


Science, Technology and Society: integrating social-science in the energy debate

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Abstract: This paper introduces key current themes in social sciences of energy that look beyond conventional concerns with energy consumers. Close, detailed studies of energy practices at all levels can offer insights into the ways that energy systems are enmeshed in social, legal, cultural, economic and political frameworks that pre-empt expectations about energy production, distribution and consumption. By bringing a sociological and anthropological focus onto the energy industries themselves, social sciences can offer new theoretical perspectives, reveal the political relations that accompany energy flows, and offer new ways to think about the potentials for current and future energy systems.

Keywords: Energy social sciences; energy services; energy practices; energy models; infrastructures

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Opening Lecture

In the last ten years, social science studies of energy have moved on apace. The journal of *Energy Research in the Social Sciences* published around a thousand articles in its first three years, and continues to expand. Ten years ago, many authors complained that energy studies was dominated by the natural and engineering sciences, but this is no longer the case. The argument for a social science of energy is now widely accepted and a rich and varied corpus of research literature is now available. So much so that the difficulty now is in navigating this broad terrain of research to find the work that is relevant for our particular projects. What have we learned about energy from the social sciences, and how can we put that knowledge to use?

Although people often expect that anthropologists will be primarily interested in the subaltern experience of energy, and although many anthropologists have indeed worked effectively on the experience of energy consumers, industrial workers, and those who suffer the costs of energy extraction, anthropologists have also long studied the powers of energy. Since the work of Laura Nader on the energy industry in California (NADER, 1981; NRC, 1980), anthropologists have also studied the energy industry, and the governance of energy systems. Cymene Howe (HOWE, 2014) and Dominic Boyer (BOYER, 2014) have worked on the structures of governance behind the building of windfarms on the Tehuantepec Isthmus in Mexico, highlighting what Boyer has termed ‘energopower’, in parallel with the Foucauldian idea of biopower. The shape of energy brings with it effects on governance, and as Tim Mitchell has elaborated, can change the nature of democracy as well as fuelling dictatorships (MITCHELL, 2011). The transition from coal to oil and gas in Europe changed the nature of the workforce. Coal requires a large workforce of manual and skilled labour to hew the coal out of the ground, transport it to the surface, another significant workforce to transport it to power stations and to household consumers, or to ship it for export. These large workforces, once organised, held significant power to force employers, owners and governments to consider their interests. Oil, on the other hand, requires a relatively small and individualised workforce to install wells and extraction equipment and to build pipelines, but operating this infrastructure offers fewer opportunities for organised labour. Hence the balance of power in European democracies changed from the coal era of large unions and nationalised industry, to the oil and gas era of financialised investments and weakening health and safety priorities.

More than this, as Imre Szeman, Janet Stewart and others in the Petrocultures Research Group (PRG, 2016) have pointed out, it changed our imaginative horizons. Our cultural and social worlds are saturated with fossil imageries and imaginaries. We use the language of fossil fuels in our everyday talk, and the scientific and cartographic imagery of fossil fuels infiltrates cultural spaces from artwork to advertising. Fossil fuels colonise our imaginations as well, as Gisa Weszkalnys’s work has shown (WESZKALNYS, 2016). The mere promise of potential fuels is enough to generate enormous financial and regulatory activities. When oil discoveries were forecast, the industrial economy of Sao Tome and Principe erupted, with foreign companies and governments pumping money into the country in anticipation of fuel appearing. The fuel remains absent, but the po-

litical and economic conditions in the country have been turned upside down with far reaching effects that Weszkalnys details. We can see similar effects in the UK, where a geological estimation of the amount of gas reserves underground led to a desperate political hope that geological techniques of hydrological fracking would enable the UK to become independent of foreign suppliers for its natural gas consumption. Rash policies in support of fracking went very much against the interests of many electors, however, and generated significant public protest. UK 'fracking' policy has so far produced a huge amount of hot air: protest, court cases, demonstrations, meetings, but negligibly little gas, as any self-respecting geologist would have been able to predict. A desperate grasping for any means of maintaining the status quo in the face of globally threatening climate change, fuelled populist politics and frustrated attempts to move to a new energy political economy. In 2019, a new government shelved fracking plans, and the focus has moved forward onto other rapidly emerging technological opportunities.

A key element in these cases is the relation between scientific evidence put forward and the support of future visions that generate anticipatory activities. Sometimes energy futures fulfil the expectations of industry projections, and sometimes they come upon us unexpectedly. The UK energy mix has been doggedly and increasingly reliant on natural gas for many years now, even as domestic gas supplies dwindle and the UK becomes increasingly dependent on imports of LNG from Qatar. After decades of lobbying, the UK government decided to invest in new nuclear power plants, to replace an ageing set of plants, and to substitute for the electricity generated by ageing coal plants that are increasingly uneconomic. Yet suddenly, in 2018, the wind turbine industry managed to redesign its way towards a halving of the spot price for wind energy, radically changing the economics of energy investment more or less overnight. Long term futures suddenly began to look different, and the politics of energy started to shift. An urgent review of the use of hydrogen to replace natural gas, and a revival of abandoned plans for Carbon Capture and Storage followed, making the energy industry landscape in the UK quite different today from where it was a year ago. And this has far reaching consequences.

Clearly, energy politics and geopolitics has profound influences on the technologies implemented for energy circulations, and vice versa¹ (MITCHELL, 2011). Yet until recently much of the debate (and a lot of the research) about addressing climate consequences of energy provision has actually been focused on consumption, and even more particularly on 'behaviour change'. Heavily influenced by the work of environmental psychologists and economists, policies have been directed towards encouraging citizens to use less energy. Translated into everyday life, this means attention has had to be drawn to the energy services that people use, since energy is only ever used to provide some kind of service, whether that is heating, cooling, lighting, sound or vision. We have seen constant injunctions to heat houses less, switch off lights and appliances, use appliances less and so forth. These messages generally ignore the dynamics of household relations, and rely on price incentives to encourage parsimony in the use of energy services. They

1 - As Mitchell has pointed out, 2011.

can be characterised as moralistic, and paternalistic, and are often full of contradictions: Turn down your heating, but don't allow elderly people or babies to get cold; Switch off your lights, but switch your light bulbs to energy efficient ones, so they don't use so much electricity and it doesn't matter so much how long you leave them on. Invest in greener technologies and renewable installations, if you are wealthy enough to do so.

More attention to the ways that people actually access energy services, and attention to the unevenness and inequalities of access brings quite different questions to the fore² (GUY; SHOVE, 2001; SHOVE, 2003). Who actually uses the most energy services? Those with the largest houses and cars. Who pays most in relative terms for their energy services? The poorest in the most inefficient and often smallest housing. How much can you actually save by turning down your heating? Actually not very much as a proportion of your bills. How efficient are heat pumps and solar panels in relation to domestic usage? Much less than predicted by almost all installers. Evidence and knowledge are being bound up in political agendas in ways that may be unexpected by the scientists and engineers producing models of energy processes, but ways that would be quite predictable among social scientists who study governance. State services of all kinds are bound into the colonial logic of the developmentalist states that most of us live in, in which citizens are increasingly treated as customers and consumers, despite the desire of many to consume less.

In this, we are in the familiar territory of governance studies, critiques of the neo-liberal state, and the now abundant literature on participatory governance. In my own work, I have both worked to encourage citizen-led governance, and critiqued the way that neoliberalising states co-opt the language of participation while disenfranchising citizens (ABRAM, 2005, 2011; ABRAM; WALDREN, 1998). Discourses of participatory democracy largely adopt the language of ground-up social movements, while moving all meaningful decision-making arenas behind the boundary of commercial contracting of services. The New Public Management was the exemplar process by which lip-service was effectively paid to citizen participation, while removing all power to design or define services behind a paywall of secrecy (ABRAM, 2007). Powers to regulate planning and development in the UK have been steadily weakened and centralised, leaving local action bereft of powers to make meaningful decisions. The future is emptied of meaning, producing a wave of cynicism and hopelessness in many areas (ABRAM, 2017). Across Europe we are seeing a rise in populist politics, and it can be no coincidence that this follows decades of hollowing out of welfare state services, and disempowerment of local governments.

And yet, we are seeing a new generation of young activists enflamed by the threatening future of climate change, demanding action and political engagement. While protests are becoming more vocal around fossil fuels and their derivatives – namely plastic pollution and pesticides – the core arguments keep coming back to energy services. If we

2 - As Shove argues – see Shove 2003 and 2010.

are to decarbonise, that means decarbonising transport, heat, electricity and agriculture. Clearly, decarbonising entails radical changes, and radical changes in practice require radical changes in infrastructure. The infrastructures that support energy services are not only cables, roads, railways, power plants and buildings. The political and social infrastructures that enable these facilities to function are not enabling change, yet they must also be changed if current global and local systems are to be effectively decarbonised.

So how can energy futures be envisaged? How can current infrastructures be turned around? How can whole countries across the globe move from carbon states to decarbonised states? Who will imagine the road from C to D? And what knowledge will they rely on to start that journey?

Science studies tell us how crucial the imagination is in generating particular futures, and show us how the forms of that imagination shape the actions and policies that flow from it. In particular, theorists such as John Law have shown how models and metaphors have been central to shaping modern states (LAW, 1986), just as sociologists such as Rose and Miller (MILLER; ROSE, 1990) and historians such as Ian Hacking (1986) have shown how numbers, statistics, calculability and probabilities have supported the science of the state, political science. Miller showed how double entry book keeping came to define the budgetary systems of modern states, defining which elements could be quantified and therefore recognised by the state. Hacking showed how these enumerations led to the 'making up of people' who would reflect the categories defined by calculable quantities. And Law showed how the very essence of state activity, as well as the path to colonialism, required on the provision of technologies for acting at a distance. All government, to some degree, relies on acting at a distance, that is, acting on others who are remote from the centre of power. The distance itself is often a function of the technologies that enable action. Long distance shipping in the 16th century brought together technological inventions in rigging and construction with governmental inventions relating to the incorporation of labour, and advances in astronomical navigation built on new kinds of cosmology. Law emphasises the translation of astronomical science into manageable rules for sailors, the translation of knowledgeable persons into routines, rules or protocols for action by others. This insight is important in relation to changing energy systems, since the people who devise models of the energy system are rarely those who implement new infrastructural technologies.

In the case of energy systems, it is important to look at how new technologies are brought into practice, and how infrastructures are shaped and controlled. While much social science attention is paid to the political economies of technology and the effects of policy, there has been less scrutiny of the forms of knowledge that support political action. The UK National Centre for Energy Systems Integration (CESI, 2020) is a research-council funded centre that aims to model integration between and among energy systems for the long term. As part of that research, a small group of social scientists, myself included, are looking at the kinds of knowledge generated by engineering and mathematical models, and the possible effects of their dominance in the production of energy futures. The

Centre for Energy Systems Integrations aims to integrate models of different aspects of the energy system, to create a combined modelling environment that allows for a view of the implications of an increasingly integrated energy system. It aims to address heat, gas, electricity, transport, communications and more. It starts from the hypothesis that a more integrated system will be more efficient and can be better optimised. The premise is the increasing inclusion of renewable energy generation on the energy grid, that is increasingly decentralised.

However, from the start, these proposals have been in doubt. Will a more integrated system really be more efficient, and if it is, will it also become more liable to system failure or security breaches? A possible increase in electric vehicles would cause a very large increase in load, while also offering a large storage facility. A system more reliant on intermittent sources might need to be balanced in a different way to one based on monolithic centralised plant. If the programme of research defines its central problem as a national electricity grid that is groaning under the weight of underinvestment in equipment, more peaky demand, and more distributed and less predictable generation, then is the answer still about managing that grid or managing energy relations more broadly? The electricity grid has to be managed and developed in new ways to keep up with changing generation and demand, while it operates in concert with a gas network that provides fuel for power station and takes much of the heating demand for a country full of low-quality poorly-insulated houses. So how do you devise new solutions? The first step in engineering is to devise some kind of model to test different options. But here we are dealing with multiple models and multiple kinds of model. The project itself divides its work into planning models and operational models, physics models and economic models. Demand models, for example, operate with data collected from occupied houses, and socio-economic data about households. Physics models work with line ratings and network layouts. The task of getting these models to talk to one another is not simple, and may not be achievable, not because engineers and mathematicians are not smart enough to put their knowledge together, but because the kinds of knowledge incorporated in different modelling approaches are qualitatively different. It takes a more philosophical approach to recognise that the problem here is primarily epistemological.

So whilst we worry about bringing together qualitative and quantitative representations, about aligning social science and science, in fact the engineering models themselves are of quite different orders and are extremely difficult to align. The point I want to make here, however, goes beyond the difficulty of integrating diverse modelling approaches, but addresses the qualitative judgements used to define numerical models (SILVAST et al., 2020). Each model is designed on the basis of numerous criteria, thresholds and tolerances, such that each time an engineer or mathematician codes a model, they decide where to set such tolerances, how to define the ‘uncertainty’ that is acceptable, and which factors to ignore. In making these judgements, they rely largely on either convention or common sense. In other words, they introduce into their model a range of cultural assumptions about what is realistic, feasible or acceptable. It is these assumptions that we have to seek out, to discover where there are differences that may be decisive once the knowledge

generated by the models becomes the basis for policy decisions or investment strategies.

It is after this process that appliances, infrastructures and services emerge in the world, to be met by people whose lives are compromised by the difference between the way they live and the way their lives are imagined by the engineers, investors and policy makers. Social Scientists spend a great deal of time and energy working with issues that emerge when communities are confronted with energy systems that cause inequalities or inconveniences. Yet by then, the system is already a thing, a problem to be dealt with. Engineers are largely inclined to be problem solvers, so if their solutions are causing trouble, we can perhaps conclude that they are solving the wrong problems. We can discover what is wrong about the problems if we look more closely at the ways that they work, and the way that their work is used and misused by others, and this requires an ethnographic approach to observing and interrogating how people live every day, how they interact with different kinds of systems, make and break relations in between the material, social, spiritual or aesthetic aspects of life (ABRAM; WINTHEREIK; YARROW, 2019).

My hypothesis here is that these kinds of system-models will be key in the imagining of a post-fossil future, in the determination of how the transition comes about, and who benefits from any new system. Of course, the engineers know that they are making compromises in their models. They are fully aware that they are approximating reality, not representing it fully. They are open about the limitations to the models. And some of them are also aware that their caution will not travel with the model when it is used in policy contexts. The ideal scenario for many of them is to use the models themselves in dialogue with industrial or governmental partners to explore a set of particular issues or problems that can be better understood through the use of a model. The worst case is for a model to be adopted by someone else and used in ways not intended by the modeller since its validity will thereby be compromised. And yet, we can be fairly sure that the first thing that happens if a model makes its way out of the lab, is that it will be compromised, if compromise is the result of the use of a tool by someone with different assumptions from the tool's manufacturer.

Let me give an example. There is much talk around the world about smart grids. The term Smart tends to imply automation with the use of algorithms. A smart grid is potentially one that diverts load to where generation is, by remotely controlling demand or load, and generation. The idea is that if you were to load an electricity grid with electric vehicles, it would switch the charging on and off depending on how freely the grid was conducting electricity – or in more technical terms, to meet the balancing needs of the grid. It is an interesting theory, supported by a number of laboratories, and some tentative attempts to set up mini or micro smart grids to test the ideas. How does this manifest on the national electricity grid? One intervention is to allow the grid to manage its own balancing, by automating the tapping of transformers, adjusting the transformer to account for the load and supply around it. The private companies managing the distribution grid in the UK have begun a process of updating switching and transforming equipment to enable automatic control. But new automated sensors are sometimes attached to very old

circuit breakers that can only be operated manually. The model of the automated grid and the reality of the legacy infrastructure actually in place on the ground are mismatched. It doesn't matter how fancy your smart grid model is if you pick out one element of the model and apply it in an inappropriate way. We are in the territory of Scott's 'Seeing like a State' (SCOTT, JAMES, 1998), where an idea that looks good on paper turns out, on the ground, to make no sense at all. But if you are able to report it as an achievement of increasing the readiness of the grid for smart operation, then the bureaucratic operation may be successful in its own closed loop, irrespective of the realities of trying to operate a grid that doesn't work properly. In such cases, it is usually only when a systematic failure occurs that the problems are identified in hindsight as obvious causes of the problem.

These kinds of example provide satisfying just-so stories, with a sense of smug superiority to commentators standing on the side-lines, but in any complex organisation, it can be very difficult to make changes from within. The challenge for the engineers modelling the energy system is to work in such a way that their systems cannot be so easily abused, and to find a way to work within the limitations of modelling activities. An engineering model used for engineering purposes is probably not so much of a problem, but when models are floated into the world of policy and investment, the limitations and uncertainties intrinsic to the model can be released as little demons to wreak havoc on the best-intentioned efforts. What we are doing in our research at the National Centre for Energy Systems Integration is trying to catch the demons before they are released into the world. We are trying to open a space for communicating the divergent forms of knowledge that are sailing between different kinds of models, and to follow them onto the networks of power. We are doing this through the kind of research outlined here, and through the kinds of educational schemes pioneered at the Durham Energy Institute that bring together graduates from different backgrounds to talk through energy issues and learn to hear each other's language. As engineers learn to hear social scientists, and as social scientists begin to appreciate technologies, there is hope for the future. We may, one day, find ourselves living with a multiply dimensioned energy system that actually offers the kinds of energy services that people need, within the limits of what the planet can support.

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Ciência, Tecnologia e Sociedade: integrando as ciências sociais no debate sobre energia

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*Dossiê Especial:
Territórios de Energia*

Resumo: Este artigo apresenta as principais questões que as ciências sociais atuais visam frente ao estudo da energia, as quais superam o nível das preocupações convencionais com assuntos como o dos consumidores de energia. Estudos aprofundados e muito detalhados de práticas energéticas em todos os níveis podem fornecer uma visão das maneiras pelas quais os sistemas energéticos estão determinados pelas estruturas sociais, legais, culturais, econômicas e políticas e que permitem compreender melhor as expectativas sobre produção, distribuição e consumo de energia. Por meio de uma abordagem sociológica e antropológica aplicada às próprias indústrias de energia, as ciências sociais podem oferecer novas perspectivas teóricas, revelar as relações políticas que acompanham os fluxos de energia e oferecer novas maneiras de pensar sobre as potencialidades dos sistemas energéticos atuais e futuros.

Palavras-chave: Ciências sociais da energia, serviços energéticos, práticas energéticas, modelos energéticos, infraestruturas.

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Ciencia, tecnología y sociedad: integrando las ciencias sociales en el debate energético.

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São Paulo. Vol. 24, 2021

*Dossier especial:
Territorios de energía*

Resumen: Este artículo presenta temas clave para el debate actual en las ciencias sociales que tratan de energía superando las convencionales preocupaciones con el asunto de los consumidores de energía. Los estudios detallados y en profundidad de las prácticas energéticas, en todos los niveles, ofrecen la oportunidad de generar información sobre las formas en que los sistemas energéticos están atados a las dimensiones social, legal, cultural, económica y política que anticipan las expectativas sobre la producción, distribución y consumo de energía. Al aplicar un enfoque sociológico y antropológico al análisis de las propias industrias energéticas, las ciencias sociales pueden ofrecer nuevas perspectivas teóricas, revelar las relaciones políticas que acompañan los flujos energéticos y ofrecer nuevas formas de pensar sobre los potenciales para los sistemas energéticos actuales y futuros.

Palabras-clave: Ciencias sociales de la energía; servicios energéticos, prácticas energéticas, modelos energéticos; infraestructuras.

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