
Photovoltaics on Existing Buildings in Barcelona and Paris: Emerging Forms of Socio-Technical Organisation in Urban Energy Provision

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Abstract

The proposition that existing systems of provision, such as energy and housing, need to undergo fundamental transformations is becoming increasingly accepted in the contemporary context of the ecological and political imperative to mitigate greenhouse emissions and adapt human settlements to the challenges posed by climate change. Through a comparative analysis of the delivery of photovoltaics on existing buildings in Barcelona and Paris, the argument is made that there are strong indications that the delivery of new energy technologies, in particular decentralised variations, will require the parallel creation of new ways of organizing actors around these novel technologies. In this way, lessons from Barcelona and Paris, despite constituting specific, locally idiosyncratic institutional set ups, are likely to be transposable to other urban contexts, and beyond.

Introduction

The imperative to mitigate carbon emissions and adapt human settlements to the challenges thought to be posed by a changing climate has found its way onto policy agendas across traditional scales of governance, ranging from multi-lateral negotiations of emission reduction agreements to the localised delivery of carbon reduction and adaptation efforts in cities, villages and communities. The focus of this article is the role of a particular technology, solar photovoltaics, in process of reconfiguring the vast bulk of cities – the existing built environment – according to more energetically sustainable principles. The following section provides a review of scholarly approaches for capturing the challenges

involved in contemporary processes of reconfiguring systems of provision in the context of the shifting governance arrangements brought on by socio-economic evolutions in infrastructure provision and new ecological imperatives. Contributions from innovation and urban climate governance studies suggest that an important strategy by which sustainability-related changes are currently being enacted is through the phenomenon of ‘socio-technical experimentation’, the orchestration of bounded sites for the trialling of new social and technological alternatives geared towards reconfiguring the perceived unsustainability of urban systems of provision. Subsequently, empirical findings from field research conducted in Barcelona and Paris are used to explore how more permanent, self-sustaining arrangements in the delivery of photovoltaics on existing buildings are emerging from temporally and spatially bounded spaces of experimentation.

Loci of innovation in the shifting governance of urban service provision

The new ecological and political imperatives articulated in climate protection policies are accompanied by what Moss (2009) has diagnosed as shifting governance arrangements in sociotechnical networks. This shifting context, according to Moss, is marked by trends such as the *liberalisation* in gas and electricity markets, the *privatisation* of utility companies delivering infrastructural services, the *economic concentration* marked by vertical integration through company mergers, the shift in *regulatory* capacities from local and national authorities to supra-national authorities (such as the European Union), and *technological diversification* made possible by innovation in new energy and other technologies. Developments, such as ‘organisational fragmentation and actor diversification’ and ‘the wider application of small-scale technologies, especially for electricity generation’ (Moss 2009, 7) open up questions about the ways in which service provision will be reconfigured in particular places and whether – and how – new models of delivery will induce favourable changes. For instance, past research explored the social justice implications of moving away

from an integrated model of utility provision, assessing the socio-spatial polarisation of inequalities through phenomena such as ‘infrastructural bypass’ and ‘social dumping’, the disconnection of less affluent customer bases, and the ‘cherry-picking’ of socio-geographically lucrative centres of activity, such as large cities and financial centres (Graham & Marvin 2001). Inquiring into the logistics of new governance arrangements, Medd and Marvin (2008) note the emergence of new forms of governance in water provision in the North West of England, characterised by the growing salience of ‘a different class of actor – intermediaries – who actively position themselves between different social interests and spatialities’ (Medd & Marvin 2008, 289). The importance of these ‘strategic intermediaries’ is thought to derive from the ‘fluid’ work they perform in integrating the diverse territorial, institutional and ecological spheres of activity related to water management by translating new priorities and organisational realities into practice through working across and beyond formal institutional structures.

More recent approaches have been explicitly concerned with exploring the emerging socio-techno-economic constellations in infrastructural systems with respect to the potential for reconfiguring models of service provision along more sustainable principles. At the scale of the city, a growing body of inter-disciplinary research is yielding valuable insights into how these shifting governance contexts are leading to the emergence of new hybrid constellations of social, technological, institutional and economic character. Contributions during the 1990s and early 2000s of a first wave of ‘sustainable cities’ literature generated valuable insights about the urban governance of sustainability through documenting, often through case studies, the challenges facing municipal authorities in bringing about sustainability-orientated transformation in the sectors of energy, housing, transport and waste (Bulkeley & Kern 2006; Betsill & Bulkeley 2007; Rutland & Aylett 2008). As a result of subsequent academic cross-fertilisation, the difficulty of enacting sustainability-related interventions in the city has been theorised as the consequence of a systemic ‘techno-institutional lock-in’ (Unruh 2000), urban ‘obduracy’ (Hommels 2005), and ‘urban infrastructure regimes’ (Monstadt 2009), characterised by features such as the sunk materiality of infrastructural

systems and established actor and interest constellations around the 'normal' ways in which urban development is conducted in the city (Monstadt 2009). These path-dependent trajectories are the result of the existence of a prior logic 'which is no longer applicable (...) but which may prove to be annoying obstacles for those who aspire to bring about urban innovation' (Hommels 2005, 324). In this context, the urgency of ecological imperatives and the changing configurations in infrastructure delivery is opening up fruitful avenues for the emergence of low-carbon and more sustainable energy futures.

In current thinking on socio-technical 'transitions' in innovations studies, such a far-reaching systemic change is thought to be realised as a result of alignments of parallel and linked-up processes in socio-technical systems. The dynamics of socio-technical innovations are captured conceptually through a framework inspired by evolutionary economic thinking which situates novelty as occurring within the constraints of a selection environment, conditioning processes of 'variation', i.e. the creation of new products and services, and 'retention', the mechanisms by which an innovation endures. Extending earlier arguments about the path-dependent character of 'technological paradigms' (shared problem solving routines) and 'technological regimes' (beliefs and expectations) among scientific and engineering communities of practice (Dosi 1982; Nelson & Winter 1982), more recent innovation scholars, inspired by the Giddensian structuration approach, have developed the notion of 'socio-technical regimes' to capture the rule-based coordination thought to be operating within as well as between different social groups more broadly. Rule systems are 'structures, which are recursively reproduced' (Geels & Schot 2007, 415), and as such they 'structure and regulate social transactions', through common problem definitions, norms, collective histories, but also through 'social sanctions and networks of control' (Geels 2004, 904). Innovative activities are thus framed by the socio-institutional and techno-economic path-dependency which is the result of coordination within and across social groups.

In this account, the 'seeds' of radical transformations are seen to reside in 'niches' (e.g. Smith et al. 2005). In the transition literature niches are commonly regarded as 'protected spaces' in which innovations are sheltered

from the selection pressures of the regime (Verbong et al. 2008). Niches may be found in ‘distinct application domains where users have different preferences than mainstream users’ (Raven 2007, 2391) – ‘*market niches*’ – or in cases where a technology ‘is not being picked up by industry or other actors’ (Verheul & Vergragt 1995, 321), for example because of ‘teething’ problems of higher costs and its early stage of development (Hoogma et al. 2002). Such *technological niches* have often been the focus of Strategic Niche Management, a particular strand of transition studies, which emphasises the role of (national) policy actors in actively fostering technological niches, such as in renewable energy technologies, by providing temporally limited amounts of protection and subsidies in the form of public funding and by applying special tax measures. The aim of these types of niches is to provide a bridge over the “valley of death” between R&D and market introduction’ (Verbong et al. 2008, 557). In contrast to this focus on sites of innovation at the market-policy nexus, other scholars have focused on *social niches*, which are bottom-up ‘grass-roots innovations’, thus emphasising the intimate relationship between innovations in social constellations that emerge through the use of novel technologies or alternative forms of service provision (Seyfang & Smith, 584). Such sites are therefore not necessarily the result of strategic orchestrations originating in the policy domain, but come into being more organically, and emphasise not only the creation of financially viable products, but rather alternative forms of social organisation around ‘different values, beliefs about the environment, and desirable sustainability outcomes’ (Seyfang & Smith 2007, 589), such as co-housing models, local and organic food sourcing, low-impact eco-housing, and renewable energy co-operatives.

In urban climate governance studies, rather than focusing on either the top-down or bottom-up character of innovations in particular places, an emerging strand of scholarship is concerned with the orchestration of ‘socio-technical experiments’; that is, the trialling of new technologies and modes of service delivery (e.g. Bulkeley et al. 2010) characterised by the participation of heterogeneous actors from across different sectors of the urban economy (and beyond) in bounded experimental configurations. Initial insights about socio-institutional innovations taking place in cities

in response to climate change are extended into a 'socio-technical' perspective, shifting the focus of analysis from the purely institutional aspects of initiatives such as planning regulation on energy efficiency and traffic management, onto the material dimension of the city. In this way urban experiments are understood as reconfiguring the socio-technical networks of the city, in the context of their 'stability, or obduracy (...) the political economies of urban restructuring and the constant flux of "metabolic circulation" in the city' (Bulkeley et al. 2010, unknown). Bringing together some aspects of both technological and social niches, urban experiments are frequently public-private partnerships, often also involving third sector organisations, and mostly include a significant technological component. Experiments such as city-scale energy services companies (ESCos), urban low-carbon zones and transition towns are heterogeneous and open-ended cases of new socio-technical constellations which are at times promoted top-down, or may arise bottom-up, or in partnerships across the sectors, drawing in actors with differing motivations, such as financial gain, the need to meet specific policy targets (e.g. emissions) and eco-environmental belief.

Evidently, the nuances between technological and social niches, and urban experiments are substantive rather than semantic. While sharing a general understanding of particular sites as the 'seedbeds' (Seyfang & Smith 2007) for wider, large scale changes, in their different conceptions of these, there are important nuances with respect to how niches and experiments are thought to bring about more fundamental changes in society at large. In Strategic Niche Management, processes of 'niche accumulation' (Raven 2007), the cumulative presence of several technological niches (such as different renewable energy technologies) is seen as potentially extending into a 'regime' of their own, displacing dominant socio-technical regimes (e.g. a centralised fossil-fuel 'regime' in the context of climate change and 'peak oil' price rises (Geels et al. 2008)). With respect to social niches, Smith (2007) noted that, often lacking immediate monetary value, social niches may be slow to 'translate' into the mainstream. However, intermediate, 'stepping-stone' projects may 'inculcate in the mainstream some of the principles and framings held in the green niche', eventually extending their benefits to a wider coverage

through processes of ‘replication’ and ‘up-scaling’ in other places (Smith 2007, 439). Urban experiments are seen as potentially reframing systems of provision within the city through showing the feasibility and desirability of specific social and technical features, as well as through knowledge sharing and inter-city competition for leadership in matters of sustainability (e.g. Hodson & Marvin 2009).

On the whole, hybrid forms of experimentation, which contain both broadly speaking ‘technological’ and ‘social’ elements and often involve the leveraging of financial (and other) support from the private and third sectors in order to overcome place-specific obduracies, have emerged as important loci for innovation. The importance of such *socio-technical* types of experimentations derives from constituting spatially and temporally bounded sites of intervention, acting as nexuses for the articulation, trialling and consolidation of new social engagements with existing or novel technologies around particular values, consumption practices and lifestyles. Interpretations of the particular ways in which these are thought to ‘accumulate’, ‘translate’, ‘replicate’, ‘up-scale’ etc. differ between approaches. However, there appears to be some agreement as to the importance of these bounded sites as gateways for change, through bringing on board new and heterogeneous actors in new constellations, new technological solutions and novel ways of organizing sustainable service provision; models which are likely to be at the same time of social, technological and economic character.

Photovoltaics on existing buildings in Barcelona and Paris

In new buildings you can enforce it, while in old buildings you cannot (...) the real public policy challenge is to think about existing buildings. It's difficult!

(Activist-Intellectual, Barcelona, March 2009)

This section draws together research findings from field research periods conducted in Barcelona and Paris between March and June 2009. Interviews about the opportunities and challenges facing urban-scale photo-

voltaic applications were conducted with municipal planning services, energy agencies, activists, experts, and other public and private organisations and consultants active in the delivery of photovoltaics in the city. The focus of the analysis centres on the challenges of retrofitting existing buildings with photovoltaics, with a particular focus on buildings that are owned by more than one party (*shared ownership buildings*), as these constitute perhaps the most challenging context for the delivery of the technology. The first part of the sections situates the delivery of photovoltaics in Barcelona and Paris as the result of the alien character of photovoltaics as a decentralised electricity generating technology, as opposed to a result purely of financial or technical considerations. The second part explores a particular instance of socio-technical experimentation, where the 'fluid' work carried out by intermediary parties is leading to the creation of a shared space where different actors' interests are made to converge in the installation of PV. Finally, the third section tentatively suggests that two types of projects, participatory projects and the formal establishment of an energy services company for the management of photovoltaic panels, constitute evidence of the emergence of more stable and permanent modes of delivery.

A shared ownership project: '... a very messy problem'

The challenge of transforming existing buildings along more energetically sustainable principles is that, unlike new constructions and renovations, it is currently not customary to impose mandatory energy performance requirements on the already existing building stock (in particular not 'expensive' technologies such as photovoltaics). Upgrading existing buildings is particularly difficult in cases where the building is owned by multiple parties, as diverse interests must be reconciled in the delivery of new technologies, however this is recognised as a particularly worthwhile enterprise as it is precisely these type of buildings that constitute the majority of dwellings in Barcelona and in Paris, where they account for roughly over half of the city's 100,000 buildings. While logistically challenging, experimental efforts to deliver PV in existing buildings are taking place in Barcelona and Paris. It emerged that in both urban con-

texts the barriers to installing PV in existing buildings were neither of a purely technical or purely economic character. Instead, the principal challenge of the existing building stock, and in particular shared ownership buildings, relates to finding a way of making diverse parties agree unanimously on the utilisation of the roof for energy generation purposes and the financial investment to be made for this. On the one hand, this results in decision-making being a lengthy drawn out process, as institutional structures for making collective decisions are not geared towards speedy resolutions, as the case of Paris's shared ownership decision-making illustrates, where the building owners only meet once a year. As noted by a Paris-based energy advisor in a local energy agency:

So in the first year, they will establish that there is a problem, and ask, 'what do we do about it?' So, 'listen, we need a study. Ok fine, what kind of study? We'll see next year'. Ok, next year, say they've chosen the type of study, they vote on it. But, what kind of organisation should do it? Comes the third year, the organisation did this and that. 'So, should we do it, or not? Yea, ok, or no'. So all of a sudden, it's been four years (...) Four entire years to ponder whether to do anything and then after four years the works and all of that still need to be done. It's really very long to implement, and it's particularly pronounced in Paris, which is a very urbanised zone and so there are a lot of *copropriétés*¹ and that makes it a really lengthy enterprise. It's a very messy problem.
(Energy advisor 3' in local energy agency, Paris, May 2009)

While the issue of reaching agreement is particularly pronounced in shared ownership buildings, it also affects a vast proportion of the urban building stock more generally, e.g. in cases of leased buildings, where agreement must be sought from the landlord to install solar panels, even in the case of long-term leases. In both urban contexts, reaching agreement was the most salient issue affecting the delivery of PV in shared ownership buildings.

Fluid intermediation: 'We have to juggle all this'

In the case of Paris, the process of bringing different parties on board for the delivery of PV installations in shared ownership buildings currently hinges upon the intermediary work of one particular person, an energy

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agency advisor who simultaneously sits in the Mayor's citizens' advice bureau. At the time of field research this person was handling four such projects (as well as other duties), with one project nearing completion. Essentially the fluid work of the energy agency advisor was that of drawing out the shared interests of all parties in delivering the PV project, effectively translating the benefits of the PV project into each of their situations:

The *copropriétaires* may be flat owners or landlords, and therefore do not have the same vision of things, so for instance the former want to make the most of their building in terms of energy performance, and then the landlord, who doesn't live there, who, well doesn't really care, to put it bluntly. We've got to make them see that it [the PV project] will lead to lower bills for the residents, that the investment is tax deductible and that landlords also get tax credits [on their income from rental] for it. It's actually a win-win situation, but they have to be made aware of this.

('Energy advisor 1' in local energy agency and municipal citizen advice bureau, Paris, May 2009)

While the exact legal set-up of shared ownership buildings differs slightly across contexts, in general these are buildings where every flat is owned by a different neighbour, who in addition have a small stake in the running costs of communal spaces such as lifts, lighting in staircases and entrance. In Barcelona the benefits of communal PV systems were similarly presented as a benefit for the residents in terms of reduced costs of running the building.

It was proposed to do installations for the collective consumption of the building's community. Collective consumption, that means staircases, lighting in communal areas, lifts and parking. These are electricity costs that are shared by the community. So the PV installation would be there to cover those expenses. You'd have revenue² [from the installation] and you simply discount the expenses. So if you enable building communities to do this you will reduce their expenses, it is an advantage for the community, an incentive.

(Energy advisor in non-profit organisation, Barcelona, March 2009)

However, the shared ownership building project in Barcelona was never actually implemented. In the minds of those that strongly favoured such an initiative, it was a case that there was a lack of political will on behalf of the municipality to put in place the intermediating function, which in

Paris was assumed by the energy advisor in the citizens' advice bureau. Municipal actors felt that the undertaking was too complex, and that there were lower hanging fruit yet to be reaped by municipal efforts, such as the much simpler PV projects in municipal buildings, which are not subject to ownership conflicts and lower risk (but, crucially, also constitute a much smaller proportion of the city's building stock). In Paris in contrast, shared ownership buildings are considered as essential to city-scale climate protection efforts. The intermediation work of the Paris-based energy advisor mostly centred on bringing on board the union council representative, who has a pivotal role in any specific *copropriété*, based on their influence in the *copropriété* set-up:

It's easiest to act when we speak to the representative of the union council, because they already have some form of power within the *copropriété*, so they influence the rest (...) On the other hand, we have to put in a great deal of work when we talk to them. We really have to convince them, because it can go either way. They are people with responsibilities within the *copropriété* and as such they are generally sceptical because they have the mistrust of the other *copropriétaires* behind them (...) But they are also often the drivers. So I talk to them a lot, so they get to know me, so that they feel they can approach someone with a face. You know, there's a very human side to this. So we have to juggle all this.

(‘Energy advisor 1’ in local energy agency and municipal citizen advice bureau, Paris, May 2009)

The ‘juggling’ work carried out by the energy advisor in the citizen advice bureau is thus an essential aspect for enrolling the relevant people in order to install PV on existing shared ownership buildings. In this case, the fluid character of their intermediary work is effectively geared towards de-risking the novelty of the undertaking by promoting trust between parties and in the technology. While this bears the characteristic of the sorts of socio-technical experimentation currently taking place across cities in the context of climate governance, considering the large number of shared ownership buildings in Paris there is a legitimate question surrounding the potential for up-scaling these early experimental efforts, in particular given the seemingly personal nature of the job. Interrogating the emergence of more durable socio-technical constellations, the next section considers ways of up-scaling the delivery of PV in urban settings

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Popular participation and roof rental: A 'hassle' or new forms of socio-technical organisation?

*We don't know how to do it, but we understand elements of it, little pieces,
but there's no miracle solution.*

(Director of a renewable energy partnership, Paris, June 2009)

While shared ownership models proved too challenging to implement in Barcelona (at least for the time being) a joint initiative between the municipal markets association (*Institut de Mercats de Barcelona*) and a local non-profit organisation, *Fundación Tierra*, was successful, to some degree, in providing a potentially more durable model for delivering PV on existing rooftops. The *Ola solar*,³ a 'popular participation' PV project, is set up in such a way that numerous small-scale investors buy into the PV installation, which is located on the roof surface of a local Barcelonan market (owned by the *Institut de Mercats*), while *Fundación Tierra* acts as the legal owner in charge of maintenance and the fiscal responsibilities of power generation. The first such installation on the *Mercado del Carmel*⁴ brings together 140 private investors, each having contributed between 1,000 and 3,000 Euros to the system costs, who receive yearly dividends of roughly 100 Euros from the income generated by the sale of electricity to the utility under the Spanish feed-in tariff. The bottom line of the project was not to create a new business model as such, as stated by the President of *Fundación Tierra* during an interview: 'sure, they are earning some money, but ok, it's not a business' (Jordi Miralles, President of *Fundación Tierra*, March 2009, Barcelona); but rather to make an ethical statement of commitment to climate and sustainability objectives:

The difference between OLA SOLAR and other [profit driven] initiatives is that (...) despite having a relatively lower yield, it is much more accessible. This makes people more likely to participate and follow the 'solar work' in the same way as those who have invested in the stock market. Investing in a project like OLA SOLAR is an ethical activity, which is sustainable and [an expression of] solidarity. It was set up in such a way as to be independent on the conventional banking system, a true mobilisation of the public in favour of renewables and against climate change. An initiative of popular capitalism.

(*Fundación Tierra*, website 2007)

While in theory the model is viable for replication, evidenced by a follow-up urban participatory project located in Madrid, the *Fundación's* President diagnoses the limitations of participatory projects in cases where support from a broader institutional base, such as the public sector – municipal, regional or national governments – is lacking. With respect to replicating the model more widely, he stated:

Ideally, promoted by the *Ayuntamiento*,⁵ managed by an NGO, or another third party (...) we proposed ourselves [for the management role], but they wouldn't let us. It was too complicated, because if you're the *Ayuntamiento*, and you just want to do it, then you do without the hassle of negotiating with an NGO in charge of the management, and having to convince the citizens (...) well, it's just much more hassle. (Jordi Miralles interview)

It was a success but neither the public administration, nor the state considered that this model had a future.

(Jordi Miralles, President of *Fundación Tierra*, Suelo Solar 2010)

Unlike in Barcelona, where the municipality, the regional and national governments did not take leadership in orchestrating initiatives, in Paris there is early evidence that a public sector-led initiative may be leading to the emergence of a self-sustaining business model for delivering PV in the city. Effectively an energy services company (ESCO), SOLARVIP is set up specifically for the management of solar electric technologies throughout the city, starting with a large municipal development, the Z.A.C.⁶ Clichy-Batignolles, which includes 40,000 square meters of PV panels on approximately 30 different buildings. SOLARVIP is a cross-sectoral partnership between the City of Paris (49 %), the utility EDF through its subsidiary SAFIDI (26 %), and the regional savings bank (*Île de France*) and *Crédit Coopératif* (12,5 % each). Municipal backing can be explained as a result of the project's significance in the city-wide climate protection policy. According to the promotional website,

The Mayor's office of Paris is embarking on this adventure based on its aspiration to install 200,000 m² of photovoltaic panels by 2014 (...) SOLARVIP, a simplified joint stock company⁷ (...) dedicated to the generation of energy from renewable

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sources, on new construction and also on the existing building stock (...) SOLARVIP will exploit and maintain for 20 years the solar panels it installs, which is the duration of the electricity buy back with EDF, it will collect the proceeds from the sale of kilowatt hours and pay rent to building owners.

(Amis de l'EcoZac des Batignolles, website 2010)

In this first experimental project, the ESCo will initially lease the roofs of buildings from the party installing the panels (in this case the municipality) at an amount which is calculated in proportion to the rate of financial pay-back of the installation through the national feed-in tariff. Once the investment into the panels is repaid, the lease is transferred to the building owners, who then receive roof rental income, while SOLARVIP continues to collect the proceeds from electricity sold to the utility under the feed-in tariff scheme. As the financial burden of the upfront investment is taken on by the 'project promoter' (in this case the municipality, but potentially others), the risk for the citizen and the third party is minimal. The operator, SOLARVIP, makes a business out of receiving the income generated by the sale of solar electricity, while paying a roof rental price proportionate to the proceeds of the feed-in tariff, initially to the project promoter, and once the initial investment is reimbursed, to the building owners. It is too early to assess the outcomes of SOLARVIP's photovoltaic systems management, as the company was only set up in October 2010, with the Z.A.C. Clichy-Batignolles to be completed only after 2012. However, there is promise in the way the business model underlying SOLARVIP intends to decouple the risks of power generation from building ownership, which could lead to simpler decision-making procedures at the level of shared ownership and leased buildings. Transferring this model to shared ownership housing communities more widely would require the shared ownership housing community (or indeed any roof surface owner), to enter into a contract with a third party to rent the roof space in order to install PV panels, which are fully operated and managed by the third party, for the duration of the contract (which is usually of a certain number of years, such as the length of the guaranteed feed-in tariff). However, the financing of the panels still has to be taken on, either through leveraging capital within the housing community itself, or alternatively through bank loans (which are currently available at zero interest rates in France for installing PV).

Conclusion

To conclude, it was found that the emerging scholarly engagement with real life processes of 'experimentation' is opening up fruitful avenues for inquiry and offering potentially valuable insights into the gradual emergence of low-carbon and more sustainable urban energy futures. In the cases of Barcelona and Paris, PV technology acts as an important nexus around which actors' interests are translated into becoming compatible and around which new socio-technical relationships are emerging and consolidating.

From the cases of shared ownership buildings it emerged that the issue of reaching agreement between multiple parties was in fact symptomatic of a deeper concern characteristic of the implementation of new technologies; related to the novelty of the technology itself, and of the concept of decentralised, rooftop electricity generation with the associated financial risks and responsibilities that come with electricity generation. In the absence of new socio-techno-economic delivery models, implementing PV on existing building relies on improvised forms of fluid intermediation which may prove relatively successful, such as in the case of Paris, or may fail to come into being, such as in Barcelona. Rather than about the technical feasibility or economic viability of the technology as such, that these emerging attempts to find logistical solutions may be seen as precursors to the emergence of new business models is supported by empirical evidence of embryonic forms of socio-technical organisation emerging around urban photovoltaics. The participatory model of *Ola Solar* trialled in Barcelona, for instance, may be more akin to a 'social' niche, what Seyfang and Smith (2007) have called 'grassroots innovation', where citizen engagement with the technology is made possible through a model based on a third party assuming the legal responsibilities of electricity generation based on ethical commitments, rather than a profit-driven agenda. In Paris in contrast, the ESCo model upon which the SOLARVIP project is based, effectively decouples the citizen (building owner) from the act of power generation and, crucially, also from the investment burden and risks associated with new technologies (similarly to the *Ola Solar*). The commonality of shielding participating parties from the risks associated with investing in new technologies and the legal responsibility of generating

power can be seen as a potentially viable way of making urban photovoltaics, and other decentralised urban energy technologies more widely available.

Through an engagement with the delivery of photovoltaics in Barcelona and Paris, the proposition can be made that there are strong indications that the delivery of new energy technologies, in particular decentralised variations, will require the parallel creation of new ways of organising actors around these novel technologies. Crucially, insights obtained from comparing the experiences of Barcelona and Paris resonate with conceptual arguments about the significance of orchestrated socio-technical experiments by municipal and other public sector actors. Importantly, the absence of public support in shared ownership projects in Barcelona suggests that there is an important role for the public sector to assume, at least initially, a de-risking function in new set-ups, as in the case of the SOLARVIP in Paris. As such, lessons from Barcelona and Paris, despite constituting specific, locally idiosyncratic institutional set-ups, are likely to be transposable to other urban contexts, and beyond.

Notes

- ¹ shared ownership buildings of private (non-municipal and non-commercial) ownership
- ² under the national Spanish feed-in tariff, *Real Decreto*
- ³ literally: solar wave
- ⁴ The investment for the system was 301,000 € for 43.7 kW_p of installed capacity, generating an estimated 51,000 kWh every year.
- ⁵ Ayuntamiento de Barcelona, the municipal authority
- ⁶ *zone d'aménagement concerté* (a comprehensive regeneration or development zone)
- ⁷ *Société par action simplifiée au capital*

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