LOWERING CO_2 EMISSIONS IN THE NEW BUILD SOCIAL HOUSING SECTOR: A SPANISH CASE STUDY

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As part of a larger UK/Spanish comparative study, this research focuses on a new build social housing development in Spain, and examines the measures being adopted by those mandated to comply with the provincial planning laws as well as the relevant national building regulations which demand the inclusion of measures to lower CO_2 emission levels. Focusing on the socio-technical networks of the principal stakeholders involved, and utilising a multi-level perspective, the research aims to better understand how provincial planning and building regulation requirements are being met, both through fabric improvements and the use of low and zero carbon technologies. Emerging findings from the case study suggest the stakeholders involved in the delivery of social housing view the introduction of such technologies differently, and this interpretation may depend on their specific view of the technology being deployed and the role they perceive it to play within their working environment. Perceptions of the new technology and fabric upgrades demanded by the new regulations are generally positive, but there is disagreement regarding technological performance and misgivings regarding its introduction given the prevailing economic situation in Spain. Implications for practice may suggest better communication between suppliers and installers, as well as some additional technical support from the technology manufacturer to help bridge perceived performance shortcomings. For policy, given the difficulty encountered during the pilot study in identifying housing developments working to the CO_2 improvements mandated by the 2006 regulations, it may prove fruitful to tie future revisions of this legislation more closely to planning permission consents.

Keywords: carbon, housing, multi-level perspective, socio-technical networks, Spain.

INTRODUCTION

Low and zero carbon energy technologies for domestic use continue to be employed in a number of ways in new build housing (NHBC, 2012). The available low and zero carbon technology options for developers can range from community based schemes, which provide district heating for a number of homes, to individual energy generation on a home-by-home basis. However, concurrent with the development of these new technologies and their subsequent implementation are a number of innovative fabric performance improvements (NHBC Foundation, 2011; CTE, Technical Building Code 2009), as well as an emerging number of allowable solutions (Zero Carbon Hub - ZCH, 2011). This doctoral research seeks to better understand how housing

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developers are meeting CO_2 emission targets specifically within the new build social housing sector using a case study methodology.

The Kyoto Protocol, which came into force in February 2005, set binding targets for thirty seven industrialised countries and the European Community for reducing greenhouse gas emissions (UNFCCC, 2010). These targets amount to an average 5% reduction against 1990 levels over the five year period 2008-2012. Additional market mechanisms agreed under the 2010 Cancún Accord and subsequently advanced at the Durban Climate Change Conference 2011, require industrialised countries to develop low carbon development plans and strategies, and assess how best to meet these, reporting their inventories annually (UNCCC, 2010; 2011).

It is against this low carbon agenda that European Union (EU) countries are committed to carbon dioxide reduction through EU directives which seek to achieve lower CO_2 emissions. The latest Energy Performance of Buildings Directive, 2010/31/EU (EPBD, 2010), has direct implications for the twenty seven nation states of the EU. This directive, now known as EPBD-2 (NHBC Foundation, 2011), follows consultation on the Recast of Energy Performance of Buildings Directive 2002/91/EC and attempts to clarify the targets for CO_2 reductions from buildings. EU member states are charged with fulfilling their obligations under directive EPBD-2 which seeks to achieve 'nearly zero energy buildings' (Article 9) in all new buildings by 2020. As the first EU country to make the introduction of renewable energy obligatory for all new dwellings (and major refurbishments) in 2006, Spain sought to utilise its solar resource and required all new dwellings to contribute between 30% to 70% of their hot water requirements from a solar energy source (CTE, 2006). The 30/70% variation depends on the geographical location of the dwellings and in which of the five climatic zones they fall (Fig 1), as well as the type of back-up energy used.

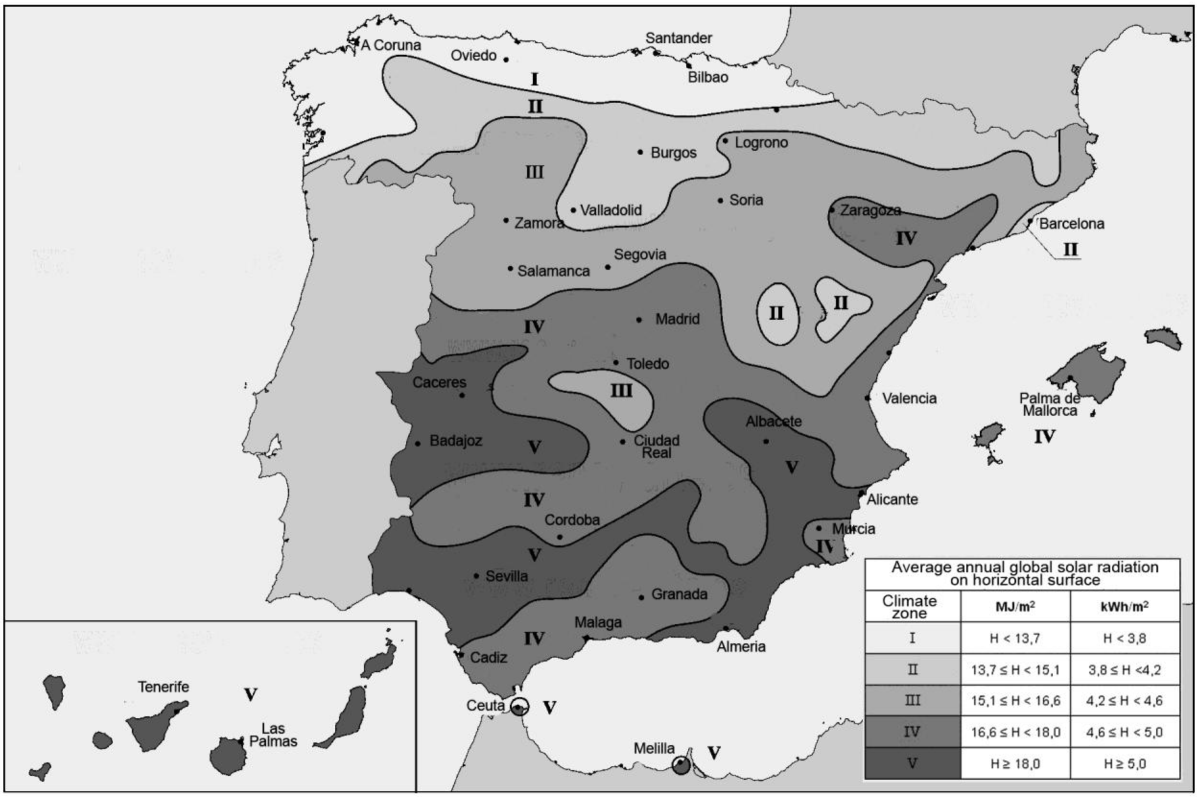

Fig 1 Map of Spanish climatic zones (CTE, 2006)

This case study was carried out in Andalucía (Zone V), which means the minimum solar hot water contribution from dwellings is 70% irrespective of the back-up energy system (oil, propane gas, natural gas or electricity). Although the 70% contribution is measured annually, there are a number of compliance stipulations which ensure there is a relatively even distribution of solar hot water production throughout the seasons (CTE, 2006).

The next section presents the case for this research and examines some of the drivers and difficulties in achieving low CO_2 emission housing. It includes a brief outline of the relevant legislation and the requirements of the Technical Building Code (CTE) relating to low carbon compliance in Spain. The methodological discussion covers the reasons for choosing the case study approach and gives the background to the case study, highlighting the data collection methods employed. The case study findings demonstrate how low and zero carbon technologies are being employed and include a diagrammatic representation of such deployment within this specific project. Finally, the discussion and conclusion section presents a summary of the findings and suggests how this research can be framed within the existing literature, highlighting its contribution within the Spanish context.

A CASE FOR IMPROVED UNDERSTANDING OF LOWERING CARBON EMISSION IN NEW BUILD SOCIAL HOUSING

European Union countries are obliged to meet demanding CO_2 reduction targets from buildings (UNCCC, 2010; 2011), and energy use from housing is estimated to account for approx 27% of all carbon emissions in the UK (DECC,2010), 20% in Spain (GBCE, 2011), and 25% of the overall emissions in Europe (EEA, 2011). Command and control regulation (Baldwin and Cave, 1999) through the introduction of the Spanish building codes (CTE, 2006), mandates the deployment of renewable energy technology for all new build housing. The introduction of this code ensured Spain was the first EU country to make the implementation of solar thermal energy obligatory in new and refurbished buildings. Along with the introduction of the government led Feed-in Tariff for photovoltaic installations in 2004, these policy incentives were intended to stimulate and consolidate supply chain integration, including job creation and investment (CNE, 2010). However, the results to date are inconclusive and Spain's initial gold rush has slowed considerably (Bloomberg, 2010; Heras-Saizarbitoria et al, 2011). In addition, the latest Renewable Energy Plan 2011-2020 (Plan de Energías Renovables 2011-2020) was introduced to provide a series of incentives for the production of solar thermal energy as well as additional methods of inspection and control throughout the various installation stages of the systems. This plan followed three consecutive years of contraction in the solar thermal sector (14% in 2009; 14% in 2010; and a forecast reduction of 28% for 2011) which largely reflects the significant downturn in the construction industry in general and the building of new dwellings in particular (Asociación Solar de la Industria Térmica, ASIT, 2012). However, despite this general contraction of solar thermal deployment in the construction industry, the 2006 building codes demand solar hot water provision in both private and social housing.

The Spanish social housing tenure is almost all owner occupied, with only a nascent renting sector (Hoekstra et al, 2009). The dwellings in the case study housing development were all social VPO registered (Viviendas de Protección Oficial -

Officially Protected Housing) from the general scheme category[2], and were all for sale, as opposed to being available for rent. This meant that their selling price was capped by the local authority (between 109.296E and 125.525E) dependent upon the m^2 of the dwelling. The right to housing is enshrined in the Spanish Constitution (Leal, 2004), and subsidised homeownership has been steered by a complex financial system in which both developers (through subsidies and soft-loans), and homeowners (through subsidies), received financial support from the government (Hoekstra, 2010). However, 'in the current context of decreasing house prices and decreasing housing production, such cross-subsidisation is not possible anymore' (Hoekstra et al, 2009 p137). Although social housing construction can account for anything between 20% and 50% of new developments (Shostak and Houghton, 2008), the developer within the Spanish case study suggested their current house building efforts were (by necessity) engaged solely on social housing. The lack of any cross-subsidisation therefore, means low carbon compliance has to be achieved within the strict cost boundaries of the capped social housing prices.

RESEARCH METHODOLOGY

Approach

A case study methodology was employed to examine some of the implications and challenges in achieving lower CO_2 housing emissions emanating from both the national legislation (CTE) and local planning requirements for social housing. Locating the research within a multi level context (Geels, 2002), a socio-technical network approach (Elzen, Enserink and Smit, 1996) was used as the theoretical and methodological lens to explore the existing situation and its dynamics while accommodating the actors and issues involved. This includes interactions between the actors, and their emergent understanding of the legislation, planning and technological requirements in meeting the challenge of low carbon emission housing. The research strategy was to select a housing development within the social housing sector that would permit access to site (including relevant project documentation), as well as access to key personnel charged with the deployment of low and zero carbon technologies within the social housing sector. The strength of the case study approach lies in providing vicarious experience in the form of full and thorough knowledge of the particular, and such understanding adds to the existing literature by extending the experience and comprehension gained through investigating particular cases (Stake, 2000). Although this case study is a bounded system (Fals Borda, 1998) and is limited by resources, it was chosen because it was consistent with the research strategy, and was considered most appropriate to deliver relevant, contextual information on low carbon housing.

Through the CTE, the deployment of solar thermal technology is a legislative requirement in this sector, and the research uses a socio-technical network analysis to examine this obligation through the complex interactions between people, institutions and technology within an empirical setting. In addition, by adopting a multi-level perspective (Geels, 2002), a range of considerations and influences on the choice and deployment of measures to achieve low CO_2 emissions in this sector are considered. Although primarily employed by Geels to investigate emerging technological

[2] The VPO comprises five categories, especial, general, municipal, a category especially for young people and a category to cover existing housing. All of these have a capped price and are destined to provide housing for those on low or limited incomes. (www.juntadeandalucia.es)

transitions, the multi-level perspective (MLP) for this case study is used to include some of the issues (CO_2 target reductions, code compliance, technological developments, planning policy compliance, construction education and training), which may impact on the deployment of low and zero carbon technologies, and which may best be explained from a generic model which can help to better understand these processes (Fig 2).

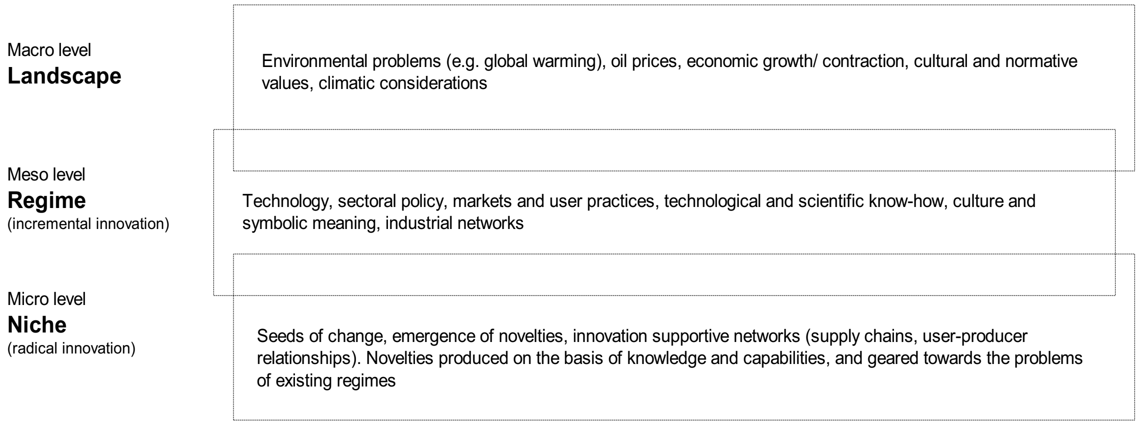

Fig 2 Multi-level perspective (Adapted from Geels, 2002 p 1261)

Utilising the MLP in conjunction with a socio-technical networks approach (Elzen, Enserink and Smit, 1996), has facilitated the examination of influences across the landscape, regime and niche levels of the MLP while identifying resilience within the network. The socio-technical analysis framework enables the tracing and analysis of factors that guide the various actors in their interactions, and acknowledges the identification of certain stable patterns whilst accounting for the different meanings that different actors attribute to the technology in question (Elzen, Enserink and Smit, 1996). A number of these influences are discussed within the actor interactions identified in this research.

BACKGROUND

The case study centred on a construction site of approximately 500 social dwellings where access was gained to both the works and the agents involved in its construction and the deployment of fabric upgrades and renewable technologies. The collated data included a variety of project specific information including project drawings, technical specifications, publicity documents, in-situ photographs from the site visit as well as a number of semi-structured interviews carried out with personnel at different levels. These included the architect, site manager, planning authorities, installers and manufacturers. Having previously conducted a pilot study, the interview questions were tailored to the building development selected, yet allowed a degree of contextual flexibility depending on the relevance of certain questions for individual interviewees. All the interviews were recorded with consent from the interviewees, transcribed verbatim, returned to each interviewee and subsequently translated into English. The transcriptions were then anonymised and only the job titles of interviewees remained identifiable. The transcripts were analysed qualitatively to identify any recurrent (including conflicting) themes arising from the discussions.

Spain has 24 million pre CTE homes (Asociación Solar de la Industria Térmica, ASIT, 2008), many of which are still under construction with planning permission gained prior to 2006. The site for the case study was chosen after preliminary investigations confirmed the development was subject to the 2006 building codes and the local planning department required compliance with the energy saving measures contained in the legislation. As this case study is part of a larger comparative study, consideration was also given to identifying a comparable development in the UK with which to make a relative comparison. Further consideration was given to the economic situation (within the landscape of the MLP) that has particularly affected Spain over the last four years which has meant it is more difficult to find developments currently under construction (Asociación Solar de la Industria Térmica, ASIT, 2012). Targeting developer organisations based on the upper quartile of volume house builders in both Spain and the UK helped to identify suitable and on-going housing developments.

CASE STUDY FINDINGS

The case study included project specific information relating to the renewable technology deployed within this development. Although developers are at liberty to include a range of technologies within their dwellings, this development included CTE compliant fabric requirements, but restricted renewable provision to the installation of solar hot water panels which provide hot water to all 500 apartments. The development did not include any additional renewable technologies.

A typical socio-technical analysis for this development is shown in Fig 1.3 superimposed over the landscape, regime and niche levels of the MLP.

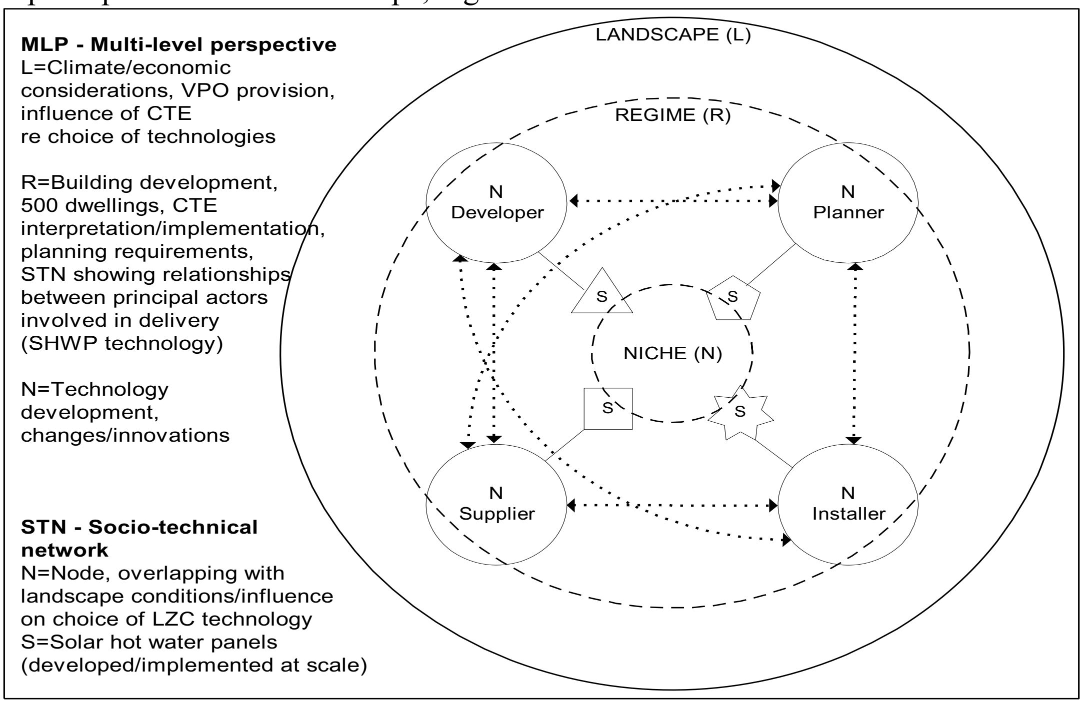

Fig 1.3 Socio-technical network (adapted from Elzen, et al. 1996 p 118) related to the landscape, regime and niche of the MLP (Geels, 2002)

The technology, in this case solar hot water panels, can move from one actor (such as the manufacturer/supplier) to others (such as the installer(s) and/or the developer) and in this sense is an intermediary. As with the social construction of technology approach (Pinch and Bijker, 1984), the socio-technical analysis recognises the interpretive flexibility of the artefact, and therefore the relevant characteristics of the artefact to that specific actor. In Fig 1.3, the actors (developers, planners, suppliers and installers) constitute the nodes of the network and the links represent the two way interaction between them. The actors can be individuals or in the case of this development, organisations.

Whilst rooted within the regime level of the MLP, the nodes also overlap the landscape level as those actors interviewed during the case study cited the influence of climatic conditions in their region as well as the existing economic situation in Spain, which was seen as a significant influence on making the implementation of low carbon measures within such building projects so problematic at the present time. Interview respondents viewed the obligatory nature of the CTE as the main reason for deploying solar hot water panel (SHWP) technology in the current economic conditions in Spain; "…now, in this economic situation, we would not deploy the technology for sure, and the developers would remove them if it wasn't for the fact they are obligatory" (Interviewee code: Installer5 23). Such responses were typical despite the fact that all those interviewed suggested that the SHWP technology was the most suitable to deploy in the domestic setting given the climatic, as well as economic conditions within the Andalucian region of Spain; "Let's see, I think that today, with the problem you have with construction costs… if you had to choose between which is the most efficient, or sustainable, between photovoltaics, solar hot water, solar thermal, or any others, then the choice we've made is correct…in SpLocation1…that is solar hot water" (Interviewee code: Developer architect1 12). Within the socio-technical analysis, such environmental influences are an important part of the framework analysis. The landscape influences in this case are generally seen as providing a meteorological impetus, as well as a very difficult economic challenge for the actors charged with deploying the technology.

The interactions or intermediaries (Callon, 1992) that pass between the actors can be made up of contract documents, money, construction diagrams, etc., and can include the actual technology being deployed. The differing shapes of the SHWP symbols in Fig 1.3 represent the meanings, and attempt to show the interpretive flexibility of that artefact for each specific actor. For instance, the manufacturer/supplier recombines many of the raw materials, machines, manufacturing processes and individual components, to produce the panels to forward on to the installer. In turn, the installer recombines these artefacts with other installed components in order to successfully integrate them into this specific development.

During the interviews it became apparent that the interpretation of the SHWP technology, particularly in terms of any perceived design/performance gap or the functioning of the panels, differed considerably depending on which actor was interviewed. The manufacturer/supplier viewed the technology most positively and suggested any blame for performance under achievement did not rest with the manufacturer; "Now, going back to the question of whose fault it is if the system does not work well. I'd like to tell you something. We have to every year receive an inspection, an audit, we have to renew our certificate and they are done in a certified laboratory. So we do go through a check-up process and we do test 100% of our production. However ask an installer how often does he get an inspection from the public sector to check that his job is well done" (Interviewee code: Supplier7 14). However, in answer to how effective the technology was from various suppliers, the installer suggested the technology worked well, but within the social housing sector; "they are installing the basic, the most basic, the bare minimum requirement so that the panels function correctly" (Interviewee code: Installer5 4). Such comments from these actors demonstrate the differences in their perceptions of the deployed technology within the socio-technical network and generally reflected poor communication between them. When it was suggested the manufacturer might provide some additional technical support to improve the technological systems being installed, it was stated this was not part of their remit and therefore was not considered part of their responsibility.

The developer liaises with both of these actors as well as the local planning department, utility companies, and the many other suppliers and tradesmen involved in the construction of these dwellings. For the developer in this case, the technology was seen as appropriate in providing building code compliance, allowing integration with existing provision, as well as future maintenance considerations (though there were some maintenance reservations given the newness of the technology). Consistent with the comments from these interviews, the technology employed on this development was generally considered the most appropriate given the climatic conditions, as well as the cost constraints imposed on social housing. Although there were misgivings regarding the introduction of new technology at such a difficult time, the legislation (CTE) was considered appropriate to ensure the region's natural solar resource was exploited within the domestic new build sector.

DISCUSSION AND CONCLUSION

This research set out to provide an improved understanding of the way low carbon targets are being met within the Spanish context and how the use of low and zero carbon technologies are being deployed in the delivery of social new build housing in Spain. Concentrating on one housing development, the collated data reveals how some of the principal actors involved in this delivery, view and interpret the technology and how it is perceived in their relationships with one another and within the wider economic and regional climatic context. The research forms part of a larger comparative study which looks to compare carbon compliance measures from two EU countries.

Given Spain's status regarding its progress in implementing its EPBD commitments (EPDB-CA, 2011) and given the recent moratorium called by the Spanish government on renewable energy subsidies (BOE, 2012), this research provides timely data on the implementation of the mandatory requirements of the CTE. Within this case study, the way the actors process and recombine the intermediaries shows that the relevant characteristics of an artefact may differ from one actor to another as in the case of the manufacturer and installer. This localisation of an actor-specific version of the artefact suggests that while there may be overlap in which characteristics are considered important by different actors, the actual SHWP technology being installed is reflected and interpreted in the variety of intermediaries sent out by the various actors within the network. However, the socio-technical network also revealed stable patterns of interaction between the actors. This is evidenced by the continued engagement of the installer or manufacturer by the developer, or by the planning authority engaging the developer from previous (presumably satisfactory) jobs. These stabilised patterns of interaction suggest actors behave in this network in ways which perpetuate their existing patterns of interaction and interviewee comments reflected the emergence of network resilience. The 'out-of network' interactions are also important in considering the interactions between the network and the environment, and for acknowledging the possibilities of technological change (Elzen *et al.* 1996).

The SHWP technology was considered the most appropriate renewable technology given the local climatic conditions, and the CTE was considered an essential legislative measure to ensure solar hot water take up and delivery within the new build social housing sector. It was also recognised that the regulatory context is the subject of on-going development and is subject to change and evolve over time. Additional discussions highlighted concerns relating to future legislative revisions and how these could relate more closely to planning permission consent, particularly relating to the 'capped' rate for social housing, and for instance, in revisions which might mitigate the perceived northern European influence on ventilation provision.

At the time of conducting the interviews within this development, the solar hot water panels were not yet installed during the site visit. Whilst this meant it was impossible to get any in-situ photographs, by visiting an adjacent (and completed) apartment block by the same construction company, it was possible to record some photographic detail of a similar system, even though the chosen system for the new block differed in its back up energy design. The back-up energy system was discussed during the interviews and was considered important both for its system design and the subsequent and future performance of SHWP technology. Future contributions from socio-technical network analysis might include an examination of different back-up systems incorporating the views of the suppliers and installers in order to provide a comparison to investigate how such support systems influence either the choice of renewable technology, or the way such technology is viewed and incorporated into the development. Further research might also explore the policy reforms in greater detail and the way the CTE has shaped and is shaping technological development in this sector. This could be extended to examine alternative technology options for future provision.

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