What Are Smart Grids? Epistemology, Interdisciplinarity and Getting Things Done

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Abstract Smart grids are defined in a variety of ways that are more or less continuous with current energy systems and technologies. Since their emergence in the first decade of the 21st century, a number of trends have become visible in the way smart grids are defined, from revolutionary break, to additive ('adding an ict layer'), to enabling the energy transition. Smart Grids as a term is increasingly accused of being a rather vague label for a variety of innovations. This scepticism around the term indicates that it may be moving from being the latest buzzword to being decried as 'hype'. But this multiplicity is in itself interesting. Closer consideration of what we talk about when we talk about smart grids provides insights into the current paths to innovation that are emerging and into the changing requirements to energy systems. In this chapter, I put forth three ways of looking at definitions of smart grids and the functions they fulfill: as promissory work, as creation of new objects and as boundary work. By considering the functional value of definitions beyond description, a richer, more critical discussion can arise. Shedding this light on the definitions of smart grids provides a tool for interdisciplinary interaction and a useful analytic basis for collaborative work on smart grids.

1 Introduction: Kinds of Work Done by Definitions

Readers of this volume will not need convincing that smart grids matter. But some may ask: why do *definitions* of smart grids warrant attention? A brief contrast between two definitions may be the best way to start drawing attention to the potential of definitions as a way of engaging with smart grids from an interdisciplinary perspective. Let's consider the definition put forth by the U.S. Department of Energy (2009):

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> A smart grid uses digital technology to improve reliability, security, and efficiency (both economic and energy) of the electrical system from large generation, through the delivery systems to electricity consumers and a growing number of distributed-generation and storage resources.

A second definition by the European Technology Platform contains interesting similarities, when it come to a focus on electricity and on delivery, and in the mention of consumers:

> A smart grid is an electricity network that can intelligently integrate the actions of all users connected to it—generators, consumers, and those that do both—in order to efficiently deliver sustainable, economic and secure electricity supplies. (http://www.smartgrids.eu/ETPSmartGrids)

These definitions also contrast in interesting ways, for example on the emphasis on centralization (stronger in the US version), and on the role of ICT. Also significant are the differences in the kind of impact that is expected: in the US, the expectation is one of improvement, while in the European definition, integration is the aim. A focus on definitions can therefore orient us to particular ambitions and goals.

A third definition, this time from a textbook on smart grids, highlights other aspects of smart grids:

> The Smart Grid can be described as the transparent, seamless and instantaneous two-way delivery of energy information, enabling the electricity industry to better manage energy delivery and transmission and empowering consumers to have more control over energy decisions (Hossain et al. 2012, 23).

Here, information is much more central to the function of smart grids and there are roles for consumers as active agents, like in the European definition (but not the American one). Note also that this definition begins with descriptors that are actually quite prescriptive. The smart grid will have to have the qualities of transparency and seamlessness and will have to be instantaneous.

This brief consideration of definitions shows that they put forth a reality, promising improvements and progress, that they articulate particular features of objects and that they situate smart grids as belonging to different spheres—markets, infrastructures, or information technologies. Definitions put forth a reality, foreground and background, include and exclude, assign active and passive roles. They are therefore better seen, not as a camera, but as an engine, to echo Mackenzie (2008).

This chapter is therefore an invitation to consider definitions as the basis for a productive encounter. The apparently simple question 'What are smart grids?' can be the starting point of very important and useful explorations that will lead to better smart grids. This is a question that can be posed earnestly: seeking a description or definition. Asking the question in this way points to a belief in the existence of smart grids and assumes that they are worthwhile objects to get to know. In this sense, the question orients us to smart grids as a particular thing, a solution to a problem, a functional answer to a set of requirements.

This question can also be asked derisively, with the asker actually emphasising doubt in the existence if this object or casting doubt on its coherence. It can also be a way to point to the mistaken belief that something like smart grids would even exist. In this sense, the question orients us to smart grids as potential hype, as a hollow term that mostly has rhetorical value and serves to make promises about potential energy systems.

A third way to ask this question is to expect a range of different answers, answers that may contrast. Asking the question in this way orients us to the status of object-in-becoming of smart grids, to their unfinished, dynamic, multiple status. As such, asking what are smart grids becomes a way to explore a technology-in-the-making, before the answer to what is a smart grid is fully settled.

In this chapter, I will explore this third way of exploring 'what are smart grids'. I will consider smart grids as a 'partially existing object' (Schick and Winthereik 2013). This means that its ontological status is uncertain, and that there is disagreement about what it is, in the view of different actors. This approach is not 'merely' an interesting intellectual puzzle or linguistic exploration. Considering smart grids as partial objects is also a way to draw attention to what needs to happen for smart grids to become 'fully existing objects'. In other words, before definitions are stabilised and before there is agreement on what is a smart grid, a lot needs to happen. This work of settling down the meaning of particular technologies and systems is a crucial part of a shift towards new energy systems.

Definitions and how they orient the development of innovations and our relation to technologies have been the object of much work in science and technology studies. In the sections that follow, I focus on three approaches to the function of definitions that are especially relevant when considering smart grids: promissory work, creation of objects and boundary-work.

2 Definitions and Promissory Work

New technologies are often involved in what is called 'promissory work'. This kind of work takes place in a number of settings where technologies get defined: proposals, media reports, research agendas. Promissory work is about shaping expectations about innovations and new technologies (Brown and Michael 2003). It is crucial in attracting investments (material, intellectual and institutional) and in coordinating actors around particular agendas. In a context of uncertainty about outcomes, expectations provide structure and legitimation (Van Lente 1993). All of this helps to create 'organising visions' that "help to mobilize the material and intellectual resources needed for innovation (Pollock and Williams 2010, 527)."

For a technology such as smart grids, put forth in a context where the future is uncertain in specific ways (global warming, oil peak, global stability), shaping expectations may be especially important. Also, in a context where actors are expected to reach across boundaries (Borup et al. 2006) the expectations of grand solutions or new paradigms such as smart grids may be especially significant (more on this below). It is also important to note that expectations may not follow a linear path, from introduction to gradual greater enthusiasm and general diffusion, but that there may different periods of enthusiasm and backlash and indifference among different groups, all of which are difficult to predict.

As an example of promissory work around a definition of smart grids, consider the discussion of smart grids in a McKinsey report of 2009. Typically, the introduction of a consultancy report will be a likely place to find promissory work. It's important to note, however, that promissory work is also found in other kinds of documents and that it also has a function in scientific work—think of research proposal or calls for scientific events. In this short text, a number of stakeholders who have something to gain from smart grids are explicitly named: utilities, technology vendors and policy-makers are all actors who will not only contribute, but also benefit from smart grids. Speaking of the smart grid:

> Its advent promises improved reliability by enabling quicker and more effective response to outages, greater customer awareness of energy usage and costs, and facilitation of the adoption of technologies such as renewable generation sources and electric vehicles (Mark et al. 2010, 2).

Smart grids are put forth as a development that is inevitable, though the early stages of its realisation may be painful or difficult. As such, the promissory work is that of a better future that will come at the cost of disruptive dynamics that may at first hinder the very actors who are responsible for the realisation of smart grids. Such promissory work tells a tale of innovation in which smart grids will come at a cost, but will be worth it in the end.

There is also a strong message of opportunity entwined with the definition of smart grids that is put forth. Smart grids are a development that arises at a site where a number of prospects can come together and reinforce each other. The promise of smart grids is that they will enable taking a range of challenges, but also the reaping of benefits because of developing trends: adding intelligence to the grid, a global platform to tackle greenhouse gas emissions, and also

> the presence of ample global stimulus funds for energy infrastructure and smart grids in particular, the heightened interest in renewable energy, and the promise of electric vehicles (Mark et al. 2010, 2).

Smart grids are defined as the set of technologies that carry a particular promise for a set of actors who must invest in them, overcoming challenges but harvesting "enormous opportunities" that are created by situating smart grids the confluence of a number of trends. Such promissory work shapes how smart grids are conceived and what we expect they can bring about for new energy systems, and especially in this version, for economic benefit.

This is but one example. Contrasting different versions of the promise would further highlight the way certain promises tend to cluster around the notion of smart grids. The point here is that by examining promissory work, we are able to understand how smart grids become situated as a future that must be realised. Analysing such promissory work makes clear what we project as a script for change, a possibility for a different future. Such promises around technologies are key to realising them, and deserving of attention.

3 Definitions and the Creation of Objects

A second way in which we can approach definitions is to consider how they are creating particular objects. Whereas in the previous section, we considered a definition of a smart grid in terms of the kind of future it might bring about ("what is a smart grid for"), in this section the focus is on how definitions are powerful accounts of what objects are (or should be). Definitions that provide accounts of objects tend to be found in scientific articles and other scientific outputs, in policy documents and in legal documents. There are also sets of definitions, such as standards, that are meant not only to describe but also to regulate explicitly what objects can be. By considering definitions in this way, we can gain deeper insight into how particular aspects of objects become essential (Jensen 2006; Jensen and Winthereik 2013). For example, when defining toothbrushes, little attention is paid to their colour. When defining wine, colour is a key feature. This contrast is trivial, but if we perform the same exercise on smart grids, we come to understand how they are being shaped and how they transform from partially-existing-objects to concrete ones, whose existence might become so obvious, we might wonder why we actually even bothered to debate them. Can we imagine that we would all obviously know what a smart grid is, in the same way that we all know a toothbrush when we see one or that most of us can unfailingly distinguish red from white wine?

One very effective way in which definitions come to be stabilised is via the creation of standards. In the case of smart grids, we can consider the work of USEF (discussed in the chapters by Ngyen et al. 2016 and by De Boer and Verhaegh 2016), as a network of actors who are working towards a set of standards that would modulate how the various technologies that make up smart grids interact.

> A unified smart energy framework will enable consumers to transform into individual energy "up- and downloaders" while keeping the overall, differentiated energy system safe, reliable, and affordable and ensuring the system develops toward increasing sustainability (USEF 2014, 4).

Such standards define the parameters of elements of the smart grids. Typically, standards both enable and constrain what can be done with the technology:

> To achieve the desired interoperability and enable system components to evolve independently, all participants in a USEF market system must share a common logical architecture and standardized interfaces. USEF defines the logical interface standard, but does not define how to implement it. This stimulates innovation and competition among both technology providers and other stakeholders active in the energy value chain. In order to kick-start this process, the USEF Foundation provides a reference implementation that can serve as the basis for full-fledged commercial USEF implementations (USEF 2014, 46).

Interestingly, definitions that constrain what an object can be are not only limiting but also empowering: by following a common standard, all these technologies will share in the same definition of the problem, possibilities and solutions for a smart grid, thereby helping to develop and extend a particular version of a new energy system. However, precisely because of the alignment that is enabled by the settling down of definitions, it is important to consider what it includes and excludes. The range of what a smart grid can be is narrowed through the implementation of definitions-as-standards, even as they become more and more robust and materially embedded.

When definitions become more and more prescriptive, the assumptions and roles that are built into them also become more difficult to change. For example, many of the promises about smart grids have to do with new roles for new actors, and put forth the potential of smart grids to help bring about autonomy or empowerment of consumers. Expectations about users of technologies are also inscribed in the way technologies are defined by designers, engineers and regulators. Kinds of users can also be differentiated because they matter more to a technology (Van Kammen 2000) or to an infrastructure (Summerton 2004). In the case of smart grids, we could think about how particular versions of smart grids shape the kinds of users it can have and the way they might act with smart grids—a user who cares about increasing their energy efficiency and reducing total use; a user who is rationally-driven to make price-based decisions, etc. We might also consider how smart grids may be shifting an early principle of access for all users, where universal access was the goal (Summerton 2004). While smart grids promise more autonomy for users, it may also be that some versions of smart grids lead to greater differentiation between users, positing some as more lucrative—and therefore more likely to be granted privileged access to the grids. Marvin and colleagues (Marvin et al. 1999) described such a dynamic in the UK energy sector, and point to the potential for polarisation and marginalisation of some users. While we can currently observe diversity in how smart grids are defined and in the roles of their users, this diversity may be limited (see also chapter by Kester 2016, for an analysis of the dominant framings of smart grids) and may become more narrow as particular sets of definitions of smart grids become dominant (for example, through the adoption of standards such as USEF) and take on a paradigmatic role.

4 Definitions and Boundary Work

A third kind of work that definitions do, besides putting forth promises and embedding particular aspects, is to link particular objects to particular lifeworlds. This is significant because smart grids become associated with specific sets of problems that they can help solve:

> The way in which a problem is conceived decides what specific suggestions are entertained and which are dismissed; which data are selected and which rejected; it is the criterion for relevancy and irrelevancy of hypotheses and conceptual structures (Dewey 2008).

For example, smart grids are often presented as the solution to greater integration of renewable energy sources. Yet, when considering an energy transition, we are dealing with more than shifts in kinds of fuels, or in a change in the so-called ‘energy-mix’. If smart grids are defined as the solution to ‘intermittent’ energy sources, this puts a specific emphasis on how smart grids can help maintain levels of consumption and the status quo of much of the system. Consider this broader framing:

> Today's electric grid was designed to operate as a vertical structure consisting of generation, transmission and distribution and supported with controls and devicee to maintain reliability, stability, and efficiency. However, the system operators are now facing new challenges including penetration of RER in the legacy system, rapid technological change, and different types of market players and end users (Momoh 2012, 1).

If we embrace the idea that it is important to keep framing energy transition as being broader and more radical than a shift in kinds of fuels, than a broader definition of smart grids is crucial.

But more specifically, different definitions of smart grids align them with particular social worlds. By drawing boundaries around what is relevant to smart grids, kinds of experts and expertise are included and excluded (Beaulieu et al. 2013). This has been termed boundary work, the simultaneous practice of demarcation and coordination between different social worlds (Gieryn 1995). I will return below to the implications for interdisciplinary work below.

For now, consider the following thought experiment: What if sociologists were inventing smart grids? In a setting where engineering and ICT are the dominant disciplines involved in shaping smart grids, this may seem like an irrelevant or even a silly question. Yet it is precisely the obvious, non-controversial alignment of smart grids with specific kinds of technologies and kinds of materials that is the result of boundary-work. Why are smart grids so naturally the domain of engineers and computer scientists? And why does it matter that they are?

While my aim here is to stimulate asking particular kinds of questions about how we define smart grids rather than to provide all the answers, an illustration of how things might be different if a different kind of boundary-work was performed can be useful in understanding how boundary work of definitions is a crucial analytic handle. Drawing different boundaries around a problem definition lead to different kinds of solutions.

Demand-side management is an activity that is often associated with smart grids and one that will be fairly familiar to readers of this book. In an analysis of demand-side management, Evans and colleagues (Evans et al. 1999) showed that depending on how utilities defined demand-side management, radically different styles of demand-side management were developed. In cases where demand-side management was defined as the development and implementation of new technologies, the style of demand management that arose was one in which the user is passive (appliances are switched on/off by utility) or reactive (variable prices are meant to discourage consumption when demand is high relative to supply). There was also a focus on finding the one (technological) solution that would solve demand-side management—a technological magic bullet. On the other hand, where utilities considered that demand-side management could be defined as a social problem, social innovations also arose, such as engagement with customers. In this style of demand-side management, the model was more participatory and the responsibilities were more widespread. There was also more room for local understandings and bottom-up solutions. Evans and colleagues also noted that a greater diversity of solutions (rather than a single dominant technological fix) were developed.

Definitions of smart grids draw boundaries around problems. This is of course necessary, because otherwise it becomes very difficult to get things done. Definitions keep things doable. On the other hand, drawing boundaries includes particular life worlds and their resources. When boundaries are too strictly drawn, the result is that interaction across boundaries becomes difficult to achieve and the creation of solutions drawing on resources across fields becomes very difficult.

5 Conclusion

The last section links definitions to the issue of interdisciplinary collaboration—a very practical issue, to which this volume hopes to contribute. Starting from ‘definitions of smart grids’, a form that is explicitly present in presentations on and discussions of smart grids, I’ve highlighted some of the kinds of work done by definitions besides providing a description.

Drawing on different lines of work in science and technology studies, I have shown that definitions can help muster support for new projects, promising particular outcomes that are of interest to particular actors. Promissory work creates expectations about new knowledge and new technologies, and may be increasingly important in a world of growing complexity and uncertainty.

Definitions of smart grids also play a role in creating objects, shaping and standardising them so that they become reliable, taken for granted forms. This kind of work is very important for projects like ‘integration’ or ‘interoperability’. Fixed, standardized and widely accepted definitions are reliable and can enable processes of scaling up and carry promises of universalization. However, the more fixed a definition, the more difficult it becomes to adapt and diversify it, so that particular roles and uses that are excluded remain so.

Finally, definitions are also ways of drawing boundaries around relevant social worlds. Whether smart grids are the terrain of engineers or of economists or of multi-disciplinary teams depends on the way we associate particular definitions to specific fields of knowledge.

The argument for considering the work done by definitions that is made in this chapter is not meant to debunk definitions of smart grids. On the contrary, the suggestion is to contrast different ways of approaching definitions of smart grids. To understand the kinds of work done by definition, we must spend time with the question ‘what are smart grids’, rather than rush to answer it. In the course of the summer schools from which this chapter arises, the tendency was strong for some participants to ask: ‘what are smart grids, really’.

If we always insist on getting an answer to ‘what are smart grids, really’, we invest in a descriptive approach. This tends to yield essentialistic and even dogmatic answers. The tendency will be to insist on either a narrow, core set of features to define smart grids, or else end up with an inclusive, grocery list approach, where the diversity of elements that make up a smart grids seems unfocussed at best, or endless at worst. Is this really desirable in a context where smart grids are still a partially existing object that needs to be embraced, if it is ever to be realised?

Instead, I suggest that we approach the question of 'what are smart grids' analytically, staying with the question rather than rushing to answer it. In considering definitions of smart grids, we need to ask

- who is defining smart grids?
- in what context?
- for which purpose?
- with which consequences?

With such an approach, we might better understand what gets systematically included and excluded. This is not an academic exercize and can have very practical results. For example, we've seen that users and publics are shaped by how a technology develops (Jensen and Winthereik 2013). The following questions can make clear assumptions that future energy systems:

- What roles do our definitions of smart grids provide for users?
- What does it mean that we may be leaving public engagement to a stage of the development when the technology is stabilised and black boxed?

Similarly, we might ask about the kinds of expertise that are invoked in our definitions of smart grids:

- Are we building in failure, by leaving some elements outside the problem (and therefore outside the solution)?

Definitions are certainly needed to get stuff done. The point is that by paying more attention to the very work that definitions do, we can use them better, with fuller knowledge that the way we talk, think, and act about definitions shape smart grids and new energy systems, how they will work and who has a say in this.

Points for Discussion

- Can you trace in your own work how your definitions of smart grids and other central concepts relate to the typology, developed in this chapter, of promissory work, creation of new objects and boundary work?
- To what extent and through which means is it possible to prevent misunderstanding when talking to people from various backgrounds about smart grids? What can be gained or lost from such interdisciplinary interactions?

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