or as a standardised commodity). In brief, notions of efficiency are in essence about delivering *the same* service but with fewer units of energy. The terms 'rebound effect' and 'elasticity' both emphasise the role of price (per unit of energy) in determining changes in demand. For example, the concept of rebound relates to the idea that the savings associated with efficiency gains might trigger increases in other (often non-energy) carbon intensive commodities and services. Meanwhile, the idea of elasticity concerns the anticipated impact of an increase or decrease in price on demand. In discussing these concepts we remind readers of the work involved in constituting 'energy' as a distinctive field of research and intervention.

The contributions in Part III focus on specific injunctions: 'first pick the low hanging fruit', 'keep the lights on' and 'promote smart homes'. In all these cases, energy (as used in buildings, or for transport) is viewed as a quantifiable resource used in delivering pre-defined services. Picking 'low hanging fruit' refers to opportunities to 'harvest' quick wins in terms of energy efficiency, and to do so without compromising the level of service provided. Assumptions about the non-negotiability and apparently 'fixed' status of energy services – and of the societal need for them – are also reproduced in the rhetoric of 'keeping the lights on'. In revisiting this idea we ask which lights need to be kept on, and why is lighting in any case so important? The third example, which has to do with the potential for using 'smart' technology and controls to manage domestic energy demand, depends on a similarly powerful set of ideas about present and future ways of life, and about the character of 'consumer' response.

The three chapters in Part IV deal with themes relating to policy. The first of these concerns the energy trilemma. The notion of an energy trilemma suggests that the goals of promoting energy security, affordability and decarbonisation are all important, but also in tension. This is so in that strategies that focus on one corner of the trilemma – like decarbonising supply – might make it harder to achieve other goals, such as providing 'affordable' power. Although talk of the trilemma is pervasive, it routinely sidesteps questions about the scale, the extent and the character of demand.

By contrast, demand seems to be crucial for those interested in flexibility and demand side management. Ideas about demand are also fundamental for debates about policies and interventions that have a bearing on the reduction and the escalation of energy consumption. So how is demand conceptualised?

Until recently, detailed questions about when and where energy is used were of relatively little concern partly because solid fuel, gas, and oil can be distributed and stored. An influx of more renewable sources of supply complicates this approach – bringing with it a new agenda about exactly when and where different forms of energy (and especially electricity) are used, and about the scope for shifting demand in space and time. From this point of view, the concept of 'flexibility' draws attention to the fact that both the location and the timing of energy consumption is indirectly shaped by policies that are not specifically concerned with energy or carbon emissions as such, but that have profound consequences for both.

In elaborating on the implications of this observation, the last fable in the collection takes issue with the view that the policies that matter for energy or transport are those that are explicitly or primarily concerned with energy or with transport.

Energy Fables highlights threads and lines of reasoning that run through the energy landscape. The list of terms and the topics we discuss is not exhaustive and others – for example, fuel poverty, comfort or storage – could be explored in similar terms.[1] In the postscript we take stock of the practical and policy implications of reviewing and sometimes overhauling the concepts and assumptions we discuss. We also recognise the everyday politics of energy and transport research: it is no accident that problems are defined and framed as they are, or that so much is invested in only some lines of enquiry and investigation. Dominant paradigms and interpretations of practical value and policy relevance interlock, and do so in ways that perpetuate many of the fables discussed here. While it would be naïve to expect new discourses and debates to spring up overnight, even small shifts of perspective generate new problem definitions, and with them new opportunities for intervention. Which new fables emerge, and how concepts of energy change and develop in the future remains to be seen. The fact that this book has no final punchline, and no one unifying conclusion, is not an accident or an oversight: it is because the field is open and because our purpose is to provoke and fuel future discussion, not to bring it to an end.

Note

1 See the online 'DEMAND dictionary of phrase and fable' at www.demand.ac.uk/demand-dictionary for more examples.

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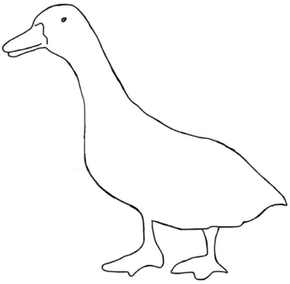
ENERGY DEMAND

Jenny Rinkinen and Elizabeth Shove



Some creatures are more insistent than others, and quacking ducks can be especially demanding. This chapter explores the social foundations of energy demand.

Introduction

Energy demand, usually indicated by the amount of energy consumed in different sectors, is a key factor in national and international energy and climate change policy. Since carbon emissions are significantly associated with the production and distribution of energy, demand reduction is a priority. This is evident in a recent strategy produced by the UK's six 'End use energy demand' research centres, which claims that 'reducing energy demand and improving energy efficiency provide the most promising, fastest, cheapest and safest means to mitigate climate change' (EUED, 2016, p. 5).

But what is energy demand, really?

The *Oxford English Dictionary* defines demand as 'an insistent and peremptory request, made of as right' (Oxford Dictionaries, 2018). In the energy world, demand has different meanings and associations: it often figures as the logical partner to 'supply'; it is tied to interpretations of 'need'; and it is the subject of various forms of intervention, including methods of 'demand side' management. As detailed below, all three of these interpretations treat energy demand as a social and economic phenomenon that exists in its own right.

This view is at odds with more sociological and more historical analyses of what energy is for and of how patterns of demand, in a more fundamental sense, emerge and change. As outlined by Shove and Walker (2014), such approaches suggest that it is not, strictly speaking, *energy* that is demanded. Rather, demand is for the services that energy makes possible: that is, for heating, lighting or mobility, for functioning televisions and laptops, for frozen food or for hot dinners. The demand for such services is, in turn, inseparable from the ongoing dynamics of social practice. From this point of view, it makes no sense to treat 'demand' as if it was in some way detached from the social arrangements and from the technologies and infrastructures of which societies are composed, and of which 'needs' are made.

In this chapter we distinguish between (a) definitions that interpret demand as the energy required to meet current and future needs and (b) those that take energy demand to be inseparable from the constitution of energy services and social practices. The first interpretation supposes that energy suppliers and policy makers are involved in meeting needs that exist, ready-made. In these accounts, demand (in the sense of what energy is for) is treated as given, rather than as a topic of research or policy intervention in its own right. By contrast, the latter position highlights the ongoing constitution of demand and the part that policy makers and others play in establishing and changing what people do and the energy requirements that follow.

Meeting demand

Engineers and economists generally think of energy as a 'resource' that is produced, distributed, and supplied in response to consumer demand. Energy is consequently treated as a standardised commodity, measured in agreed units (therms, kWh, Mtoe, etc.), and subject to various laws of the market. For example, if prices rise, consumers are expected to cut back on the amount of energy they use, and to consume (somewhat) more if costs go down. This relationship is complicated by different forms of 'price elasticity'. In practice, consumers are more willing or able to reduce some forms of energy demand than others. But in general, and alongside this uneven sensitivity to price, the consensus is that consumers buy the amount of energy they need unless there is some kind of shortage, and unless they cannot afford to do so. As a result, need and consumption are regularly taken to be the same. This line of argument is consistent with the view that producers and distributors aim to meet consumers' needs and design and organise systems of provision so that supply matches demand.

The scale of energy supply, now, and in the future, consequently depends on estimates of present and future demand. Established methods of demand forecasting involve judgements about trends in urbanisation, lifestyle, population and economic growth (Asif and Muneer, 2007). Not all forecasts anticipate increases in consumption, but those that do justify investment in more extensive systems of provision (more power stations, more roads etc.).

In treating demand as an outcome of a host of economic and other consumer-oriented factors, forecasters treat the estimate of future supply as something that is quite unrelated to past and present technologies and infrastructures of provision. Put differently, they do not imagine scenarios in which demand grows *in response* to supply, nor do they consider the possibility that forecasts are themselves part of engendering future needs.

This is consistent with the tendency to think about the need and the demand for energy and for the services it makes possible as something that exists as a social and economic 'fact' and that is, at any one point in time, non-negotiable. Various authors argue that people have certain 'basic' needs, and that these underpin an also basic level of energy demand (Day, Walker and Simcock, 2016; Gough, 2017). Much of this literature supposes that basic needs (for nutrition, shelter, clean water, education, thermal comfort, a non-threatening environment, etc.) are universal. Exactly how these needs are met changes over time, but the contention is that there are certain unwavering requirements and that these account for some, but perhaps not all, energy demands (de Decker, 2018).

In practice, interpretations of exactly what these needs are continue to evolve. For example, services that are now thought to be essential in some societies are considered luxuries, or not considered at all in other countries and contexts. While this is obvious, discussions of entitlement are usually bound in time and space, meaning that they rarely engage with underlying processes of change and variation. Instead, interpretations of acceptable standards of living are treated as matters of normative judgement. From this perspective the challenge is to ensure that people have access to 'necessary' services and resources, whatever these might be. This leads to the conclusion that the amount of energy needed in any one society is that required to enable everyone to participate effectively in it, whatever that entails. Again, these approaches situate demand as something that exists and that is largely independent of technologies and systems of supply thorough which needs are constituted and met.

Ironically, the language of 'demand side management' also takes demand (in the sense of the underlying services and practices that depend on energy consumption) for granted. This concept refers to measures and steps taken to reduce the amount of energy people use. Some forms of demand management are intended to limit consumption at particular times of day. Others, including improvements in energy efficiency, are about minimising the resources needed to deliver specific services. These strategies suppose that aspects of energy consumption can be manipulated and influenced by designers, suppliers and policy makers. For example, real time pricing is intended to encourage consumers to turn off 'unnecessary' appliances, or switch the heating or air conditioning down for a few hours to reduce peak load.

In this context, reference to the 'demand side' simply means that measures are focused on people who use energy rather than on those who generate and deliver it. Programmes of demand side management consequently target consumers (individuals or organisations), who are thought capable of increasing, or decreasing energy consumption (within limits) at will. There is considerable support for such approaches. For example, the European Commission states that 'European households and businesses should be enabled to lower their bills and obtain further benefits if they help relieving pressures in the energy system by simply adapting their demand' (European Commission, 2013, p. 2). As this focus on individual action suggests, 'demand side' measures are not intended to transform the range and character of energy services on which demand depends or to have a major or lasting impact on what people do: they are essentially about trimming energy consumption while maintaining 'normal' levels and standards of service.

The result is an odd situation in which reducing energy consumption is an essential element of climate change policy, and at the same time, the extent and character of 'demand' (what is energy for?, how does this change?) is rarely a topic of analysis and debate. For example, the UK's recent clean growth strategy (HM Government, 2017) does not explicitly discuss demand at all. Instead, the focus is on methods of meeting present 'needs' more efficiently and with fewer carbon emissions than might otherwise be the case. In other work, including that by the UK's Committee on Climate Change, increases in population, growth in GDP, and anticipated improvements in technological efficiency are factored into estimates of future energy consumption. However, this is essentially a matter of quantifying the future energy costs of enabling present ways of life, the basic parameters of which are expected to remain the same. This is not the only possible approach.

Making demand

The positions considered in this second section do not suppose that energy demand 'exists' as a phenomenon in its own right, aside from policy or from systems and technologies of supply. Instead they start from the common proposition that energy demand is an outcome of the social, infrastructural and institutional ordering of what people *do* (Shove and Walker, 2014). Defined in this way, energy demand has a history (in fact, multiple histories) and is constantly changing in line with the practices on which it depends.

For example, the energy 'needed' for transport and mobility is closely related to the development of what Mattioli describes as 'car dependent practices' (Mattioli, Anable and Vrotsou, 2016). Working, shopping and visiting friends and family do not always depend on the use of a car, but in some situations material arrangements such as city planning, road infrastructures and systems of public transport mean that cars and driving are indeed required (Shove et al., 2015). The resulting 'demand' for fuel is not to be taken for granted, nor is it an expression of consumer choice. Rather, 'energy demand is inscribed and reproduced through the combinations of practices and infrastructures of which contemporary forms of car dependence are made' (Shove et al., 2015, p. 275).

Although they underpin what people think of as 'needs', arrangements like these are inherently unstable. From a longer-term perspective, 'needs' are always dynamic and always in flux. Thermal comfort is a good example. Significant amounts of energy are used for heating and cooling buildings and for maintaining the increasingly standardised indoor conditions in which people live, work and play. But how much energy is needed, and what is comfort? Meanings and expectations of comfort have evolved alongside technologies of heating and air-conditioning, and along with standardised methods of building design and mechanical engineering. The result is a very specific understanding of 'need' (buildings are now generally designed to deliver around 18–22 °C) arising from correspondingly specific developments in methods of calculation, in judgements about 'normal' forms of clothing and activity, and in building codes and standards (Cass, 2017; Chappells and Shove, 2005; Shove, 2003).

As this example illustrates, meanings of service (here comfort) and related demands for energy are provisionally held in place by a raft of social and technical arrangements, all of which have complicated and contested histories, all of which are open to negotiation and change and none of which are inevitable or natural. This is not an unusual story. The 'need' for the energy used in lighting, cooking or watching TV is established in much the same way.

These different 'end uses' combine to form what we might think of as the total demand for energy. However, this is only part of the picture. The constitution of demand also depends on related forms of generation, distribution and supply, all of which are implicated in the emergence and disappearance of energy-related services and practices. Policy strategies like those of 'predict and provide' lead to investment in forms of provision (roads, gas networks, electricity grids) that make specific energy-demanding practices possible. More than that, and as Hughes and others have shown, forms of infrastructural development often depend on actively 'making' and not simply meeting pre-existing or 'unmet' demand (Hughes, 1983).

These are not localised or isolated processes. For instance, infrastructures (reliable electricity networks; frozen food distribution systems) and domestic appliances (refrigerators and fridge freezers) are jointly implicated in the development of increasingly global systems of food production and retailing, linked to also changing diets and methods of cooking, buying and storing food at home (Rinkinen, Shove and Smits, 2017). The result is a globally distributed process of 'demand-making' that operates across many places and practices at once.

Given that these examples illustrate the making of demand and given that demand reduction is an important policy goal, further questions arise about how governments and institutions might act to foster less energy-demanding services and less resource intensive practices. In other words, what, if anything, can be done to change the very basis of demand?

Strategies for demand reduction

As indicated above, energy and climate change policies tend to take 'demand' for granted, supposing either that demand exists ready-made (that it is a non-negotiable 'need'); that it is made by uncontrollable market processes, or influenced by policies in other fields. From this perspective, it is perhaps unrealistic, and perhaps not legitimate to even think about intervening with the aim of changing the nature of demand itself. On the other hand, all policy positions influence the ongoing trajectories of consumption and provision. From this point of view, taking demand for granted is itself an active stance, favouring some forms of investment and making some future social practices more likely than others.

It follows that there is, at least in theory, scope for governments to change tack and to think about opportunities for reducing demand 'at source'. Some methods, like planning cities in ways that limit the need to travel, are already established. Other strategies, like those required to challenge contemporary understandings of comfort are less well-developed (one exception being the Japanese government's Cool Biz programme that changed dress codes and reduced the need for air conditioning). Meanwhile, technology-driven goals of increasing reliance on renewable sources of power, or of substituting electric for petrol-powered cars, are set to shift features of infrastructure and provision. Whether intended or not, interventions like these are likely to have some impact on the detail of daily life and hence on the extent and the timing, and not just the (decarbonised) form of energy demand that follows.

Equally important, policy makers involved in making and implementing strategies in areas including health care, economic policy and more, are also involved in changing infrastructures and related systems of provision and practices – all of which matter for energy demand. Recognising that energy demands are defined and shaped by a wide range of non-energy policies leads to the obvious, and also simple, suggestion that non-energy policies might be deliberately mobilised as instruments of demand reduction.

In conclusion, if we define demand as the amount of energy consumed in delivering an already specified service (or set of services) demand reduction is likely to depend on forms of efficiency, on methods of demand side management, and on means of decarbonising supply. All these strategies focus on meeting 'needs' as effectively as possible and on doing so in discrete sectors like those of transport, buildings, industry and so forth.

On the other hand, if we define demand as an outcome of the many services and practices that energy systems and technologies make possible, demand reduction is about steering the constitution and transformation of what people do. From this point of view, demand reduction depends on reconfiguring services and social practices, not on intervening in different sectors, one at a time, and not on progress in efficiency either. For the moment, it is not clear when, whether or how this more extensive interpretation of demand might take hold, or which government departments or policy actors might take the lead.

In the meantime, and in the short term, this chapter provides an important reminder of the fact that there are very different ways of conceptualising 'demand', and that these have practical consequences for how agendas and priorities are established and pursued in research and policy.

Further reading

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3

ENERGY SERVICES

Janine Morley

Do squirrels distinguish between sources of energy (the nut) and the services that energy makes possible (sustenance)?

Introduction

It has long been recognised that energy is not consumed for its own sake but for the services that it provides. Although the majority of energy research and policy remains firmly focused on energy itself: as a resource that is measured in units like kWh, litres or cubic meters and that is knowingly and rationally acquired and used, there is growing interest in 'what energy is for'. Within this literature, concepts of service are often taken for granted or used inconsistently (Fell, 2017). This chapter shows that a focus on energy services can help develop and strengthen understandings of energy demand that go beyond those rooted in a view of energy as a resource.

Energy as a resource: A common but limited perspective

It seems obvious that people use energy (Janda, 2011) and that in order to manage or reduce energy demand, they need to cut back on their consumption. This can be achieved in a number of ways: by installing energy efficient boilers, heat pumps, insulation and renewable generation in homes and workplaces (Bartiaux et al., 2011; Fawcett, 2013); by driving more efficiently, buying fuel-efficient vehicles or choosing to cycle instead (Barkenbus, 2010; Gallagher and Muehlegger, 2011). Advocates of measures like these assume that energy is a quantifiable and knowable resource that people manage by exercising choice in how it is used. It follows that enhancing choice and awareness should facilitate reductions in energy consumption because – it is also assumed – people will be motivated to save money, even if not by concerns about the environmental consequences of what they do (Sweeney et al., 2013).

This understanding of energy as a resource underpins the vast majority of policies aimed at managing or reducing energy demand. In the UK, there is an emphasis on improving the efficiency of appliances, new technologies and buildings through technical standards and on persuading consumers to opt for more efficient solutions (Warren, 2014). Across Europe (European Commission, 2009) and internationally the roll-out of smart meters represents another key area of policy. Smart meters are designed to provide 'near real time information on energy use' so that 'you will be able to better manage your energy use, save money and reduce emissions' (HM Government, 2017b).

Such measures suppose 'that individuals act as 'micro-resource managers' weighing up the costs and benefits of consuming resources in accordance with their desires, opinions, values, attitudes and beliefs' (Strengers, 2011, p. 36). Although it is common and may be appropriate some of the time (e.g. when analysing energy supply systems), this view is limited in that it overlooks more basic questions about 'why people use resources, how these 'needs' and 'wants' are constituted and how they are changing within the broader context of everyday life' (ibid.). Shove makes a similar point, noting that 'when energy is in the spotlight, the services it provides are in the shadows' (Shove, 1997, p. 271). If we are to understand how energy demand changes and how significant reductions in demand might be made, we need to move away from a fixation on 'energy' per se, to consider the services that energy provides.

What are energy services?

People do not consume energy in the same way that they eat food or drink water, nor do they use it in the way they use a kettle, a car or a TV set: that is, by directly handling, controlling or interacting with it. Instead, energy works in the background: to power appliances and vehicles or to provide lighting, heating, ventilation and so on. This means that people do not demand or benefit from energy as such, but from the services that it makes possible. Accordingly, energy services are usually defined as the useful work that energy does and the benefits this provides.

This distinction between energy and service dates back to at least the 1970s when, in arguing for a more strategic approach to planning electricity infrastructure, Amory Lovins (1976) noted that the qualities of supplied energy did not matter to consumers so long as their 'needs' were still met:

> People do not want electricity or oil, nor such economic abstractions as 'residential services,' but rather comfortable rooms, light, vehicular motion, food, tables, and other real things.
>
> *(Lovins, 1976, p. 78)*

The point is that 'real things' can be achieved through other means than electricity, which was increasingly being used as a default source of power.

The term 'energy service' is then taken up by Reister and Devine as something that is 'measured in units of work, of heat at various temperatures, etc., but these quantities are merely surrogates for measures of the satisfaction experienced when human wants are fulfilled via the direct use of energy' (Reister and Devine, 1981, p. 305). Distinguishing the use of energy from the 'measure(s) of service' it provides, allowed these authors to show how technological changes in the means of provision affect the overall cost of energy services. Since then, other researchers have found it helpful to distinguish between the costs of energy as a resource and the costs of the services it provides. This is, for instance, important when thinking about the consequences of improving efficiency. By reducing the energy required to deliver a given service, such measures also reduce the cost of that service, and may increase the demand for it (Berkhout, Muskens and Velthuijsen, 2000; Herring and Roy, 2007) (see Chapter 5 on rebound).

This begs further questions about what determines the demand for services like heating or lighting. Is it just a matter of their cost, perhaps relative to incomes? Anthropologists and sociologists suggest that the quantity of heat that people 'buy' is also, and perhaps more significantly, related to social, cultural and collective histories and traditions linked to 'socio-technical change and the co-evolution of infrastructures, devices, routines and habits' along with the 'inter-dependent practices of producers, providers, utilities and governments' (Wilhite et al., 2000, p. 118). Although it is important to think about heating and lighting, and not just energy, there is a further step to take. As detailed below, lighting and heating are not the only kinds of service that energy makes possible (Shove, 2003).

In reviewing the ways in which energy services have been defined, Fell (2017) notices that the term is used in two different senses. The first refers to situations in which electricity or fuels are converted into more 'useful' formats, such as lighting, heating, motion, sound and combinations of these in the functioning of appliances like washing machines and computers. Fell refers to these outputs as 'energy services' (ibid.).

The second common meaning refers to the benefits that 'energy services' provide or facilitate, and thereby their usefulness. This refers back to the 'real things' that are demanded directly or indirectly in the course of everyday life: things like comfort, getting to work, sending an email or going on holiday, which Fell (2017) describes as 'end services or states'. Thus, heating (energy service) is undertaken as a means to achieve thermal comfort (end service), and lighting (energy service) is used for the purpose of seeing at night (end service).

It is vital to recognise the difference between these two kinds of service. For example, while it may help, ensuring that room temperature in a building falls within a certain (limited) range does not deliver or guarantee comfort. The room may be unoccupied; or those who are in it might find it too warm, depending on how they are dressed. That is to say, 'energy services' like heating are not inherently useful. In Fell's (2017) terminology, it is 'end services or states' that are actually closer in meaning to the general understanding of energy services as the *useful* work and/or benefits that energy provides.

Despite the centrality of 'end services', they remain poorly conceptualised and often overlooked. In particular, questions of comfort or of what journeys are 'for', tend to be neglected by economic analyses of 'service demand'. As Haas et al. (2008) explains in the case of travel, while 'the *actual energy service* is to reach the shop where I can buy a certain product or to reach my office. . . a common and more technical definition of transport energy services are distances travelled' (ibid., p. 4012, emphasis added). Due to the methods used to model and analyse services and demand for them, the purpose of journeys or the characteristics of comfort are often out of sight. While these issues are attended to in other literatures (Mattioli, Anable and Vrotsou, 2016; Nicol and Humphreys, 2009), this is often not the case in the energy field. It is worth thinking further about how such broad 'end services' as 'comfort' or 'mobility' are conceptualised and how they might be included in research and policy making alike.

Energy services, meta-services and energy demand

The concept of final or end services is familiar in the analysis of energy and material flows. Final services are categories of consumption that can be achieved in more and less eco-efficient ways, commonly including communication, illumination, hygiene, sustenance or nourishment, mobility or transport, shelter or structure, and thermal comfort (Cullen and Allwood, 2010; Roelich et al., 2015; Heiskanen and Pantzar, 1997; Baccini and Brunner, 1991). Such services are characterised in various ways (Heiskanen and Pantzar, 1997) but there is a tendency to interpret them as enduring and universal types of 'need', desire or function that are always present in some form and that must be satisfied in some way. Such an 'excessively functional view' (ibid., p. 424) fails to address the 'socio-historical dimensions' of categories that are themselves changing and culturally varied.

Not surprisingly, anthropologists and sociologists often work with a broader, social and historical notion of services. For example, Wilhite et al. (1996) investigated cross-cultural variations in the meaning and achievement of what they called 'cultural services' such as cosiness and cleanliness, which just happen to depend on energy. Shove (2003) also developed an account of sociotechnical change in everyday forms of consumption in which similar services, like comfort and cleanliness, were central to the analysis. Defined as 'composite accomplishments generating and sustaining certain conditions and experiences' (ibid., p. 165), there is a resemblance between Shove's use of the term 'service'; and that of 'end services or states' (Fell, 2017).

However, to distinguish them from functional understandings I introduce the term 'meta-service' to describe these more expansive, composite 'services' to which energy services contribute. What does the concept of 'meta-services' add to understandings of energy demand? The following three features are especially important (Morley, 2018).

More-than-energy services

Firstly, meta-services like comfort, cleanliness, entertainment or mobility are useful or beneficial conditions, experiences and achievements that depend upon *more* than energy alone. Sometimes energy is not required; often human labour or inputs of some kind are. Meta-services almost always depend on other products, appliances and infrastructures, many of which may not consume energy directly themselves (such as roads, building structures and furniture). The concept of meta-services thereby calls attention to how 'suites of technologies operate together' (Shove, 2003, p. 60) in a 'blend of method, meaning and hardware' (ibid., p. 166) to 'co-constitute[s] the collective conventions of everyday life' (ibid., p. 60). One consequence is that it is not just energy-consumers who are responsible for the shaping of meta-services and the demand for energy services they entail. Many different parties are involved in provisioning, structuring and defining meta-services.

For instance, the fashion industry which supplies clothing and shapes our understanding of what is appropriate to wear is implicated in the achievement of thermal comfort (Morley, 2014).

No fixed or universal 'needs'

Secondly, it is tempting to interpret services such as comfort or mobility as fixed and universal categories of 'need' to which energy services (like heat or transport) contribute in more or less efficient ways. But a key quality of meta-services is that they vary from culture to culture and change over time. This means that what we understand, recognise and physically experience as thermal comfort today, may have been very different in the past; and might not even have existed as a distinctive concept in its own right. In other words, comfort is not simply a pre-existing end for which heating and cooling technologies were developed and thereby became immediately useful. Rather, 'something must have changed in everyday life for these new technologies to *become of use* to large numbers of people' (Kuijer and Watson, 2017, p. 78, emphasis in original).

Meta-services change when their components change

The third key point is that meta-services change when the means of achieving them change (Heiskanen and Pantzar, 1997). For instance, concepts of comfort are conditioned by the technologies that sustain and enable them. It is not uncommon today for people to attribute their own experience of indoor comfort to heating or cooling systems, 'forgetting' that what they are wearing, and their levels of activity and health also contribute. The tendency to equate comfort with the operation of heating and cooling technologies is something that has evolved over time, and that has evolved with those same technologies. Similarly, new 'needs' for communication emerge and co-evolve alongside new 'means', as in the way that internet technologies have incrementally become 'necessary' for most households (Walker, Simcock and Day, 2016).

One consequence is that apparently simple substitutions between different 'means', including more energy-efficient technologies, may lead to shifts in how meta-services are understood and experienced. For instance, air-to-air heat pumps are more energy-efficient but they tend to be used in different ways compared to central heating or direct heating, including for air conditioning in the summer (Gram-Hanssen, Christensen and Petersen, 2012).

In sum, the demand for energy services depends on how meta-services are organised. By focusing on meta-services as more encompassing formations of convention, experience and means of provision, in which energy services like lighting and heating are usually only one among many components, we can better recognise the dynamic and collectively distributed nature of demand. As described above, changes in heating-related energy use are not only a question of how people perceive and manage heat, but also of the wider arrangements in which such experiences transpire: what type of clothing is worn and how indoor spaces are designed and used.

What does this analysis of meta-services imply for demand management policy and intervention?

Managing meta-services to reduce energy demand

When energy is viewed as a resource, energy demand is simply interpreted as the volume of energy used (in other words it is equivalent to energy use itself). Demand management and reduction strategies therefore focus on reducing such quantities, and the most common approach is through energy efficiency (see Chapter 4). But when energy as a commodity is put to one side, and the services that energy provides are in the spotlight, demand management is a matter of *managing or reducing the demand for services*.

There is some interest in modelling the impact of changes in service demand on carbon reduction policies (Haas et al., 2008; Kesicki and Anandarajah, 2011; Kainuma et al., 2013; Fujimori et al., 2014). However, exercises like these tend to focus on economic factors such as the price of services or incomes. Beyond this, the possibility for interventions in service demand, as part of energy or wider carbon reduction policies, does not receive much attention.

There could be several reasons for this, including the way that government departments and energy companies are organised, and what kinds of intervention are considered to be within their remit. But that remit is not fixed, and there may be a case for extending and reformulating it in order to achieve the long term and sizeable reductions in carbon emissions required by climate change targets. The analysis set out here suggests that there is no need to worry that service-demand reduction equates to reductions in levels of wellbeing or quality of life; which can be one concern. This is because meta-services are not the same as energy services. Thus, changes in quantifiable levels of energy services (e.g. room temperature), which is the goal of service-demand reduction, do not translate directly into equivalent changes in meta-services (e.g. comfort). In fact, some reductions in energy services might bring about improvements in meta-services: such as when over-heating in buildings occurs or long-distance commuting declines. The point is that levels of heating, lighting or travel are not themselves synonymous with levels of well-being. There may be some important dependencies, but also considerable scope for re-organisation.

What would it mean to take meta-services as a point of intervention for policy makers charged with the task of reducing energy demand? In theory forms of 'meta-service management' would focus on how meta-services are organised and thus the demand for energy services that they generate. This is not so far away from current discussions about how services are provided and about the potential shift to service-based business models. One complication is that energy policy makers are not the only actors involved.

If as suggested above, meta-services consist of composite arrangements of products, systems, understandings and practices, re-shaping them in less energy-intensive ways will likely involve a number of different parties. This means extending efforts beyond end-consumers, since they are not the only ones involved in shaping meta-services like comfort or entertainment, and also beyond energy actors and explicitly energy-related forms of governance. Developing meta-services in ways that reduce energy demand means identifying the parties who are *already* shaping relevant experiences, conventions and the means of providing for them, and devising ways of reconfiguring their involvement.

For example, the producers of energy-consuming appliances are already required to (re)design their products to meet efficiency standards. But these producers also promote the use of such products in the first place, and when they do so they are potentially changing and reinforcing particular concepts of meta-service, such as what the home or family life should be like. Such shifts could well be in more energy-intensive directions.

Bringing such parties into the project of reformulating meta-services (to radically reduce carbon emissions) is likely to be challenging. Broadly it would mean tracing and emphasising the indirect implications of commercial enterprise and policy decisions for overall energy demand, perhaps as a point of public, social, and ethical concern. One approach to this might be to extend the kind of indirect environmental impacts (or externalities) that are addressed in corporate social responsibility evaluations. Another might be through developing industry-wide initiatives, potentially on a voluntary basis and organised by third sector organisations. For instance, rather like the involvement of supermarkets in the issue of food waste (Evans, Welch and Swaffield, 2017), large fashion retailers and clothing manufacturers could become involved in discussions about sustainable or seasonal clothing and the energy demand that clothing styles imply for buildings. Governments may also have a role in funding or leading initiatives like the Cool Biz programme in Japan, which changed conventions of office wear thereby reducing the 'need' for air conditioning and for the energy demand associated with it (Shove, 2014).

Another route is to focus more explicitly on the delivery and definition of 'services'. Such strategies already feature in some areas of energy-related policy. Service-based business models which focus on selling services, rather than products or commodities, are often invested with the promise of reducing energy demand. This is because the financial incentives to improve energy efficiency are shifted to providers when customers buy services (for instance warm buildings or cloud-based computing services), rather than resources. Policies in the UK support the development of energy service companies (ESCos) and their extension beyond their current, limited role in large organisations (HM Government, 2017a). While this seems like a move in the right direction, there are some risks involved. For instance, if utility companies attempt to *sell* comfort, cleanliness, entertainment or communication, this could entrench existing and energy-intensive interpretations of these meta-services, rather than challenging them and reducing demand for the energy services on which they depend. For instance, comfort as provided by a utility company is likely to be defined by the energy service they can actually deliver (heating or cooling), occluding the wide range of other means of achieving comfort – such as wearing different clothing. In other words, the shift to service-based business models does not inherently challenge 'meta-services' or reduce levels of energy service demand.

Conclusion

To conclude, policies and strategies that focus on energy as a resource are inherently limited. To be fixated on energy, and even on energy services, excludes serious consideration of the social and collective arrangements (meta-services) to which these forms of provision contribute. Not only does this run the risk of misunderstanding how and why energy demand is changing, it also obscures opportunities for managing and reducing energy demand. Exploiting this potential depends, at a minimum, on recognising the roles that diverse policies, companies and practices play in shaping meta-services, now and in the future.

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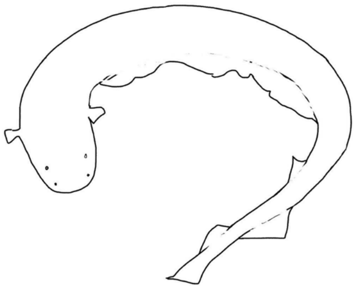
8

KEEPING THE LIGHTS ON

Gordon Walker

Electric eels have muscle-like cells, called electrocytes. These enable them to deliver electric shocks at any time of the day or night. Electric eels do not light up, but they can produce enough electricity to illuminate up to 20 light bulbs, for an instant (Tennessee Aquarium, 2015).



Introduction

Keeping the lights on is a recurrent phrase used in political and public discussion of energy issues. It conveys the idea that it is crucial to keep energy systems working, smoothly and uninterrupted, and for governments to ensure that this is achieved. While evidently an important goal, its commonplace use is grounded in a set of assumptions about how 'keeping the lights on' is to be ensured and how the relationship between supply and demand is to be managed.

Classic 'keeping the lights on' thinking sees energy demand as non-negotiable, lying outside the frame of legitimate policy debate. As such, it justifies a focus on energy resources and generation with the aim of ensuring sufficient supply to meet whatever demand exists at any point in time, with the implication that failure would be catastrophic: the lights would go out and chaos would follow. This thinking can be challenged. Keeping a wide range of energy flows and services going does not have to be just about endlessly focusing on and increasing supply. We are already starting to see responsive demand management as a way of reducing demand at peak times rather than meeting it with peak supply. But given the challenge of meeting CO_2 emission targets, a far more fundamental debate is also needed about how much energy is enough; or exactly how many lights (and other energy uses) need to be kept on, now and in a necessarily low carbon future.

What has 'keeping the lights on' come to mean?

There is evidently a direct literal meaning to keeping the lights on, that of sustaining electrically powered illumination and not letting 'the lights' go out. But the phase is also idiomatic, conveying more than just its literal meaning; or metaphorical, a figure of speech which is symbolic of a wider concern.

Examples abound in the media, in government statements and reports, in political rhetoric, and in marketing by companies working in the energy sector. An internet search finds examples related to energy issues in Latin America, Asia, Western and Eastern Europe and the US, making it a globally circulating idiom.[1] In the UK it tends to feature on a seasonal cycle as winter approaches and concerns are voiced by politicians and media commentators about how close we might come to electricity supply not being able to meet peak winter demand (see for example Guardian, 2016). But it is also mobilised by policy makers, industry lobbyists and non-governmental groups in relation to longer running debates about new supply-side decisions or investments, as well as energy company regulation (see for example Ratcliffe, 2016). It is very much, therefore, a phrase that has become commonplace, embedded in ways of thinking through its repetition and largely used without critique.

Captured in how the phrase is used is an apparently simple and powerful metric of success and failure. The lights not being kept on is symbolic of failure, of a system that is not fit for purpose and of a government that has not properly done its job in looking after a core need of the economy and its citizens. Keeping the lights on is to be 'secure and stable', to have resilience and to be successfully planning ahead to deal with the stresses and strains that an energy system is foreseeably likely to encounter, including predicted future patterns of demand, old power stations being decommissioned and established energy resources 'running out' or becoming more expensive. During the UK coal miners' strikes of the 1980s, Mrs Thatcher reportedly used the justification of 'keeping the lights on' (Marsden, 2013) in drawing up plans to use the military to counteract the perceived threat of Trade Union action.

In many of its applications then 'keeping the lights on' becomes pretty much synonymous with the notion of energy security (Bradshaw, 2010; Winzer, 2012). While making most obvious sense when applied to electricity systems (as nearly all lighting is electrically powered), sometimes this specificity is lost and it is used as a metaphor of energy system security more generally.

What is the history of the idea of 'keeping the lights on'?

Keeping the lights on doesn't have a clear or obvious history, a 'first use' or similar. We might assume though that its appearance was associated with the establishment of electricity as a widespread and increasingly national infrastructure in more wealthy countries in the first half of the twentieth century (Hughes, 1993; Cubitt, 2013). Light was the first energy service that electricity was used to provide commercially, through lighting installations in high-end hotels and residences and stretches of electric street lamps in places such as Godalming in the UK, and Wabash in the USA. As local grids spread and eventually became joined together to form regional and then national grids, and in particular where municipal or national governments had direct responsibility for establishing and running these electricity systems, 'keeping the lights on' emerged as a responsibility of government and became symbolic of its competence.

It is significant that the breakdown of electricity supply has also come to be represented through a light-based idiom – 'blackout' has a variety of historical uses, including the wartime dousing of visible lights during air raids (Nye, 2010), but has come to be used to capture the most visible and obvious consequence of a power outage. In political terms blackouts are resolutely bad things to be avoided, the opposite, therefore, of the good thing to do – keeping the lights on. Power outages evidently do not only turn lights off. Much else that the modern world has come to depend on, such as information technology infrastructures, electronic payment systems, petrol pumps, tram, metro and electrified railway networks, can also fail to function (Shove, 2016; Walker, 2016). Light has become established and sustained as the commonplace idiom for talking about maintaining a secure electricity supply, despite the many ways in which it is now not only the light that matters.

What is wrong with 'keeping the lights on'?

So what is the problem? Surely keeping the lights on *is* a good thing to do? Taken literally artificial light is indeed an important energy service that brings well-being to people's lives in various ways (Petrova, 2017), enhancing their fundamental 'capabilities' (to use a language often applied to development issues) (Day, Walker and Simcock, 2016). Bringing electric light to rural communities in Africa, for example, is recognised as enabling people to work and study later into the evening, meaning they can enhance their education and livelihoods (Jacobson, 2007; Diouf, Pode and Osei, 2013). Streetlights and traffic lights make driving and streets safer, people feel more secure in well-lit urban spaces, and more prepared to walk and exercise outside, improving their health and well-being (Cerin et al., 2017). Artificial light matters undoubtedly in fundamental ways to making life better, so keeping light predictable and secure in its availability makes a lot of sense. If we extend beyond light to other energy services – such as heating, hot water and refrigeration – we can also spell out why they matter, and how they are also evidently fundamental to the basics of a normal, ordered, healthy and satisfactory everyday life (Walker, Simcock and Day, 2016). Surely we *do* need to avoid the many forms of interruption, disorder and sometimes chaos that ensues from power outages when the 'lights go out'?[2]

The problem is not with the objective, but rather how 'keeping the lights on' has come to be understood and how it is assumed to be realised – or how it *does work* in practice as a commonplace idiom or metaphor. The strongly embedded logic of the 'keeping the lights on' discourse is that if the problem is one of potential failure in supply – the electricity system in particular failing to be reliability secure in its operation – then that's where to focus attention, on supply. Core assumptions then follow that can be found reproduced across many examples. 'Keeping the lights on' means (i) replacing old power stations with new ones when they come to the end of their life, (ii) investing in additional capacity because energy demand is going to be higher in the future than it is now, (iii) securing new supplies of primary energy resource where these are needed to replace others that are running out or are too high in their carbon emissions, and (iv) investing in ways of generating power that are secure, reliable and predictable because that is what meeting demand needs. These are all actions that focus on supply, resources and generation, with demand the fixed variable that can only be followed not managed or reworked in any significant way. The extract below from an article titled 'Shale and nuclear are the way to keep the lights on' in the business pages of *The Telegraph* displays this supply-dominated logic:

> If we assume that coal will be phased out in the next few years then the burden on gas and nuclear only increases. We are totally dependent today as a country on gas and nuclear. There are no viable alternatives on any sensible time horizon. But, and it's a big but, we are fast running

> out of gas in the North Sea and our nuclear fleet is ageing. North Sea gas production peaked in the year 2000, and is now running at less than 50% of its peak; in 10 years' time it will be at less than 20%. So we must choose between Russian imports and expensive LNG imports, or developing a shale industry of our own.
>
> *(Ratcliffe, 2016)*

As in this article, which also argues that 'industry will wither and die' unless energy costs stay secure and competitive, the urgent focus on supply choices is often informed by a sense of foreboding and crisis – keeping the lights on will not be possible by other means, the route being advocated is necessary and vital, to do otherwise is to risk failure and political ignominy. Hence the seasonal pattern to media reporting in the UK; as winter approaches so does the potential for crisis if margins are cut too tight. And given the routine assumption that energy demand is always and inevitably going up in the future, there is crisis just over the horizon if the right decisions on supply are not made right now. Using a crisis-discourse has been long recognised as a political tactic in attempting to force or justify government action of a particular character and form (Jhagroe and Frantzeskaki, 2016), including in relation to 'peak oil' discourses (Bettini and Karaliotas, 2013; Huber, 2011). Arguably 'keeping the lights on' when deployed as part of an impending crisis narrative with the situation presented in those terms, can be read as an instance of intentional crisis-making that supports incumbent supply-side interests in the energy system.

How can the mentality of 'keeping the lights on' be challenged?

So what happens if those interests and the assumptions they are built on are challenged, most fundamentally by reorienting how the relationship between supply and demand is approached and how demand itself is thought about? Classic 'keeping the lights on' thinking sees demand as an aggregate block, to be met in its totality, essentially undifferentiated with all of the kilowatts of particular end uses adding up to make megawatts and gigawatts of total demand at any point in time (Patterson, 2007). There are daily and seasonal patterns in how these end uses add up, making load curves that supply needs to meet and constituting patterns that are to some degree predictable but *not* essentially changeable. The logic is thus one in which peak demand, which crisis narratives often focus on as the crunch point in time where demand exceeds supply capacity, will be what it will be; and supply has to be in place to meet it.

An alternative approach is to see demand not as a monolithic aggregate block, but made of an enormously differentiated set of uses of energy for different purposes as a part of many different everyday practices (Shove and Walker, 2014; Walker, 2014), and demand as continually being produced moment by moment – a living and breathing entity in effect, complex and interwoven with how society functions on an ongoing basis. Focusing on peak demand in these terms can lead us to ask what are peaks in fact made up of (Torriti et al., 2015), why a peak is produced when it is, and crucially whether some of what makes it up could happen at a different point in time. If armed with this knowledge, the dynamics of demand can be intervened in to spread or 'shave' the peak, by making particular uses of energy more flexible and responsive in their timing to the needs of the energy system (Torriti, 2016), then we have an alternative way of avoiding the 'crunch point' – managing demand to fit with supply capacity rather than supply always and forever following and meeting demand.

This alternative approach to keeping the lights on is increasingly becoming recognised as having an important place in the management of electricity grids (Torriti and Grunewald, 2014). For example, a suite of demand response schemes are being run by National Grid in the UK[3] with the aim of incentivising industrial and commercial energy users to essentially turn energy-using devices off at peak times in order to help keep the wider electricity system in balance (which includes avoiding high cost and high carbon generation); and there is much attention also being given to finding flexibility in the temporal patterns of domestic energy demand once smart metering technologies are in place. The implication is though that turning some things off is still about keeping a vast multiplicity of other things switched on.

Shifting demand around in time is therefore only a starting point in challenging classic 'keeping the lights on' thinking. The wider insight is that by approaching demand differently, disaggregating and not taking it for granted, opportunities to intervene are revealed. This applies to longer term trajectories in which the 'keeping the lights on' crisis is presented as a problem of how to keep up with ever rising electricity demand. Rather than just taking the assumption of ever rising demand for granted – indeed as a good thing symbolic of strength and economic power – approaching demand differently opens up questions about how its trajectories are both internally differentiated and potential sites of intervention. Questions can then be asked about the value and need for particular uses of energy and the normalised ways of living they are sustaining.

Even though, as argued earlier, a range of energy services can be seen as enabling the basics of well-being, whether and to what degree energy use, in all of its contemporary variety, really needs to be integral to living well is an open question. Evidently many of the ways in which we have become apparently energy-dependent are about going far beyond the basics of well-being. Considering light as just one example, yes modern lighting technologies provide for the basics of illumination in people's homes, in workplaces, on streets and so on. But it has also become an integral part of interior design and the selling of products in shops, both of which have proliferated the number of light fittings and illuminated bulbs. Many lights are now kept on in the daytime even when natural light is plentiful, more buildings are floodlit than in the past, sports grounds are ablaze into the evening. The use and purpose of artificial light has evidently been changing over time and we are undoubtedly keeping exponentially many more lights on than we used to, counteracting to some degree the significant gains in bulb efficiency (Boardman, 2014; Jensen, 2017) that have been achieved. So does 'keeping the lights on' just mean continually meeting all of this evolving demand for electricity, all of the time, regardless? And how about all of the other examples of proliferating and escalating patterns of energy demand that we could identify, information technologies being a prime example (Hazas, 2015)? Surely questions can and should be asked about the need for energy and the scope for using much less, rather than just accepting the dynamics of demand as they materialise now and into the future?

Keeping energy systems working and avoiding failure is important, but we need to look at how to achieve this beyond building more supply to meet an unquestioned demand. Starting with asking what in fact energy systems are working for would be a good first step, opening up a question that is systematically ignored by classic 'keeping the lights on' thinking.

Notes

1 See Millán et al. (2003) on Latin America; Nahzi (2016) on Kosovo; EAC (2009) on the US; Boren (2016) on the UK; Anderson (2015) on the Middle East; and Shell (undated) on the Philippines.
2 In many less economically developed countries blackouts can be a relatively regular and 'normal' occurrence, meaning the degree of immediate disruption and chaos is lessened, although the social and economic consequences of being without electricity can still be severe.
3 See the National Grid's 'Power Responsive' initiative (http://powerresponsive.com).

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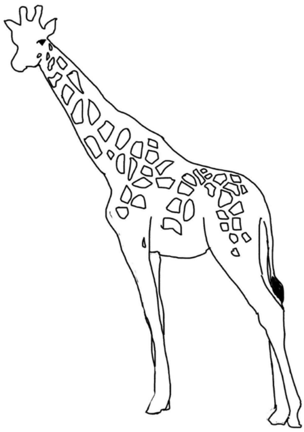
10

THE ENERGY TRILEMMA

Jenny Rinkinen and Elizabeth Shove



Like many other animals, real and imagined, giraffes have four legs, not three. The energy trilemma refers to tensions between three poles: energy security, affordability and decarbonisation. Is energy demand a missing dimension?

Introduction

The 'energy trilemma' is a term used to describe the policy challenge of simultaneously responding to the potentially competing goals of energy security, energy affordability and low carbon energy supply. The fact that the energy trilemma has become a powerful rhetorical device across policy and research is not surprising in that it is consistent with other prevalent policy discourses. For example, the three dimensions of the trilemma (security, affordability and low carbon supply) resonate with the suggestion that there are three pillars of sustainability – economic, social and environmental – an idea that has figured strongly in policy discussions since the Bruntdland report of 1987.

The trilemma also resonates with popular discourses of clean energy, green growth and efficiency (HM Government, 2017). For example, clean energy policies are not only designed to cut pollution, but to also boost employment and national competitiveness, and help ensure a reliable energy supply.

In addition, and because the trilemma is frequently cited in support of efforts to diversify primary energy supply and electricity generation (World Energy Council, 2016), the concept is strongly associated with a technological view of provision. For example, Blumsack and Fernandez (2012) argue that the smart grid is vital in addressing the trilemma.

Although it is said to provide a holistic view of energy systems, we contend that the trilemma is in fact lopsided and partial. In focusing on features of supply it overlooks fundamental questions about the scale and dynamics of demand. In effect, talk of the energy trilemma, and strategies and policies informed by it, take energy demand and the practices on which demand depends for granted.

In using the energy trilemma to frame the terms of energy policy, and positioning it as a 'basis for the prosperity and competitiveness of individual countries' (World Energy Council, 2016, p. 2), institutions such as the World Energy Council direct attention away from questions about demand and how it evolves. For example, discussions about how the goals of security, affordability and decarbonisation might be balanced rarely refer to the extent and character of demand. Behind the scenes, there are numerous tacit assumptions about demand – after all, the meaning of 'affordability' and also 'security' are in the end related to the quantities of energy involved. But because these understandings are almost never explicit, debates about how the trilemma might be managed almost always focus on the supply side and on the means through which demands are met (Shove and Walker, 2014).

Amongst other things, this approach supposes that systems and technologies of supply are not, in themselves, implicated in the constitution of energy demand. It also excludes serious analysis of how demand changes and what this means for both the scale and the character of the challenges represented in the trilemma.

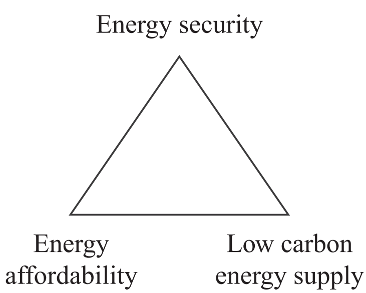


FIGURE 10.1 The energy trilemma.

A history of the energy trilemma

The *Merriam-Webster Dictionary* definition of a trilemma is that it is 'a state of things in which it is difficult to determine which one of three courses to pursue'.[1] The concept of a 'trilemma' is used in disciplines such as philosophy and business to refer to a choice between three options, each of which is (or appears) unacceptable or unfavourable in that it might compromise other goals. Often the trilemma is mentioned in discussions about how to find an acceptable balance between three options.

In the energy field, the electricity supplier E.ON was one of the first to describe the challenge of balancing the sometimes conflicting goals of energy security, energy affordability and low carbon energy supply as the 'energy trilemma' (E.ON UK, 2008, cited in Boston, 2013). Used in this way, it indicates the existence of multiple considerations, and the complexity of the energy system as a whole.

A number of countries explicitly refer to the trilemma in their energy policies and plans. For example, in the UK, the objectives of the Electricity Market Reform Bill are clearly spelled out with reference to the trilemma, and in the business sector, efforts to encourage investment in lower carbon products and technologies are justified in the same terms (HM Government, 2014). The trilemma has also been used in various policy analyses such as those by Sautter, Landis and Dworkin (2008) and Gunningham (2013), and by UK research councils (Sharick, 2015). However, the details of exactly how one node or pole relates to another are unclear: more or less effort or investment at one point of the triangle does not translate equally, or have any necessary effect on any of the other dimensions.

Despite these complexities, there have been some attempts to describe policy interventions with reference to a trilemma 'index'. Since 2011, the World Energy Council has been particularly active in promoting the concept, publishing annual reports on what it describes as the 'World Energy Trilemma'. The latest report, *Defining measures to accelerate the energy transition*, evaluates the performance of different countries using a 'trilemma index'. This index, discussed at greater length below, is presented as an important tool for assessing progress towards lower carbon energy transitions (World Energy Council, 2017).

To understand how the concept of the trilemma influences plans, ambitions and forms of evaluation we need to take a closer look at each of the three dimensions: security, affordability and lower carbon supply.

Security

First, security. Following the oil crises of the 1970s, soaring energy prices and other uncertainties prompted energy-importing countries to re-evaluate levels of self-sufficiency and the security of their energy supplies. The availability of different fuel reserves and their affordability are central to the International Energy Agency's definition of energy security 'as the uninterrupted availability of energy sources at an affordable price' (International Energy Agency, 2014). According to the World Energy Council, energy security is about the management of primary energy supply from domestic and external sources (at any scale), reliability of energy infrastructure, and the ability of energy providers to meet current and future demand (World Energy Council, 2016). But what does this really mean?

In practice, specifying and planning for 'security of supply' is much more complicated than these broad statements suggest. For example, decisions have to be made about exactly how much gas or oil should be kept in reserve, and there are judgements to be made about how long these reserves should last. Questions of resilience – often discussed in terms of the need to 'keep the lights on' (see Chapter 8) – also influence major investment strategies (for example, building the Hinkley Point nuclear plant in the UK). In general, a preoccupation with security of supply favours investment in the technologies and resources needed to meet 'baseload', often at the expense of developing other more flexible forms of infrastructure.

Meanwhile, and over the longer run, the social and political significance of security evolves. For instance, changes in the energy mix (such as those associated with the need to decarbonise forms of energy supply), change the profile of security concerns, and shifts in technology (such as the plummeting cost of solar energy; the decreasing competitiveness of combined cycle gas turbines) have the same effect. This is a circular process. Previous concerns about security favour some kinds of technological investment and not others: so shaping both the context and the definition of present concerns, and their salience in contemporary energy policy.

Affordability

Energy affordability is often seen as the social or the economic aspect of the trilemma. It refers to the availability of affordable energy across the population, and as such rests on some tacit understanding of how much energy people need. In broad terms, 'affordability' describes the extent to which members of a population can access electricity or other energy services, and their ability to pay for these services (see IEA, UNEP and UNIDO, 2010). Questions of access and affordability apply between as well as within countries. For example, the World Energy Council has recently underlined the significance of *universal* access to affordable (and modern) energy services (World Energy Council, 2016). On a national level, questions of energy or fuel poverty – the inability to afford to keep one's home adequately heated – tend to focus on the cost of energy (Heffron and McCauley, 2017), rather than on the provision of services as such (see Chapter 3). Methods of tackling fuel poverty consequently focus on fiscal policies designed to help less-affluent citizens buy the energy they 'need'. According to recent research by Demski, the UK public think that affordability is more important than the other poles of the trilemma (Demski et al., 2017).

Low carbon supply

The third big challenge of energy trilemma is that of decarbonising energy supply. Following commitments to CO_2 emissions reduction targets, which began in the late 1980s and gained momentum through the 2000s, there is increasing pressure to reduce energy-related carbon emissions. Measures adopted in response include efforts to increase energy efficiency and the development of more renewable and low carbon forms of energy supply (World Energy Council, 2016). Lately the emphasis has been on decarbonising the electricity sector as electricity's role in transport and heating (and cooling) is expected to grow (ibid.).

Although it is widely agreed that all three aspects are important, they are linked to very different areas of policy responsibility including welfare, business and innovation, sustainability and technological efficiency. Not surprisingly, there is a tendency to treat each 'pole' as a distinct problem, framed with reference to different arguments, approaches, metrics and policy objectives. Rather than pointing to a single solution, responding to the trilemma as a whole depends on the mutual calibration of a mix of policies. In this role, the trilemma underscores the need to bring different forms of energy governance together in a single frame (Goldthau, 2011), but as Gunningham (2013) notes, studies and initiatives encompassing all three dimensions remain rare.

Balance or choice?

The energy trilemma is commonly depicted as an equilateral triangle in which relations between the three dimensions are indicated by lines or double headed arrows (Figure 10.1). This representation emphasises the ideal of achieving a perfect balance between the three priorities of security, lower carbon supply and affordability. From this point of view, effective energy policies are those which contribute to this ambition.

But as critics have observed, the more common pattern is for one or two of the three goals to be favoured over the other. For example, Heffron and McCauley (2017) argue that focusing on low cost and efficient solutions (affordability) has led to a continued reliance on fossil fuels in the short term, and at the expense of building low carbon energy infrastructure or developing a low carbon economy. To give another example, rather than being an outcome of 'balance', decisions to pass the costs of ensuring more secure, lower carbon supplies on to the consumer arguably represent a choice in favour of these two 'nodes' at the expense of consumer 'affordability'.

The relationship between choice and balance is also complicated. In so far as the energy trilemma is a 'true' trilemma in the philosophical sense, one or two of its aspects have to be compromised. Since policy makers have to make choices between the three policy goals involved, it follows that the trilemma can only ever be 'managed': it cannot be resolved (Gunningham, 2013).

Working with the trilemma

These observations are important in thinking about the trilemma's status within policy. If we accept that there is no 'solution', what part does the trilemma play in guiding policy action? One response is that it serves to remind policy makers (typically focusing on one or another of the three poles), that they should at least consider the consequences of their actions for the energy system as a whole. Another is that it provides a point of reference and a benchmark in terms of which policies can be evaluated. As mentioned above, the World Energy Council has come up with an aggregate national-level measure – the 'energy trilemma index' – with the aim of increasing the transparency of energy governance, and of identifying and benchmarking 'good' or more balanced responses. The index ranks countries in terms of the emphasis they place on energy security, affordability and sustainable provision, and provides a measure of how 'well' they handle these competing goals.

Since 2010, 125 countries have been given a 'balance score' that represents their performance in these terms (World Energy Council, 2017). The Energy Trilemma Index turns a very complicated policy concept – which already consists of competing policy ambitions – into a single measure.

This makes it possible to produce regional and country-specific profiles, and to enable comparison. In use, the index shows that countries often excel in one dimension of the energy trilemma but struggle to balance all three priorities. For instance, many of the countries performing well in the energy security dimension – such as Russia, US and Qatar – have extensive fossil fuels reserves, including coal, oil, and gas. By contrast, the countries that rank high in terms of environmental sustainability tend to be those that have a lot of geothermal or hydropower (both of which have low GHG emissions). Meanwhile, these same countries score less well in terms of 'security' because of what seems to be an over-reliance on a single energy source. In addition, and as Putra and Han observe, there are significant differences in how the trilemma is 'managed' in developed and developing countries, some of which are wary of risking economic growth for the sake of mitigating climate change (Putra and Han, 2014).

There are lots of questions one might ask about the basis and the purpose of this index. For instance, what are the units of analysis (in each area); what constitutes a 'good' balance; and what is the policy relevance or purpose of this measure? Questions about the scale at which 'the energy trilemma' arises are also important: is it something that affects households, regions, or only nation states. Equally and perhaps more importantly, trilemma-based discourses and policies do not explicitly engage with vital questions of demand. In the next section we draw attention to this missing part of the story.

The dilemma of the trilemma: where is demand?

As a concept, the energy trilemma is all about supply: is supply secure, is it affordable, and is it low carbon? In so far as policy goals are specified in these terms, they also focus on matters of supply. But what about the details of consumption and demand? How do changing patterns of energy demand figure in the trilemma, if at all?

The World Energy Council's energy trilemma index does take note of growth in energy consumption, but only on the basis that it presents challenges for security of supply. A change in energy consumption relative to growth in GDP is one of the measures that affects a country's rating in terms of energy security. As a result, some of the most significant fossil fuel economies, such as Saudi Arabia and the United Arab Emirates (UAE), are not ranked highly in the World Energy Trilemma Index (World Energy Council, 2016). Demand also figures in the guise of 'demand management'. For example, the World Energy Council claims that 'efforts to increase resource productivity and manage energy demand growth will be key in ensuring a balanced energy trilemma' (ibid., p. 4).

But what is meant by demand in this context? Often demand is equated with efficiency or associated with arguments about the scope for decoupling economic growth and CO_2 emissions. As such it is implicitly located within the 'lower carbon' pole of the trilemma. If demand is interpreted as the 'need' for fossil fuel, innovations in supply – like the introduction of more renewable energy – qualify as forms of 'demand reduction'. For example, Italy has recently set 'a target for renewable electricity generation – set at 10% by 2020 – to help counteract increasing energy demand and reduce GHG emissions' (World Energy Council, 2016).

More commonly, the level of demand – in the more fundamental sense of how much energy a society uses – is simply taken for granted. Chilvers et al.'s representation of future energy demand in the UK is typical:

> End-use energy demand is likely to remain roughly around its current level, although the energy transition out to the mid-21st century will require some switching towards greater electricity use, particularly for heating and transport. Consequently, achieving the UK CO_2 emissions reduction target will require a greater emphasis on systems for producing, delivering and using energy that is not only low carbon, but also secure and affordable for consumers both large and small.
>
> *(Chilvers et al., 2017, p. 441)*

Similarly, in a report produced by the World Energy Council, energy efficiency and so-called demand management strategies are deemed important in ensuring that countries continue to meet what are assumed to be unwavering and often growing needs (see Chapter 8).

> Energy efficiency and managing energy demand continue to be globally perceived as top action priorities with huge potential for improvement. . . . Policymakers must align the interests of asset owners, users and regulators, and continue to implement a combination of energy efficiency standards, performance ratings, labelling programmes and incentives.
>
> *(World Energy Council, 2016)*

As these examples show, discussions of the trilemma and how it might be managed do not engage with issues of demand head on. Instead, demand is typically equated with present levels of consumption, or with some very broad expectation of increasing future demand. This is consistent with a broader tendency to take the 'need' for energy as a given and to focus on methods of meeting demand more efficiently (Shove and Walker, 2014; Shove, 2018).

Although rarely discussed as a topic in its own right, levels and forms of energy demand are hugely significant for the trilemma, and for policy responses to it. One way of making this visible is to modify Figure 10.1, adding demand as a new dimension (Figure 10.2).

Turning the flat triangle of the energy trilemma into a pyramid immediately draws attention to issues of scale. By implication, the dimensions of the triangle (conventionally used to represent the trilemma) shrink or grow depending on the scale of demand. This is something of an over-simplification in that the three poles of security, affordability and low carbon supply are not fixed

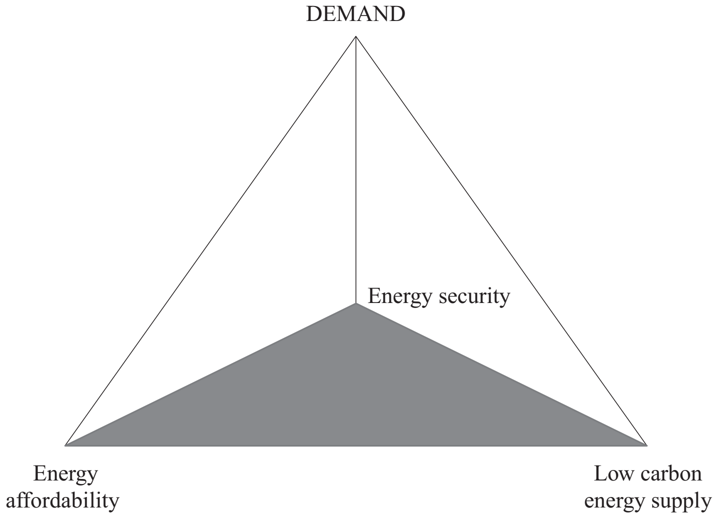


FIGURE 10.2 Demand and the energy trilemma.

together, nor are they relationally linked in quite this way. However, that does not undermine the importance of articulating the practical and political implications of the overall 'size' of the problem, or the value of showing that this is tied to the extent of demand.

Assumptions about the fixed or fluid nature of demand also matter, qualitatively, for the sorts of considerations that gather at each of the three poles. For example, methods of decarbonisation that make sense *assuming present levels of demand* are likely to be more costly and less affordable than the sorts of measures that might be required if demand, itself, fell by 50 per cent (Strbac et al., 2016). Rather than taking such possibilities into account, responses to the trilemma involve comparing and evaluating methods of delivering the same (energy) services more cheaply, more reliably or with 'cleaner' resources. Strategies of analysis and intervention based on the trilemma consequently disconnect the discussion of energy from a discussion of the social practices on which energy demand depends, and from questions about how, in what direction and at what rate energy demanding practices are changing.

This is a problem in that demand is not some pre-existing 'need' that systems of supply (energy and transport infrastructures and technologies) simply meet. Instead, social practices and related technologies, systems and infrastructures of provision constitute each other, and energy demand is both a consequence and a part of these dynamic arrangements. It follows that the scale and character of demand – and thus the size and character of the trilemma – is never static. This is important in that many of the challenges that the trilemma addresses are significantly affected and to an extent caused by increasing demand.

Challenging the trilemma – how and with what consequences?

The concept of the energy trilemma highlights linkages between the 'great challenges of energy policy' – namely energy security, energy affordability and low carbon energy supply. In doing so without explicit reference to the dynamics of demand it perpetuates the myth that questions about what energy is for are somehow outside the remit of legitimate policy response. The trilemma focuses on supply, and because of this, responses are at least implicitly designed to ensure the same or increasing levels of service. In overlooking demand, talk of the trilemma inadvertently sustains specific understandings of 'normal' and acceptable practice and favours technological responses and solutions that cater to these so-called needs. In this respect, trilemma-based discourses help perpetuate present (contemporary, Western) practices and in so doing help maintain (or extend) the 'size' of the triangle, and thus the scale of the problem.

This begs the question of whether it is possible to take demand seriously *within* and as part of the trilemma? At a minimum, such a move would involve reflecting on the unintended consequences of taking need for granted. More ambitiously, thinking along these lines might enable new and perhaps more challenging proposals for reducing demand by halting or reducing escalating expectations of (energy intensive) service provision. Such strategies would reconfigure all three poles of the trilemma and the ways in which these dimensions interact. Far from limiting the scope of intervention, such a response would highlight dynamic relations between issues of security, affordability and carbon *and* currently invisible processes involved in the constitution and transformation of demand.

Note

1 *Merriam-Webster Dictionary*, s.v. 'trilemma', https://www.merriam-webster.com/dictionary/trilemma [accessed 28 February 2019].

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