ENERGY

Peer effect and social learning in micro-generation adoption and urban smarter grids development?

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The adoption speed and scale of a low-carbon technology (PV) is investigated and the importance of peer effect and social learning for future UK urban energy network de-carbonisation is questioned.

Cities are vital to achieving the EU's objectives of 20% energy savings and Greenhouse Gas (GhG) emissions reductions by 2020 (European Energy Package 3x20%) and numerous initiatives are under way. In addition to a renewed global climate regime, bottom up solutions are needed and cities are now viewed as drivers for renewable energy transition (IEA, 2009) and even green growth (for instance the OECD's 2011 Cities and Green growth initiative). The latest CCC report (CCC, 2012) identifies areas where Local Authorities can make the biggest contribution to carbon reduction and preparing for climate change. However, there is little systematic evidence and few guidelines on how to escape carbon lock in (Unruh, 2002; Rydin et al., 2010) and promote resilience.

The CLUES (Challenging Lock-in through Urban Energy Systems) project looks at the range of urban and relatively small scale energy initiatives occurring in the UK and investigates their potential to help achieving national decarbonisation targets by 2050, as well as their impact on the shape of future cities and overall sustainability goals. The CLUES project delivered a typology of different urban energy initiatives together with an analysis of the patterns of these initiatives. Adopting a co-evolutionary framework enables investigators to tackle the combination of technological, governance, economic and cultural factors at city level that characterise 'lock-in' and impact on the development of urban energy systems.

We contribute to this special issue as we are interested in energy efficiency (including retrofitting and new low carbon buildings) and patterns of adoption of micro-generation for electricity. We also want to investigate the role of social learning (Snape et al., 2011) on future Smart Grids or smart cities in urban areas where major consumption occurs. We acknowledge the potentially very important impact of district heating, in particular in the UK, but in this paper focus on a shorter timescale than that may be required for such infrastructure investment.

Focus on domestic users and the role of early adopters and disrupters amongst the cohorts

Domestic actors have a potential significant role to facilitate energy transition (Nye et al., 2010), via change of their energy-using routines. As Nye et al. note, adoption of low-carbon technologies such as smart devices or micro-generation can help to disrupt domestic actors' energy using routines and facilitate active participation in the energy system.

In this short article, we focus on the domestic users of the electricity network as potential adopters of renewable micro-generation. It is of particular interest as such adoption may disrupt the business as usual use of the electricity network, and especially may contribute to visions of the electricity network as a Smart Grid. The vision of the electricity network as a Smart Grid often forms part of a conception of Smart Cities, therefore also looking at the production of heat and cooling and transport fuels and mobility patterns. Within such visions, the adoption of disruptive, innovative technology and sufficiency lifestyles by domestic consumers is regularly presented as a necessary condition for the Smart Grid to deliver the benefits promised to urban energy systems.

Such adoption might change the ownership model for electricity generation infrastructure, enabling the emergence of energy cooperatives and also new institutions to collectively identify negawatts and reduce end- use energy demand (Rynikiewicz 2010). It will potentially lead to altered ownership and business models at larger scale (Rynikiewicz, 2010; Watson & Devine-Wright, 2011). In turn, such changed relations between consumer and producer, with the erstwhile consumer becoming both a producer and consumer (prosumer) may well lead to the emergence of new consumption practices and new economic relations between customers and energy companies (at either national, municipal or neighbourhood scale).

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In future Smart Grids, prosumers and consumers will reply differently to price signals. In the UK including London, Smart Grid pilot projects received funding from the Low Carbon Network Fund and will provide interesting outputs for research and in particular further evidence on diffusion of micro-generation technologies and the role of social learning.

Evidence of micro-generation technology diffusion in the UK

It is, for the moment, too early to draw definitive conclusions on the effect of the different new instruments to drive the energy transition in the UK. DECC adopted the feed-in-tariff (FIT) to encourage micro-generation and help meet the government's twin targets of 15% electricity generation from renewables and a 34% reduction (below 1990 levels, according to CCC proposed third (2018-2022) carbon budgets) in greenhouse gas emissions, both by 2020. Other instruments are the RHI (renewable Heat Incentive), recent Local Energy Assessment Funds and other opportunities under the Green Deal which still remain unclear. What is clear is that the carbon policies directly focused on the development of low carbon technologies will impact the electricity market regime and Finon (2012) even argues that public co-ordination with long term arrangements needs to be introduced as a substitute to long term co-ordination by the market.

By analysing UK FIT data we illustrate how policy, social effects and changing technology attributes can influence consumer adoption of local renewable technologies, mostly PV but also micro-CHP which might play a bigger role in the future. The UK experience demonstrates how a policy based on economic incentives combined with media coverage and social learning can encourage widespread adoption of photovoltaic (PV) domestic electricity generation.

Initial analysis of the data, as presented in Fig 1, indicates that adoption has rapidly gained momentum in response to a generous financial incentive. This has indeed been the case until March 2012. The speed of photovoltaic diffusion has prompted the UK Government to review the tariff with a view to reducing the incentivisation of photovoltaic installation in particular (citing falling photovoltaic capital costs).

A more detailed analysis of diffusion patterns reveals more complex effects, the lessons of which will be important for de-carbonisation of electricity generation and supply nationally – and urban energy systems as an important constituent thereof.

The time series presented in Fig 2 reflects the rapid increase in photovoltaic installations revealed in Fig 1. However, it also shows some more localised effects. For instance, the areas with highest uptake both before the FIT and especially at the end of 2010 remain "hotspots" by the end of 2011. In particular, some of these hotspots are centred around urban conurbations, notably Bristol (4444 installations, population 860,000) and Sheffield (5726 installations, population 1,283,000 population). We can also discern "cold spots" around some of the major UK conurbations – in particular London and Birmingham. This is a potentially large problem when one considers that more than 15% of the UK population live in these two cities alone.

This visualisation highlights the fact that rapid adoption both commences and continues in certain distinct areas and questions the reasons for that. It is likely that such reasons are complex and inter-related, for instance property ownership (e.g. fewer owner occupied dwellings), physical conditions (e.g. more shading from neighbouring buildings), socio-economic demography and municipal government policy will combine with the financial incentives that are present nationwide. However, the localised nature of adoption is evident and raises the question of how empowerment and social learning influences the adoption decisions of individuals.

There is a growing body of literature and case studies

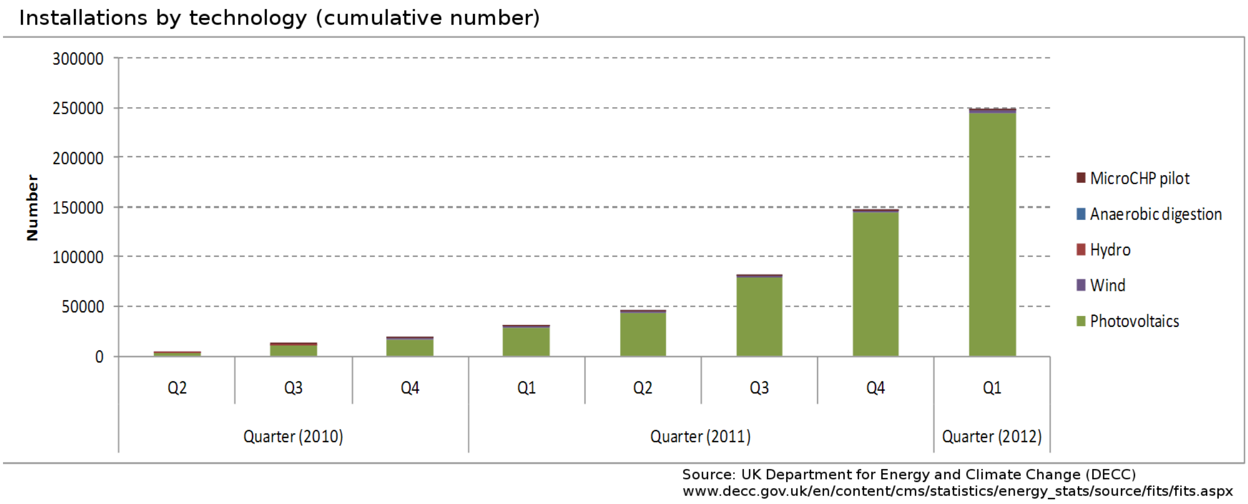

Figure 1 | Distributed renewable adoption

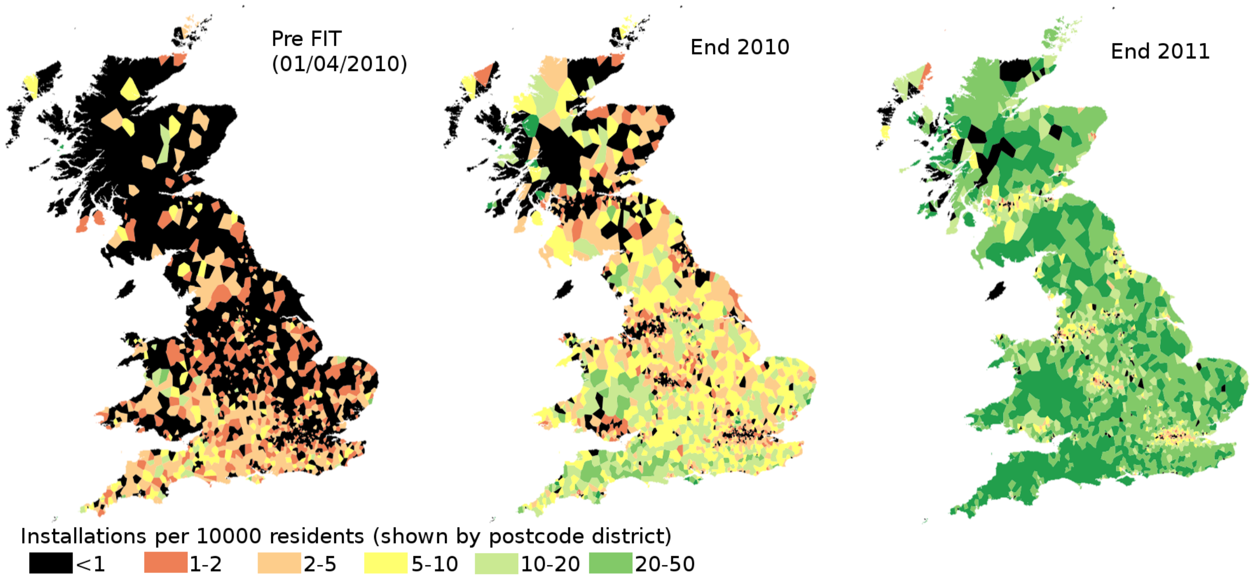

Figure 2 | Cumulative number of photovoltaic installations per postcode area in UK. Own visualisation of data from (REF, 2012)

highlighting the importance of intermediaries and 'learning' across different local projects. In the case of photovoltaic adoption in the UK, it is clear that a policy of on-going, guaranteed financial incentives have precipitated a rapid adoption of the technology. However, it is also notable that previous schemes incentivising installation by subsidising capital costs did not result in similar adoption rates, despite reducing payback period. It seems that other forces are in play in addition to the pure financial incentivisation. Several factors have contributed to rapid adoption, including a proliferation of technology adoption contractors, media highlighting benefits / incentives increases awareness, reputational kudos of "being seen to be green" (photovoltaic installations are easily visible and it is therefore easy to observe whether your neighbour has such an installation), widespread media coverage, both documentary and advertising which combine into a growing normalisation of photovoltaic installation. In a recent study, Bollinger and Gillingham (2010) studied peer effects in the diffusion of solar photovoltaic panels, drawing on a ten year database and back the motto that "In residential communities, solar is contagious".

Moreover, what is really of interest in terms of meeting carbon budgets is whether the neighbourhood effect (if understood and analysed correctly) will enable action beyond adoption of a single technology involving a suite of GhG emission reduction measures (insulation or building retrofitting, new appliances, and low carbon lifestyles measures) and maybe group learning, leading to what is called the "Energy Descent Action Plan" in the Transition Towns movement or "Plan Climat Energie Territorial" (mandatory territorial action plans) in France. Another key question is whether the notion of domestic actor as prosumer will "catch-on" or become the norm.

For the moment, we might suggest that the current arrangements in the UK, combined with local social learning, has led to a scenario where adoption is weakest in urban areas, where density and therefore energy consumption is highest. In this scenario, any effect on urban de-carbonisation would appear to be via importing low-Carbon electricity from the national network, rather than direct local de-carbonisation.

Although the role of social learning in energy de-carbonisation remains a largely under-explored landscape, there is evidence that the role of consumer behaviour and behaviour of first movers is increasingly of interest to policy makers (through, for example, the past EU CONCERTO program and the new Smart city funding). Academics have also stressed and studied the importance of social learning in particular in community energy innovation or grassroots innovation.

Social learning across scales and networks

Social learning may be defined most simply as learning based upon the vicarious observation of others' decisions and outcomes as well as your own. In understanding the diffusion of de-carbonising technologies, social learning can be a useful lens through which to view adoption, most obviously at the level of the individual, but also at the level of the firm, co-operative or community. We argue, along with others (Watson & Devine-Wright, 2011), that the scale of both the network decentralisation and the behaviour change observed are key factors in escaping urban Carbon lock-in. It is interesting to note, for instance, that the FIT has mainly encouraged very small-scale, highly decentralised, installations. While the sight of photovoltaic cells on individual rooftops has become normal, community owned photovoltaic installations remain the exception rather than the norm. Although it is too early to definitively analyse the true level of individual engagement with decentralised micro-generation, it would appear that the social learning thus far has encouraged UK consumers toward Watson and Devine-Wright's "decentralised engagement" scenario where end users actively participate in installation and use of decentralised micro-generation, rather than one of "decentralised disengagement" where such installations are installed and operated by, for instance, community energy service companies.

Snape et al. (2011) provided a review of current work studying the co-evolution of Smart Grids from the perspective of how system actors learn and change. In a previous paper (Rynikiewicz & Snape, 2012), we described the potential of Agent Based Modelling (ABM) to investigate and gain insight into Smart Grid initiatives, stressing in particular the importance of social learning. The CASCADE project continues to develop an ABM to model and investigate these effects.

Urban energy network de-carbonisation initiatives (for instance Smart Grid visions) may radically change the energy industry, challenging the traditional roles of actors within the system and business models of market participants. Given that these visions often count upon change in energy consumption practice at the scale of the individual and community, it is important that we recognise, investigate and learn from prior experiences and experiments. In particular, it is important to acknowledge the effects of social learning and normalisation and where they may combine with technology to either form a barrier to widespread adoption, or synergistically overcome such barriers. ★

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