Energy Research & Social Science 48 (2019) 166–176

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Solar energy for all? Understanding the successes and shortfalls through a critical comparative assessment of Bangladesh, Brazil, India, Mozambique, Sri Lanka and South Africa

Ankit Kumar[a,b,*], Raihana Ferdous[a], Andrés Luque-Ayala[a], Cheryl McEwan[a], Marcus Power[a], Britta Turner[a], Harriet Bulkeley[a]

[a] Department of Geography, Durham University, United Kingdom
[b] School of Innovation Sciences, Eindhoven University of Technology, The Netherlands

ARTICLE INFO

Keywords:
Energy access
Solar
Assemblage
Energy justice
Socio-technical
Agency

ABSTRACT

Lanterns, homes systems, hot water systems and micro-grids based on small-scale solar have become prominent ways to address the energy access challenge. As momentum grows for this form of energy transition this paper draws together research on small-scale solar in six different countries – Bangladesh, Brazil, India, Mozambique, Sri Lanka and South Africa – to argue for a need to understand how, when, and for whom solar provides energy access. It argues that an assemblage perspective can provide vital insights into the diversity and dynamism of energy access. The paper demonstrates that the diverse ways in which solar provides energy access is a function of the flexibility/fixity of the socio-technical assemblage and the de/centralisation of agency.

The central thesis of this paper is that energy access is fluid and ever changing and we need fluid, easily maintainable, locally modifiable 'assemblages' for providing such access. Using this perspective, we find three common features of solar energy access across our case studies. First, there are significant gaps between what solar projects are designed to achieve and what they deliver, which are highly contingent on the flexibility of their structure and the decentralisation of agency within them. Second, access needs to endure continuously. Third, to foster enduring access, projects should embed logics of improvisation.

This paper is based on six separate qualitative research projects conducted during 2010–2016. It draws data from 482 interviews, 91 home tours and 12 group discussions.

1. Introduction

Providing access to "affordable, reliable, sustainable and modern energy for all" is regarded as central to development and enshrined as one of the Sustainable Development Goals ([1]:9 [2];). Yet what constitutes 'access' to energy remains a contested issue, with different approaches stressing different aspects, forms and beneficiaries of energy services as of central importance [3]. The UN Secretary-General's Advisory Group on Energy and Climate Change defines energy access as "access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses" [4]. Scholarly and policy literature has also stressed basic needs, reliability, affordability, adequacy, quality and increasing electricity consumption ([5–8]). If initial approaches tended to regard energy access as a singular occurrence – the provision of a 'modern' energy service to those without – more recently it is recognised that access is not a "single-step transition" but a "continuum of improvements" ([9]:2). Yet at which point on this continuum, and for whom, energy access is granted remains moot.

To address the definitional and implementationchallenges of working with the fuzzy and contested notion of energy access, the UN and World Bank have adopted a multi-tier energy access tracking framework. The framework captures the "multidimensional nature" of energy access ([10]:47) and outlines several attributes that it tracks through its multiple tiers. For electricity access, for example, these attributes are capacity, duration, reliability, quality, affordability, legality and safety [9]. For clean cooking, the criteria are health, convenience, safety, affordability, efficiency, quality and availability [9]. Yet despite the recognition of the multi-dimensional nature of energy access, it remains predominantly understood in technical terms, with a focus on an "increasing level of electricity consumption over time" at the household level [11,12]. While some approaches recognise the

* Corresponding author at: Technische Universiteit Eindhoven, School of Innovation Sciences, IPO 2.03, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands.
E-mail address: a.kumar@tue.nl (A. Kumar).

https://doi.org/10.1016/j.erss.2018.10.005
Received 12 March 2018; Received in revised form 30 September 2018; Accepted 4 October 2018

importance of taking into account issues of affordability, adequacy, reliability, quality and relevance for basic needs when assessing access [5–7,13], the predominant tendency, as encapsulated in the UN-World Bank Framework, is to assume that once energy services have been provided access is a relatively straightforward matter and that improved energy access can be built from the provision of such initial services.

Drawing on research conducted in South Asia, Sub-Saharan Africa and Latin America, this paper seeks to advance the understanding of energy access. First, we consider how the "needs" that energy should serve are conceived in relation to energy access and in turn how this *configures* the forms of service that are designed and implemented to provide access. Dominant approaches tend to work on the basis of a hierarchy of services, such that particular services (lighting, mobile phone charging) are regarded as basic needs whilst others (e.g. TV, kettles) are not. The UN-World Bank multitier framework operationalises this hierarchy of needs approach. Yet others suggest that "what matters ultimately to the end user is the utility of energy" ([14]: 16). Energy access should be mobilised in ways that accommodate people's agency of defining and deciding their (basic) needs [15] and measured not in terms of targets for the provision of certain forms of infrastructure but rather in terms of development gain that are locally specific and diverse [15,16]. Second, we examine what it means to move away from an idea of energy access as a singular momentum to a continuum, specifically focusing on the socio-technical dynamics through which access energy *endures*. We examine the value chains and social arenas within which energy access has to be sustained, and consider which forms of intervention may be the most successful in ensuring that gains in energy access can be sustained over time.

Over the past five years, small-scale solar energy systems have increasingly been heralded as a means upon which energy access as development can be built [17]. The falling cost of solar PV and the growing range and flexibility of solar innovations, from lanterns and home systems to micro-grids, has made solar an attractive technology in the quest to create access to 'modern' and sustainable energy [18,19]. In this paper we argue that the dominant framing of energy access in technical and economic terms creates specific configurations which mask the critical social and cultural dimensions that shape the extent to which solar can provide energy access, how such access is endured and its consequences for the kinds of energy transitions that are possible [20,21]. In examining these issues, we adopt an assemblage approach which suggests that access to such energy services is not only a matter of the material components of solar systems, but is configured by the social relations, regulations, standards, institutions, processes and practices that serve to make up a solar socio-technical assemblage [22–24]. Energy access is created not only through "designed and engineered material objects" but through an entanglement of "producers, infrastructures, users, consumers, regulators and other intermediaries" ([25]: 459; see also [26]: 900). Access to energy is therefore neither a singular endeavour nor a step-wise progression, but a condition sustained through the ongoing social, political and economic work of maintaining the provision of energy services [27–29]. In short, energy access is created by the socio-technical assemblage through which it is provided.

2. Taking an assemblage approach

The concept of assemblage is increasingly advanced across the social sciences as a means through which the complex and interwoven relations of and between the social and material can be interrogated. As [30]: 82) puts it is useful in, "decentring the technological artefact as the object of inquiry and expanding scholastic focus on 'technology' to include the vast social and cultural networks surrounding it". Mcfarlane and Anderson [31]: 162) have argued for the potential contribution of assemblage "not simply as a concept, but as an ethos of engagement attuned to the possibilities of socio-spatial formations to be otherwise within constraints and historical trajectories".

Although it is a conceptual approach that has to date had more limited purchase in relation to questions of energy access, Walker and Day's analysis of household energy vulnerability as assemblage is a notable example of what assemblage thinking can help unpack:

> "what might, through other kinds of lenses, be seen as coherent, similar kinds of force being in operation, can through assemblage analysis be revealed to be heterogeneous, quite diverse situations with internal inconsistencies and idiosyncrasies" ([32]: 23).

These insights provide a compelling argument for putting assemblage thinking to work in the context of energy access. The complexity and messiness of energy access as an empirical phenomenon produces a need for an analytical tool which is capable of grappling with the "inevitable gap between what is attempted and what is accomplished" ([33]: 1). The concept of assemblage allows the examination of "an array of heterogeneous actors", in "different spatial locations" and with "temporal rhythms" that more constrained theoretical approaches do not allow ([32]: 26). Energy services and how they can be accessed "cannot be understood in solely technological or social terms, but rather represent hybrid 'assemblages' operating across a multitude of scales and sites" ([34]: 34). Assemblages are 'open wholes' ([45]: 35), which are continually being assembled, disassembled and reassembled in time and space, generating particular agency. The notion of *agencement* as suggested by [35]:9) strengthens the point that assemblages are not simply socio-technical arrangements but "arrangements endowed with the capacity to act in different ways, depending on their configuration… agencies and arrangements are not separate". The capacity to act of a particular assemblage will, in other words, change if the socio-technical arrangement changes. For the endurance of energy access this is an important point: assemblages, are contingent and fragile configurations that require constant work [36].

While many researchers have documented the fluidity, indeterminacy and material agency of devices ([37]), the concept of assemblage offers a means of analysing how the fluidity and indeterminacy of devices are situated in time and space. By consistently attending to the agencies of both individual actors and the assemblage as a whole, where both entities and their agencies "can change over time and through interactions" ([38]: 25), assemblage thinking allows for registering "diversity of situations" and at the same time "reveals commonalities" of trajectories, influences, definitions and approaches ([32]: 26). For Ranganathan [39]: 1315), in case of stormwater drains in Bangaluru, India an assemblage approach "makes visible unusual suspects… disrupting how we conceive of agency and perform critique". Exposing the ways in which energy access is assembled helps critically reflect on it and address its inadequacies [40].

Critically, assemblage thinking draws attention to the operations of power. Working towards energy access inevitably disrupts established power relations long embedded in other infrastructural encounters and dis-encounters [41]. Power in the assemblage lies in all the agents, or rather, in their ability to mobilise different powers at different times. In a world that operates through combined human and material agencies [42], power "is recursively woven into the intricate dance that unites the social and the technical" ([43]: 18). This distributed notion of power opens up possibilities for examining how power operates through the push of multiple stakeholders, in multiple sites and through a range of diverse practices. Drawing on Li [36], the exercise of power in the assemblage involves reassembling, forging alignments, authorising knowledge, managing failures and contradictions and even masking political challenges as simply matters of technique. It also means acknowledging the materiality of infrastructure as a vibrant force [44,45]. Yet, there is a risk that such distributed understanding of power depoliticises the intentional or voluntary use of power by delegating agency to the assemblage as a whole[1]. Especially, gendered

[1] Thanks to the anonymous reviewers for reminding us of this point.