Organising Energy: Consumption, Production, and Co-Provision

Heather Chappells, Centre for Science Studies, Lancaster University
Elizabeth Shove, Centre for Science Studies, Lancaster University

ABSTRACT

The fragmentation of utility networks and the emergence of new energy providers, including community-based organisations, calls for a more consumer-oriented examination of utility systems management. Although demand-side management (DSM) approaches have claimed to draw the consumer more into energy network planning, this has often involved only a partial understanding of consumer interests in the energy field, which are still seen from a largely provider-oriented perspective. Such a position ignores not only the importance of issues such as consumer comfort in setting energy schedules, but also the scope for consumers to act as joint 'scripters' of energy network arrangements. This paper calls for a re-examination of the organisation of utility "systems of provision" and of the technologies involved in the provision of domestic energy. Drawing on examples from the UK, we explain how particular storage systems and devices are strategically configured along utility supply chains in order to frame how and when energy can be consumed. As well as providing an overview on how energy is controlled and organised, the paper will reveal the range of actors (utility companies, community organisations and households) involved in the tactical configuration of what amounts to the "co-provision" of energy at various levels. This is important since such configurations shape the distribution of individual and organisational responsibility across the network and so influence the points and possibilities for intervention in the cause of energy efficiency.

Introduction

Conventional ways of describing how energy systems are organised and reproduced provide only partial frameworks for understanding the interrelations between consumers and producers. As a general rule, the roles of utility companies and their customers are seen as clearly segmented and are treated separately. In turn, relations between supply and demand have often been misconstrued and options for managing these through various modes of public, private or domestic provision have been limited. With the recent fragmentation of responsibilities for energy provision in mind, we take a fresh look at how consumer-provider relationships across utility systems of provision can be understood and at the social, technical and institutional factors that can influence them. We contend that it is no longer acceptable to draw sharp distinctions between consumer or producer roles in service provision. Instead the multi-dimensional and intricate relations along energy systems of provision and between different sorts of providers and consumers needs to be carefully sifted out.

In the first part of this paper we consider some of (mis-)conceptions surrounding the organisation of energy provision. We begin with a review of the roles producers and consumers are often ascribed by utility managers, energy researchers and consumption theorists. In re-construing relations between providers and consumers we introduce ideas from the sociology of consumption and in particular the "systems-of-provision" framework

for understanding how consumption is organised (Fine and Leopold 1993). This approach reiterates the importance of studying the complexity of supply chain relations - through distribution, retailing, consumption and so on - as a means of understanding how services, like energy, are provided and consumed. It also calls for a closer look at the unique modes of provisioning that characterise particular systems. For example, in their studies of food systems, Fine and Leopold (1993) explore the shift from personalised grocery services to self-service supermarket provision. Each of these arrangements constitutes a distinct mode of provision in which consumer and provider responsibilities for the overall management of supply and demand are blurred.

By setting the provision of energy services in a systems-of-provision framework, we are able to reveal a further blurring of the distinction between provider and consumer roles. We argue that both are tied into a relationship of mutual dependency. As energy flows along infrastructures we show how it passes through a range of organisational regimes in which provider and consumer roles are merged, intermingled and redefined. For example, 'consumers' can acts as 'generators' of their own energy supply or utility companies can be locked into contracts with households for the provision of energy efficiency. These relationships of "co-provision" are at work right across energy systems and are important because each mode of co-providing offers a variety of different possibilities for managing energy demand.

Although offering a more encompassing view of energy relations, the systems-of-provision framework needs to be extended to take into account the influence of technologies and household infrastructures. The raft of everyday devices that mediate energy and enable us to provide heat or light, are pervasive features of energy arrangements (Shove & Wilhite 1999). These come with their own scripts and regimes that can dictate household or provider activities (Cowan 1983; Shove & Warde 1998). With this in mind we extend our framework and view systems-of-provision as socio-technical systems of "scripts".

With insights from our own research,[1] we go on show how consumers and providers in the UK electricity sector are locked together in relationships of organisational interdependency, which are reinforced by particular household technologies or infrastructures. For example, we explore the struggles of self-providers who attempt to act as mini-utility providers in their own right and to breakaway from conventional grids with only limited success. We also investigate some of the storage and control devices that are bought into play in different modes of co-provision and show how "co-conscripted" consumers and providers are locked into the on-going battle to manage demand in the confines of storage heating systems. The examples we present serve to reinforce the argument that approaches to reconfiguring energy demand need to be set in the context of the energy system of provision as a whole.

[1] This paper presents findings from the DOMUS (Domestic Consumers and Utility Systems) project funded by the EU DGXII initiative for Science, Research and Development. The DOMUS research investigates consumer involvement in utility services by focusing on cases of environmental innovation in the UK, the Netherlands and Sweden. A number of interviews with UK energy service providers have been undertaken as part of this research.

Ways of Describing the Organisation of Energy Provision

Conventional ways of describing the organisation of service provision have tended to provide only partial frameworks for understanding the interrelations at work between consumers and providers. Here we discuss some of these approaches and suggest ways in which they limit our ability to manage energy demand by restricting the terms of analysis and action.

The complex interdependencies between producers and consumers of goods and services have only recently been recognised and scrutinised more closely in consumption studies. In conventional accounts, the roles of these two groups are largely dissociated and positioned in opposition to each other. Consumers are often cast as the 'captive' and 'passive' users of state-dictated energy services or sovereign wielders of market power with the ability to reshape energy demand through purchasing choices (Saunders 1986). Providers, on the other hand, are represented as the authoritarian dictators of consumer choice or, alternatively as slaves to the dictates of consumer demand. Whatever the claim, it is often the case that consumer and provider roles are clearly segmented, one has dominance over the other (Abercrombie 1994). Reshaping energy demand, therefore, depends on focusing on changes in one or the other camp. More recently, however, rather than claiming that one or other of these groups have an authoritative role in shaping the demand for services sociologists of consumption have attempted to present a more nuanced understanding of the multiple and mutually related roles of each (Warde 1990).

Another common feature of conventional consumption analyses has been the tendency to generalise across goods and services. Fine and Leopold (1993) argue that by employing "horizontal" reasoning, that is taking an explanatory mechanism and assuming it applies across goods and services as a whole, consumption theorists miss the crucial point that different goods and services have specific characteristics which shape the ways in which they are consumed. The idea that there are common mechanisms driving consumption practices is particularly flawed in respect of services such as energy. As Shove and Warde (1998) point out, some of the things we consume, like utility services, are acquired and used in ways that do not necessarily confer self-identity or mark attachment to social groups in the ways that conventional consumption theories imply. As Hutton (1998) further reminds us, energy cannot be treated like other commodities, such as designer dresses, because of its embedded character and critical role in daily life, a point all too clear at moments of system breakdown – such as power cuts.

A further criticism of studies of service provision is that they have tended to distinguish too crudely between only public or privatised modes of provision (Saunders & Harris 1990). Such distinctions do not go far enough because they fail to appreciate the different scales of service provision within these crude categories and the less formal means by which services might be delivered. For example, Warde (1990) describes in food systems how the provision of nourishment can be negotiated through a number of different modes - the provision of meals by the state, the choice of eating out at a restaurant, the possibility of cooking at home, informal provision by friends and so on. In respect of energy as well as food, the different scales at which these modes are organised is also important in defining how demand is managed, for instance the self-provision of household energy implies different levels of access, use and intervention than that delivered by centralised networks.

The points made above suggest that energy services require special attention if we want to understand how they are organised, and that this has only been partly achieved. We now turn our attention to utility managers and energy researchers to consider what their own descriptions of energy management reveal about the ways in which they understand critical relations between consumers and providers and supply and demand.

Discussions of demand and supply relations in utility systems have been dominated by provider insights. Histories of public utility provision describe the coming together of once private electricity companies to form a mono-dimensional picture of public sector supply (Guy & Marvin 1996). These social and technical arrangements position providers as the managers and controllers of the system as a whole, simultaneously situating consumers as the passive beneficiaries of uniform energy supplies. While policy makers' and utilities' representations of consumer demand have changed over time these have failed to completely draw consumers, their needs and activities into the supply-demand picture.

The development of demand-side management (DSM) promised to change at least part of this picture. Such approaches aim to improve the efficiency of generation and transmission networks by evening out peak load and curbing demand in stressed parts of the network to delay further investment in supply capacity (Siohansi 1996). For a start, DSM positions the consumer back in the picture and opens up the energy supply chain – through generation, transmission, use - to greater scrutiny (Gellings 1996). Yet such strategies are still largely dominated by supply-side perspectives. While demand-side management might identify alternative ways of meeting service "needs", for instance by encouraging the production of efficiency or non-consumption at certain times, they do not go so far as to question exactly what constitutes consumption. Utilities may have reached further into the home, but they have failed to appreciate the extent to which consumers and household infrastructures are part and parcel of the total system they are striving to control. On the one hand this has meant that the cultural components of demand have been overlooked (Lutzenhiser 1992). On the other, the extent to which consumers can be involved in different stages along the supply chain and the way this relates to the specific mix of modes and scales of provision has been largely ignored.

Though consumption practices have a place in contemporary theories of demand-side management, these models and the policies they inspire continue to view provision and consumption as clearly separate, well-defined functions. Along with many conventional analyses of consumption, they too depend on a clear-cut distinction between the roles of consumer and provider. This is misleading, for as we go on to show, the energy sector is marked by rather more complex relationships of co-provision and interdependence. These are revealed when we take a closer look at how energy is organised as a distinct system of provision.

Organising Energy in Systems of Provision and Co-Provision

The "vertical" reasoning proposed by Fine and Leopold (1993) requires that we look at the variety of organisational stages that energy passes through across the chain of provision. At each "stage" different relationships between providers and consumers are revealed. Electrons flow along cables, across pylons, from generating stations, through substations and transformers and into the home. Along the way electricity comes into contact

with an impressive cast of social actors - including generators, transmitters, regulators, installers, suppliers, consumers and maintainers - each of whom have a part to play in service provision. By closely investigating interactions between these groups at a variety of sub-stages, we discover how electricity is mediated and controlled and how consumers and providers are implicated in a much wider range of roles than conventional analyses imply.

To expand our conception of provider and consumer roles, it helps to remember that electricity can be delivered to the home by a variety of actors – public utilities, private companies, local authorities, community collectives and households themselves. Not only are modes of provision important in this respect but so too are scales of provision. The details of consumer-provider interdependence and the complexity of the supply chain of provision for electricity depends on the scale at which generation, management, distribution, storage and usage takes place across each of these modes. Already, in the UK we can identify the proliferation of more localised forms of provision. For example, many city councils are involved in developing combined heat and power schemes that provide home heating and generate surplus electricity for sale to tenants or to the grid (Hodgson 1997). Localised generation is not especially new but the proliferation of novel alliances, for instance, between utilities, housing associations, local authorities and self-providers suggests that what used to be the core concern of established public monopolies is being 'attacked from the margins' (Gosling 1996). Such developments are important for they promise to generate new interests in demand management and new sub-level interdependencies across grids.

Closer inspection of chains of provision also highlights a number of curious situations in which conventionally taken-for-granted consumer and provider roles are scrambled up and in which multiple modes of energy provision can be located. Taking the ideas developed by Fine and Leopold (1993) a stage further, it is conceivable to talk of systems of "co-provision". Whether involved in the design of heating systems, the setting of heating controls or the generation of household energy, consumers are drawn into working relationships with a variety of other providers across systems of provision.[2]

So far, we have shown that viewing electricity in the context of the system of provision within which it is organised is conducive to capturing the multiple and mutual relationships and modes of providing at work. However, there are still some missing dimensions when it comes to understanding the way in which domestic energy provision comes to be arranged in the ways it is and who or what is involved. As we go on to show the provision of electricity has important technical as well as organisational features.

As noted above, energy provision can take many forms. What is important is that most of these forms are mediated by some intervening device. Electricity is consumed when making ice cubes, hoovering the floor, and illuminating the living room (Shove & Wilhite 1999). While it is possible to simply drink a glass of water, electricity consumption inevitably depends on the development and diffusion of things like storage heaters, light bulbs and air conditioners. Whatever the mediating technology involved, the general point is the same:

[2] In adopting the term "co-provision" our intention is to show how the management of energy draws together consumers and providers in new relationships of co-dependency – not simply centred around key moments of exchange (e.g. billing and payment) but right the way through the supply chain (e.g. generation, distribution, maintenance etc.). This is not to say that consumers and producers have an equal influence on shaping the system of provision or that consumers are conscious of their involvement in energy management. The details depend on the particular mode of co-provision in question.

energy is important not for itself but for what it makes possible, that is, cleaning, cooking, lighting, heating, and so on. Since it is the services provided which count not the resources themselves, more efficient technologies make it possible to do more for a given amount of electricity. In short, provision is mediated by a raft of everyday gadgets which play a tremendously important part both in determining the resource intensity of everyday life and in ratcheting up what become normal standards and practices of comfort (Cooper 1998; Shove 1997).

By adding this technical dimension to our understanding of electricity provision, we can refine our argument. Electricity systems are not only systems of co-provision, but also systems of "co-conscription", by which we mean that consumers and providers are not only in relationships of organisational co-dependency, but that these relationships can be reinforced and reproduced by the technologies in place. By focussing on the multiple mechanisms of storage and the devices designed to improve efficiency at different points and scales of provision we can begin to appreciate the extent and reach of the organisational and technical interdependencies on which energy infrastructures depend.[3] Such systems are undoubtedly characterised by flexible relations between providers and consumers but these are not infinitely malleable. They are sometimes restricted by the embedded characteristics of devices positioned throughout supply chains. In the next part of this paper we use three examples of the reconfiguration of co-provision in the UK to develop this argument.

The Co-Provision of Energy Services

The three examples we describe focus on different modes of co-provision in the UK energy sector and are based on the findings of interviews with providers and consumers undertaken as part of the DOMUS project. The first, a review of heating self-provision by households in a sustainable community near Nottingham, considers issues relating to the scale of provision and how co-existing modes of provision interlock. The second, an examination of storage heating practices in rural Northumbria and Scotland, shows how providers and consumers are conscripted into energy regimes by the historical legacy of night store heaters embedded in household infrastructures.[4] The final example, the design of in-built heating systems in a housing association development in city centre Liverpool, demonstrates how intermediary organisations and consumers negotiate the manner in which energy is supplied sometimes with the emergence of conflicting scripts. Although our examples focus on some of the more extreme modes of co-provision that are being worked out in the UK, we suggest that there are generic lessons to be learnt and that these are of relevance to an understanding of utility systems in different sectors and national contexts.

[3] "Storage" in this sense refers to the range of instruments and devices that can be bought into play to contain, impede or encourage the flow of resources at certain times and hence influence their use for certain social practices. In this case, our examples focus mainly on the storage of heat, for example, radiators and storage heaters, the capacity of the home itself to act as a heat store along with 'back-ups' such as the potential for tapping into other grids to top-up supply.

[4] Electric night store heaters have been used in the UK since the 1950s. Dense bricks are heated up during the night, using off peak electricity, and slowly release their warmth during the following day.

Interlocking Scales of Co-Provision

Across the UK, a variety of small-scale sustainable housing projects have been developed by households and communities attempting to go "off grid" by disconnecting from conventional supply networks. In such situations, the roles of consumer and provider collapse into one. Because of the highly localised nature of energy supply infrastructures, ceilings of available energy capacity are typically low and unpredictable. For instance, household heating levels may literally depend on recent weather patterns which sustain solar or wind energy systems, along with the total storage capacity and back-up options available.

Because of the tight balance between energy consumption and supply, consumer-providers like the residents of Hockerton, a sustainable housing development near Nottingham, are involved in more or less constant monitoring of the relationship between supply and demand. Operating like mini-utilities in their own right, they adopt demand-side management strategies on a daily basis, for example, putting on sweaters during cooler weather rather than switching to mains supply when the installed passive solar energy systems provide inadequate heat. These localised management arrangements are also reinforced in the setting up of new legal entities and maintenance agreements which aim to self-regulate how much energy is consumed by each household at certain times.

Following conventional reasoning, it might be assumed that in such situations consumers have much greater control over their demand and over the operation of the energy system as a whole. For a start, they are inevitably closer to the source of their energy supply and involved in the day to day generation, transmission, monitoring, management and use of the energy produced. It might also be assumed that such communities are largely autonomous, in both an organisational and technical sense from networked energy supply. However, as the following example shows, relationships of interdependency between conventional and self-providers persist and are reinforced by specific organisational and technical arrangements.

In organising their domestic heating, the self-providers at Hockerton have had to think carefully about how their own household arrangements connect to the national systems of energy provision. This is reflected in their decision to retain 'back-up' heating systems to bring into operation during cold winter nights, when passive solar strategies are insufficient. After rejecting the use of diesel generators on environmental grounds and running into planning opposition for a proposed wind turbine, the residents opted for mains supply of electricity to boost temperatures. For the time being, at least, the consumer-providers are in a relationship of dependency upon the local utility.

On the other hand, these co-providers struggle to reciprocate by becoming suppliers of energy to the national grid. In the UK any small renewable generator that wants to sell excess energy back to conventional suppliers (often a necessity in terms of cost-effectiveness of new systems) needs to pay to register with the electricity grid. Furthermore the set of metering equipment required to police this arrangement currently costs over £2000, excluding many small providers. In terms of putting into place alternative scales of provision, the configuration of mains grids and metering devices, clearly has a bearing on the ease with which new utility formations can be put into place. Although consumer-providers at Hockerton interact with utility companies, this relationship is not evenly balanced.

Self-providers' continued reliance on a central energy grid illustrates the range of negotiations that need to take place across different scales of provision. To intervene in energy efficiency requires consideration of how demand management activities are shared out across different scales of co-provision. As the next case suggests, much the same sort of juggling of responsibilities goes on in national utility networks.

Conscripting Consumers and Providers

Even in cases where utility companies continue to provide energy services, interdependencies between providers and consumers, as co-managers of demand exist. As our second example shows, consumers and providers can be seen to occupy mutually captive positions in which technical arrangements reinforce organisational relationships. As we have already explained, energy technologies are not neutral devices for they also help to define and re-define normal standards of domestic life.

As energy flows along systems of provision, it passes through a variety of organisational regimes. There is not one provider but many - including suppliers, generators, transmitters and households - each rather directly dependent on the actions and practices of the other. From this perspective, the householder is not just a consumer but is also the owner of an array of wires, meters and heaters, that are literally part of the infrastructure itself. At each step, energy is "stored" or controlled in order to manage peaks and troughs in demand at the next point in the 'supply chain'. Storage and control systems each set localised limits or ceilings of available capacity. When thinking about the supply and demand of energy, we need to recognise that there are many ceilings, and therefore many points at which demand might be managed along the supply chain of provision.

The use of devices designed to even out the daily demand for electricity has the further effect of binding households into networks of provision and positioning them as (perhaps unwitting) partners in the management of supply and demand. The example of night storage heaters illustrates the point. These devices consume cheap rate electricity during the night, store it up as heat, and release it gradually throughout the day, thus helping utilities match supply to demand. In rural Northumbria, the electricity company has been so successful in persuading householders to buy storage heaters (thereby transforming the pattern of peak demand which the utility has to manage) that it has created a new problem of its own making: the daily peak is now at two in the morning when all the night stores kick in! Although part of the electricity infrastructure, night store heaters belong to individual consumers and are therefore difficult to change.

In Scotland, another energy manager described how the various organisational regimes through which energy is mediated, influence the extent to which providers and consumers can act, and how a trade-off needs to be made between the different interests involved. Representing the 'supply' part of the company this particular manager's role is to balance customers' expectations (providing a fair amount of heat in the day) to generators' demands (building-in as much flexibility as possible to accommodate fluctuations in resource capacity). These twin objectives are achieved by means of storage technologies and "more controllable" heat for households. How this division of interests pans out is revealed in the example below.

In one of the Scottish utility's schemes a heating system was installed with a three-zone timer. The timer is pre-programmed by the utility to ensure that energy is delivered at times which meet the generator's requirements. Consumers can, however, change the settings and boost or lower the temperature of a particular zone. What surprised the company was the extent to which customers were "happily readjusting the system and using more than just the pre-programmed options". One elderly tenant explained how she had re-set the temperature and time zones (on the advice of a utility engineer) since she found that the house got too warm. Such a situation highlights how micro-adjustments can increase the uncertainty of demand back at the generating station and shows how technologies, as well as commercial imperatives, mediate the struggle between the fundamentally different priorities of households and utilities.

If consumers had the freedom to really control the energy drawn from the grid, and if they could do so in a way which precisely matched their requirements, generators would be faced with much more extreme problems in operating within resource ceilings. As far as Scottish Hydro is concerned, the majority of consumers simply have to relinquish some control over their "own" heating systems, even if this means some level of discomfort as people find themselves too hot or too cold.

This example illustrates the extent to which household technologies and practices influence the problems and opportunities open to both providers and consumers involved at different points in the electrical supply chain. Utility providers find themselves in the complex position of managing the timing of demand to maintain an optimal balance between consumption and non-consumption from the perspective of efficient generation. Meanwhile consumers are also involved in trying to optimise the level of comfort. The historical legacy of the technology embedded in the household means that both providers and consumers are held more captive in relation to each other. They are "co-conscriptors" of demand within rather inflexible thresholds. Having considered the historical legacy of storage heaters embedded in the household infrastructure and shown how conventional utilities and their consumers are locked into relationships of co-provision, we now look at how new relationships of co-provision are being forged in housing projects in the UK.

Intermediaries and the Building-in of Scripts

Although housing associations and local authorities have long been charged with the role of providing shelter and warmth for their tenants, more recently a range of sustainable building projects have placed these organisations in the role of efficiency mediators or demand-side managers as well. In many situations, the precise configuration of household heating arrangements is the result of negotiations between housing providers and tenants, rather than utility companies themselves – what we refer to as intermediary arrangements of co-provision. Rather than providers dictating the mode of heating provision, the intention is to offer more mutually acceptable systems through tenant-provider negotiation over heating design. Sometimes this does not sit well with efficiency objectives.

At the Harlow Park housing development in the centre of Liverpool, the housing association took the decision to provide tenants with high levels of insulation supplemented by a single gas convector heater in the living room. These in-built heating systems are seen by the housing association as adequate for keeping tenants warm and surpass norms for

comfortable levels of heating. The households, on the other hand, refuse to accept the housing officer's guarantees that a single heater could ever provide adequate heating, and most have insisted on the inclusion of supplementary central heating. In this situation the outcome is that two forms of heating are eventually installed side by side. Consumers defy provider's expertise to follow their own logic of what constitutes adequate heating.

The extent to which tenants are able to negotiate over efficiency and consumption does not imply that they have an authoritative role. In the same scheme, the inclusion of a fixed light fitting in the house design, means that tenants have to install energy efficient light bulbs. The housing association, by fixing a technical device into the home infrastructure effectively 'locks' consumers into a new form of lighting provision. The relationships of co-provision sometimes favour housing providers and further their objectives. Sometimes tenants are able to negotiate new parameters of comfort. As with other forms of co-provision, the relationship of dependency is never as straightforward as conventional frameworks suggest. Many other housing developments in the UK are also incorporating tenants' feedback into design procedures, with the result that conflicting logics of efficiency and comfort will need to be ironed out.

The three cases show that energy can be organised in different ways with significant consequences for how demand is managed and who takes responsibility for this. To add a word of caution, consumers are still somewhat limited in the roles they can take in energy system management. The framework of provision in the UK is skewed around the interests of providers who are keen to retain a firm grip on the flow of resources and are reluctant to explicitly enrol consumers in the roles of resource managers, unless they can guarantee a typical end-of-pipe response. Nevertheless, the cases indicate that consumers have more of a role in setting the parameters of demand management than conventional wisdom suggests.

Co-Managing Demand

In this paper, we have argued that the organisation of energy services can be analysed as systems of co-provision. Providing energy involves relationships of interdependency between different consumers and providers right across supply chains and at a range of different scales. We have shown how, in a range of specific situations, households, intermediaries, utilities and self-providers are variously able to influence the organisational and technical regimes of energy management. These relationships of co-provision are not unbounded. Some technical and institutional arrangements prove particularly inflexible and systems of energy organisation also involve powerful technological "scripts". Investigating these interdependencies is important because it helps in understanding the options available for the reshaping of demand and, critically, allows us to identify who is best placed to intervene.

On the one hand we have seen how modes of energy provision are mutually supporting. There is not one way of providing energy but many. Each of which depends on the negotiation of responsibilities between different groups. While the recent 'privatisation' of the UK electricity industry suggests a history of provision characterised by a neat shift from a public mode to a new private era, it is more appropriate to say there is now a range of multiple, but co-existing modes of provision. So far, much research has assumed that demand-management can be applied across the energy system as a whole, failing to recognise

distinct modes of organisation, operating at a range of different scales and locked into a network of mutual interrelationship.

More research into the multiple ways of (co-)providing energy services is needed. To intervene in demand-management strategies means working out first and foremost which part of the system we need to intervene in and where the responsibilities lie. This involves looking beyond specific scales of energy management and working out where these different scales of management inter-lock. For instance, many self-providers retain a semi-autonomous connection to their mains energy provider. Being able to influence energy demand means tapping into both scales of provision. In this sense, energy management is not only a question of *how* to influence demand but of *where* exactly to do this – both across systems and modes of provision.

As well as suggesting that organisational arrangements of provision are more flexible than we might imagine, our research also explored the degree to which existing technologies and structures thwart or support providers and consumers efforts to be demand-managers. Systems of provision are also systems of scripts, this is important because if we want to influence energy demand we not only have to consider the roles that co-providers might play, we also need to consider whether technical arrangements have to be re-scripted or replaced.

New negotiations over energy efficiency and household infrastructures are continually taking place. As our final example showed, these can result in built-in systems that require the renegotiation of comfort. Giving either providers or consumers the final say in these arrangements can result in problematic regimes of energy or comfort management. The overly-prescriptive configuration of energy-efficient technologies may generate unsatisfactory household infrastructures – as where two forms of heating are eventually installed side-by-side.

In summary, although we have not yet gone far enough in exploring the demand implications of energy co-provision, we have made some inroads into understanding the ways in which energy is organised. First and foremost we have shown that there is no one energy system but, rather, many co-existing arrangements. Across these systems, provider-consumer interactions are flexible but not unbounded. Even if co-providers adapt their activities, in the cause of energy efficiency, this might not be enough to influence demand. Energy management also needs to consider the reconfiguration of heating devices and comfort conventions, along with interlocking scales of provision.

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