Installing Photovoltaic Technology in the UK: Some User Constructions

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Abstract

The UK faces many challenges in the deployment of renewable energy technologies (RETs) and energy efficiency measures, with targets to lower carbon emissions and reduce reliance on fossil fuels. This research attempts to examine the deployment of RETs using approaches from science and technology studies. Taking the example of photovoltaic technology, this paper summarises findings from two case studies involving the installation of photovoltaic (PV) panels on residential buildings that were funded by the Photovoltaic Domestic Field Trial. By focusing on the processes of constructing the user, the study shows the various user constructions employed by the project managers during the installation and how these constructions shaped the users' relationship with the photovoltaic technology.

Introduction

Despite the availability of renewable energy technologies in developed countries and the well-documented studies on their economic and environmental benefits (Alanne 2006; Edinger & Kaul 2000), the situation regarding their actual implementation remains a cautious one. Currently, predictions as to the economic feasibility and the viability of these energy sources are fraught with conflicts and contradictions from various voices, encompassing scientists, politicians, economists and environmentalists (Cooke et al. 2007; Dinica 2006; Duke et al. 2005; Stanford 1998). Moreover, in the UK, questions are being asked regarding the requirements to effective implementation of renewables, given that the country has set ambitious targets—lowering carbon emissions by 60% before 2050 and designated a target of 10% of energy to be from renewable sources (Boardman 2004; Mitchell 2003).

Currently, only 1.3% of the UK's electricity was supplied from renewable sources, compared with 16.7% in Denmark and 3.2% in Germany (DTI 2003). Therefore the situation suggests that more research is needed to examine economic and policy measures necessary for reaching the targets set for renewable energy technologies (RETs) and carbon reduction. A general overview of some of the current literature on the implementation of RETs and energy efficiency finds a wealth of research into the economics of RETs and the feasibility of deploying energy efficiency in buildings, as well as a critique of the major policy initiatives that have been adopted by the UK government (Duke et al. 2005; Ekins 2004; Helm 2002; Mitchell & Connor 2004). Focusing on end-users, the review finds that current research tends to emphasise the need for education and awareness to stimulate behavioural change among end-users of RETs (Dias et al. 2004; Reddy & Painuly 2004), whilst others focus on the economic incentives needed to encourage the adoption of new technologies (Batley et al. 2001; Eikeland 1998). Other studies exploring the behaviour of individuals within their homes contextualise this aspect within cultural habits and consumption practices (Barr & Glig 2006; Wilk 2002; Wright 2005; Zukin & Smith-Maguire 2004).

Conceptions of the user of renewable energy technologies

Whilst it is not the intention of this study to dispute the usefulness of the above approaches, the concern is in examining the implementation of renewables from a socio-technical perspective (Guy 2004; Shove et al. 1998), thus providing insight into the various meanings that can be given to RETs and their relationship with users. In doing so, the study avoids the limited views of the techno-economic approach which assumes a linear process of technological diffusion based on technical and economic approaches to the analysis of society (Guy & Shove 2000) and exemplifies a more central role of social science research, questioning the various conceptualisations regarding barriers to technology diffusion and behavioural change (Shove et al. 1998). Acknowledging the limitations of the techno-economic approach that does not answer the gap between policy and implementation (Shove & Wilhite 1999), this research aims at understanding the implementation of RETs by taking the example of solar photovoltaic technology. The analysis adopts theories from science and technology studies that have explored the way users are constructed and configured during technological innovation (Akrich 1992; 1995; Woolgar 1991) and extends their application to the phases of technological diffusion (Callon 1995), arguing that the process of configuring the user into particular roles continues during the deployment of RETs, involving the decision-making, preferences and beliefs of additional actors and intermediary users.

A socio-technical view on users and technologies

According to Oudshoorn and Pinch (2003), users have always been considered an important element in the process of technology diffusion and implementation. Indeed, forums and associations have been organised in order to educate users on the benefits and use of technological innovations. However, this approach placed users at the receiving end, portraying them as passive recipients of technological innovation. In recent years, scholars within the tradition of science and technology studies (STS) have been increasingly concerned with the role of users in the conception, development and implementation of technology (Aune et al. 2002; Guy 2002; Jelsma 2003; Kline & Pinch 1996; Mangematin & Callon 1995; Oudshoorn & Pinch 2003; Rohracher 2003; 2005b; Shove & Chappells 2001).

Moreover, theoretical work within the STS tradition is interested in the ways in which the concept of 'users' is constructed and represented in technological development and implementation, aiding innovators in configuring modes of use for technological artefacts (Woolgar 1991) and the 'scripting' of use and users during the design of technologies (Akrich 1992; Akrich & Latour 1992). Designers and engineers face various challenges during the conception and development of technologies, especially the adoption and appropriation of an artefact, which particularly relies on the decisions of the user (Aune et al. 2002). As such, to ensure the success of the technology and its adoption, it is argued that designers configure users by limiting their actions and creating boundaries between them and the technologies. Through researching usability trials of personal computers, Woolgar (1991) shows how the preconceptions of the users made by the designers influence the process of product development, where the identity of the user is presumed and constraints into the expected actions of the user are defined. Designers, therefore, configure the user, influencing the path of technological development.

Studies from an actor-network theory analysis show how the design of technological artefacts 'scripts' users into particular modes of action and behaviour, whereby agency is distributed between the artefact and its user (Akrich 1992). During the adoption of a technology, however, users can 'de-script' technologies, appropriating their use and changing the meanings associated to the artefacts, thus challenging intended modes of use. As Akrich (1995) finds, firms producing technological artefacts employ various methods of constructing and representing the user to aid in imagining the identity of the user, the mode of use and its objectives. Such representations are necessary as they inform the design and marketing departments of companies on target users and ways of improving technological products.

This paper argues that during the promotion of RETs, various constructions of the user take place that aid the way consultants, energy experts, local authority personnel, and developers undertake implementation projects. Moreover, the implementation of RETs entails a process whereby users are configured into particular roles that aid project managers and developers through the process of technology implementation and use. This process takes place in complex actor-networks that are built around the renewable technology, involving the relevant actors who are recruited and mobilised for the success of the technology's implementation.

Adoption networks of renewable energy technologies

From an actor-network perspective, analysing RETs during their implementation phase provides an opportunity to research these technologies during their deployment and use (Akrich 1992) by means of extending actor-networks as we follow the actors from the phases of innovation to that of diffusion. However, such an exercise requires a shift of focus from the conception to the adoption of technology and accordingly a redistribution of relations of power, knowledge and interests. This requires an expansion of the practices concerning the technologies that are studied (Rohracher 2003), and results in a more complex network with various categories of users often overlapping (Rohracher 2005a). According to Callon (1995), it is necessary to have a unified framework for the analysis of the conception and the adoption of a technology mainly because of the influence of the former on the dynamics of adoption and the reciprocal impact in the long run, as experiences of adoption redefine the formation of conception networks.

In the case of RETs, adoption practices expand to include an array of activities from housing developments to neighbourhood regeneration projects. Moreover, they involve a different set of actors that come from various backgrounds and can have differing interests and agendas (Rohracher 2003). The aim of this research, therefore, is to analyse how users are constructed during the implementation phase. Such an analysis would provide an opportunity to move away from essentialist notions of users' identities and economically determinist views on RETs diffusion. In studying how users are constructed at the implementation level of RETs in England, this research focuses on the actors involved in these application projects—including planners, project managers, housing developers, energy consultants and policy makers—and the various user constructions made during these processes. The study uses various methodologies within science and technology studies,[1] and builds on case studies of RETs implementation at the neighbourhood level. The following case studies involve the installation of photovoltaic (PV) panels on two types of housing, private homes and council flats in the north of England.

The next section provides a contextual background of the projects, an account of the project stages and the preliminary analysis of the findings regarding the construction of the end-users of the photovoltaic system. The two case studies show that un-packing the 'trial'—which connotes a straight-forward illustration of a technology in exemplar circumstance—consisted of far more complex activities, the purpose of which was to ensure the installation of the technology within project deadlines. The result is a sequence of activities that confine the role of users into specific roles to complete the installation within financial and time constraints.

The Photovoltaic Domestic Field Trial

The UK Energy White Paper (2003) made a significant promise to lowering carbon emissions—a 60% reduction by 2050. It sets forth a framework for research and development, innovation and policy implementation that includes energy conservation in buildings, increased energy efficiency and the promotion of a mix of energy sources, including renewable energy technologies such as solar and wind power. A vision of the energy future in 2020 is described briefly in chapter 1 of the paper, where 'there will be much more micro-generation such as photovoltaics. This will generate excess capacity from time to time, which will be sold back to the local distributed network' (DTI 2003, 18).

The growth of PVs as an alternative renewable energy resource is relatively new in the UK, with the technology constituting a small percentage of the total non-hydro renewables produced in the country. However, there has been a significant increase in the last few years culminating in 5.9 Mega Watts in 2003 generated from PVs. Much of this increase is due to the expansion of the grid-connected market, as well as government support, including the Major Demonstration Programme and the Domestic Field Trial, which accounted for almost 66% of the total new capacity (IEA 2004).

A closer look at the Domestic Field Trial (DFT) reveals that the aims of the programme were not only to increase the deployment of PVs but to create a learning opportunity for utilities, building developers and other key players in the area of design, construction and monitoring of PV installations. The aim therefore, was 'to take a systematic approach to the assessment of the domestic application of photovoltaics in the UK' (Pearsall & Butterss 2002), resulting in best practice recommendations as well as information regarding system performance, maintenance, reliability, buildability and user satisfaction (BRE 2005). Managed by a consortium of energy and housing experts—as well as the Department of Trade and Industry—the trial's objectives included the assessment of design and installation quality, monitoring the performance of the PV systems, assessment of the buildability issues (such as necessary modifications to the roofing in place), and 'user responses based on inputs from the project teams' (Pearsall & Butterss 2002, 1497). Under the DFT scheme, 32 projects that included two different types of PV systems (bolt-on and building integrated) were installed with a total budget of £5.4 million. The type of projects varied among clusters of dwellings in social, private and mixed developments that were either new built or part of refurbishments. According to the DTI's *Third Annual Report* (BRE 2005) the projects have delivered an estimated total capacity of 750 kilo Watt peak (kWp) for 470 homes benefiting from the scheme.

The installation of PVs on the two projects under study was funded by the DFT scheme. Both projects were completed in the last two years. One involved installing 25 PV panels on the roofs of a three-storey social housing block, thus providing 25 flats with clean energy (BRE 2005). The total peak power is 38kWp, which equates to savings of up to one third of the total electricity consumption of the flats. The second project is a new-build, private development which involved the installation of PV systems on twelve individual houses. The project utilised two different types of panels: building-integrated PV tiles that are installed as part of the roof and a bolt-on system, which is installed onto the roof.

Installing PVs for social housing flats

The activities of the projects were controlled by various actors; the case of the social housing involved the local authority as well as the social housing management organisation (HMO), the consultants who were contracted through the DFT scheme on behalf of the DTI and who were expected to carry on the monitoring work after the completion of the project, and the PV installers. The social housing project was contracted after energy consultants approached several city councils in the north of England, with proposals to install the PV panels which would be funded by the DFT scheme. The proposal was prepared by the consultants and then submitted to the City Council for approval. It was later submitted to the

DTI, along with maps, figures and other details, for grant approval. The grant of £250,000 was needed to cover all the costs for the project including consultant fees. The City Council was expected to commit their time and staff in kind.

The City Council was informed by the consultants that they were more likely to obtain the grant if the building for the intended PV installation was to take place is in a high Multiple Deprivation Index (MDI) area. With this in mind, one council estate was chosen, which consisted of a number of buildings that were being refurbished, was selected for the installation project. As the properties were under the control of the HMO, the City Council had to enrol them into the project, thus securing extra funds if necessary. The local authority needed the HMO's consent to gain access to the property, but their responsibilities were limited to practical issues pertaining to building and construction work. As the energy officer stated, 'they were more concerned about the practical things, like the decoration and if they need to do the painting again', but the City Council 'involved them, as [they] had to get some money from them' (Energy officer). The HMO were interested in the project but preferred to remain in the background, perceiving themselves to be in a mediating role between the project managers and the tenants. However, the structural modifications that were required prior to the installation of the PV panels meant that further interest from the HMO was essential for the success of the project. The money was needed for structural changes in the roofing to make it suitable for installation of PV panels.

The chosen building was a three-storey block of flats, with a south-facing roof aspect. The choice of a block of flats, as opposed to terraced houses was to make the two-year monitoring phase cheaper and easier to manager, hence avoiding the need for planning permission and additional expenses for connecting telephone lines. The proposal was prepared to install 25 PV panels, which would be connected to 25 flats within the block. After the final approval for the funding, work began on the planning of the installation process. A survey of the roofing on the chosen building was conducted and major modification work had to take place in order to install the PV arrays in a way that would not risk structural damage to the building in case of wind lift. The engineers from the City Council were not well experienced with this type of technology and the project managers preferred to 'err on the safe side' regarding safety standards of roofing (Energy officer). After the necessary modifications for the roof were completed, the awaited installation of the PV panels took place and was completed in the following twelve weeks.

PV technology on single private dwellings

Unlike the social housing project, the private developers were interested in the installation of PVs in order to comply with planning requirements pertaining to their development. Because it was on a green field site, the local authority required the installation of various types of energy conservation technologies on the homes within the development. As a result, different groups of houses were built with different types of energy conservation methods and renewable microgeneration technologies that were considered suitable and exemplary for the domestic sector. One of the energy projects implemented was the installation of PV panels on twelve houses, as suggested by the energy consultant who was involved in installing RETs on other sites on the development. Consequently, the consultants presented to the developers an energy project that would aid them in complying with their planning requirements and provide them with the grant through the DFT to fund the installation.

The work then consisted of contracting an engineering consultancy, which had previous experience with the installation of PVs, as well as the PV installers. The consultant was then responsible for managing the project and liaising with the various actors, including potential homebuyers. By the time the project was completed, the consultant prepared a home owner's information pack consisting of general information and the user manuals of the various components of the PV system in their household. The document included clear and simple information for the day-to-day running of the system and other technical matters, in addition to the technical manuals, maps and contact numbers in case of maintenance needs and emergency.

Having described the two case studies explored in this research, the next section will demonstrate the different constructions of who the users are, which both project managers employed. These constructions were employed by the managers to aid them in understanding the role of the tenants and homeowners during the installation. Using different resources to help them understand the users' roles, the managers represented their users through their demographic characteristics, their imagined relationship with the technology and as rational consumers of energy in their homes.

Some user constructions

Social constructions of who the users are, or 'visions of users', Summerton (2004) labels them, can be contradictory but are often utilised by the stakeholders to explain the reaction of the end-user to the project. From interviews with the project managers and the documentation available, several constructions of the identity of the users is revealed as the respondents describe their experience during the installation of PV panels on the two projects. These 'visions', it is argued, influence the project managers during project implementation as they try to rationalise the users' behaviour with respect to the reasoning they employed, as well as the assumptions and decisions that they have made regarding the introduction of PV panels into the building.

The co-construction of artefacts and user identities in techno-scientific practice has been described in numerous STS studies of specific technologies, including reproductive technologies (Oudshoorn 1994), vaccines (Rose & Blume 2003), computers (Woolgar 1991), and photoelectric lighting (Akrich 1992) among others. As Akrich describes in her study on the 'scripting' of users during technology design (Akrich 1992), designers and engineers define 'actors with specific tastes, competences, motives, aspirations, political prejudices and the rest' (Akrich 1992, 208). These 'scripts' or scenarios, as Akrich refers to them, result from the visions of both the projected user and the context of interactions between the user and the technologies. As such, the technological artefact defines the framework of action in which the relationship between the user and the artefact is negotiated.

The managers in the above example of PV installation constructed the users based on their socio-economic status, their age and the managers' own knowledge and experience regarding RETs and climate change issues. Hence, users were perceived as rational consumers, in line with the general 'common sense' view of economically rational individual behaviour. Moreover, the users were characterized as ignorant and passive and therefore unlikely to be interested in the project or the technology involved. The sections below describe the different user constructions employed by the managers as they worked on installing PV systems on homes.

Users as economically rational

Visions of the economically rational user were implicit in the assumptions the project managers made regarding the acceptability of installing PVs on the roof. The actors who believed in the feasibility of the system expected the tenants and householders to be pleased with a technology that could save them money. Other managers who doubted the economic benefit of the PV technology in this part of the country associated the lack of interest on the part of the tenants to be the result of the minimal savings on their electricity bills. This vision was in line with the general view of society members being consumers who are chiefly interested in their economic benefit (Dinica 2006; Duke et al. 2005). The project managers expected the tenants and householders to react positively to a money-saving technology and to choose houses with the panels installed for that reason alone. In the words of the housing officer, 'there is the assumption that people would be happy about it because as you know, it is going to save {them} money'. The generally economic view of users' interests is also represented in the managers' view that the diffusion of PVs has been slow because it is expensive and not as financially feasible as other RETs suitable for the domestic sector. The economic benefit was emphasised further in the social housing project, promoting it as an ideal solution for low income families who would be interested in lowering their energy bills.

Users as ignorant

Several studies investigating the diffusion of technologies as PVs have stressed the importance of education, awareness and information about the technology that are necessary for their successful implementation (Assefa & Frostell 2007; Bahaj & James 2007; Dulleck & Kaufmann 2004). In the case of the social housing project, the project managers had to organise consultation sessions with the tenants prior to any construction work taking place. The tenants were constantly informed about the various activities on the project site through letters, and latterly were invited to attend a 'consultation workshop' (Energy officer).

The latter event involved a meeting with the energy officer from the local authority, the consultants and officers from the housing association. The energy officer prepared a presentation that focused on the practical matters such as noise, disturbance, and other construction related matters, but also 'included a bit of information about climate change' (Energy officer). The intention was to educate the tenants as to the benefits of having a PV system in their homes and the dangers of global warming. In addition, the project included flyers that promote the savings possible as a result of the installation with some explanation of how the technology works. According to the housing officer, the focus on the environmental benefits was minimised and simplified, citing the perceived socio-economic status of the tenants and their educational background as a barrier for understanding the value of the technology.

The level of education of householders in the private development was expected to be higher than in the social housing project. However, the project managers included a two-hour private consultation with these homeowners where they 'explained everything they need to know about the panels', as the project consultant emphasised. The consultant involved in these home visits stressed their importance in raising the homeowners' awareness of climate change and reducing carbon emissions. The focus was on informing householders about the PVs 'as it is a new technology that not everyone is knowledgeable about' (Energy consultant). However, the information had to be simplified and technical matters were limited to the user manuals which they had to include in the home information pack. In general, the project managers did not perceive the level of knowledge the private homeowners had about the practicalities of PVs to be very different from those of the social housing. As my respondent points out, 'you'd think people know a thing or two about it, but no, one of the householders asked if he always needed to have his socks on when at home' (Project consultant).

The project managers in both case studies felt that it was necessary to explain the practical matters surrounding the construction and installation (such as noise, dust, parking space, etc.) so as to avoid or minimise complaints that might delay or jeopardise the project. The expectations of the City Council and the HMO was that the tenants are likely to be concerned with disturbance and the construction work and an emphasis was made of informing them ahead of time and practicing good customer services measures. The perceived ignorance of the end-users in both projects by the managers was not only about how PVs work, but also how saving energy is necessary given the threat of climate change. As such, the tenants in the social housing were not expected to appreciate PVs on their roof because of their low educational attainment. Moreover, the private developers were reluctant to sell the houses with the PVs at a higher price because 'people in the north are not interested in green issues' (Private developer).

Users as passive

A significant image of the residents in the above projects was that of a passive user of PVs. The passivity was constructed mainly by how the managers thought PV technology functions. As such, the idea that the technology 'just works on its own', with the user not needing to 'do anything about it' (Engineering consultant) meant the absence of any potential role of user involvement in the installation or functioning of the PV technology. As Woolgar argues (1991), the photovoltaic system was interpreted as independent of the behaviour of the user at home, perceiving it as nothing more than an electricity generator on the roof.

Additionally, the tenants in the social housing were seen as passive, mainly because they were young and single. The previous experience of the HMO in other projects involving housing improvements suggested that young, single persons are the least interested in work taking place in their homes or in the neighbourhood. As such, the expectation of the housing association was of minimal involvement from the tenants and as a result, the process of enrolling them into the project was limited to letters informing them of the various stages of the work. Moreover, the tenants were absent during the consultation event and the media event which was organised after the completion of the project. Their indifference was understood to be in relation to the environmental aspects of the installation, prompting the energy officer to indicate that 'nobody [of the tenants] cares about climate change' (Energy officer). Their indifference was perceived to be related to the tenants' socio-economic status and the general apathy of this group to matters of sustainability and the environment.

On the day of the consultation, few of the tenants attended and those who did were reportedly mainly concerned with the practical matters, such as the availability of parking space. The perceived and consequently reported lack of interest in the environmental or economic benefits of PVs on the part of the tenants was analogous to the focus the project managers placed on these practical matters. That was driven by previous experiences with projects within the DFT in similar areas, where there were major problems related to vandalism, security and disturbance that caused delays. In an effort by the managers to complete the project with minimal interruption and complaints, due to the bureaucratic nature of dealing with such matters, an overemphasis was placed on these issues. Consequently the users were confined to a passive role with the project that minimised their interaction outside the boundaries of what the managers deemed as appropriate, which were the practical issues.

Having summarised the main user constructions that were employed by the project managers, the next section explores how these user constructions influenced the design of the PV system and running of the installation project. Hence, this research argues that during the installation of the PV technology, the project managers represented (Akrich, 1995) the users as consumers who were passive and who needed to be educated. This resulted in a particular configuration of technology's design and functioning.

Configuring users through the installation of PV systems

In configuring the user, Woolgar (1991) shows how the preconceptions made on the 'nature and capacity of different' users affects the actions and decision of designers and results in a particular configuration of the user and the technology. When the characteristics of the end-users are presumed, a process of constraining and defining their actions takes place. In the case of the PVs in the north of England, this process can be described as an attempt to explain how the activities and decisions made by the project managers defined the role of the user during the implementation and operation of the PV system. This paper argues that the various actions of the key stakeholders resulted in configuring the end-user into various roles within which they were expected to perform. The purpose was to ensure the successful completion of the projects whilst reducing the costs and ensuring a smooth process of construction and implementation.

As the case of the social housing project shows, to ensure the effective completion of the project, a huge effort was made to avoid all possible delays that would strain the available budget and cause further delays. As such, the choice of the three-storey building was perceived as advantageous because access was not required to the flats and so no potential delay could affect the installation work. The consultation revolved around informing the residents of practical issues and eventually configuring them as passive recipients of a technology that 'could only be good for them' (Housing officer). Throughout the various phases of the project, the issue of the tenants 'never came up' and the energy manager was 'thrilled that the installation was complete with no complaints' (Energy officer).

Part of the PV system is a display monitor that is designed to show the user the amount of energy the PV panel is producing and its contribution to the total energy consumption of the household. Installing the monitor was a DFT requirement, the purpose being to visually demonstrate to the user the effectiveness of the PV technology. Although ideally the display monitor should be located within the home, in the social housing project they were mounted on the wall in the common hallway facing the entrance to the building. The monitors were encased with break resistant glass to avoid vandalism. Despite a button on the display monitor that said 'Press Here', the action was impossible because of the encasing. As such, the emphasis on safety from vandalism and to save time from accessing individual flats, the managers opted to mount the monitors outside the flats, arguing that they were visible to the residents as they went in and out of the building. The resulting situation, however, was a separation of the tenant from the technology, creating a boundary due to the perceived complexity of the system and its independence as a functioning energy source. The physical boundary—materialised as a break-proof encasing of the display monitors—symbolises the expected relationship between the tenant and the technology. As such, the design of the installation configured a passive, indifferent user to a technology installed onto their roofs and not in their homes.

A similar separation of the user from the technology occurred in the case of the private development. Because only twelve homes were to have PV panels installed, the potential buyers were not told about the technology until after they had made the decision of which property they wanted to buy on the developer's plans. The reason for that was the fear the developers had of the technology discouraging buyers from purchasing these houses. The invisibility of the PV technology on the map was also reflected during the installation, influencing where the system components —the meters, inverter, and display monitor—were to be located in the house, and the homeowner was discouraged from interacting with the technology. However, the location of the display monitor within the house was also negotiated between the various actors involved in the project. The consultant wanted to install the monitor in the kitchen or hallway, a location that would make the monitor more visible, optimising its potential as an educational tool. However, the developer did not want to risk lowering the value of the house, and consequently insisted on the display monitors mounted inside the cupboard which housed the utility meters. The result was a compromised solution, where the display monitor was either in the cupboard or in the utility room near the kitchen.

Concluding remarks

According to Akrich (1992), managers constructed scripts that embodied their representations and expectations with regard to users' preferences and actions. The managers' visions of who the users are were related to their socio-economic status, their age, and their perceived knowledge about the PV technology. As the sections above demonstrate, the project managers attempted to define the role and actions that these users can or should play in the process of technology installation and operation. Studies in STS on users also emphasize the multiplicity of actors who are engaged in the 'configuration work' by which users and technologies are co-constructed (Oudshoorn & Pinch 2003), especially after the technology is deployed (Kline 2003). In addition to the designers of technologies as identified by Woolgar (1991) and others, the project managers who decided where, how and in what way the panels were to be installed on the roofs were also configuring the user into certain roles.

As these cases show, the users had to be confined into a project-friendly role that ensures the smooth completion of installation, especially in the case of the social housing project. Moreover, the users were separated from the technology due to its perceived complexity and the assumed ignorance the residents had about its benefits or operational functions. As such, this research argues that in trialling the PV technology, the interest in 'user responses to the technology' (Pearsall & Butterss 2002, 1947) shifted into a process whereby the role of the user was peripheral to the design and functioning of the photovoltaic technology.

Note

1 Empirical work was undertaken as part of a doctoral research and consisted of two case studies involving a total of 25 interviews, as well as an analysis of relevant project documentation, reports and literature.

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