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The financial entanglements of local energy projects

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ABSTRACT

There is currently an expansion of local energy initiatives, underpinned by the desire to reduce energy-related carbon emissions and in recognition of the importance of the local arena to achieving such change. Much of the research on these initiatives has been framed by a conventional economic approach, identifying barriers, drivers and incentives to explain their emergence (or not). Here a new economic sociological approach is taken which sees markets as socio-materially constructed and points to the importance of tracing exchange flows and determining modalities of valuation for such exchanges. Artefacts or market devices are seen to play a particular role in connecting actors and technologies within coordinating institutional arrangements and offer the potential for making innovative projects conventional. These aspects are explored in four international case-studies from Wales, Sweden, Germany and USA, mapping relations, identifying exchange flows, pinpointing how artefacts coordinate and showing the multiple modalities of valuation involved in each case. Conclusions concerning the importance of negotiation against a market backdrop and rendering exchange flows more certain are drawn.

Introduction

> The government should provide more financial support to businesses, local authorities and schools to help them install renewable energy such as solar arrays and wind turbines, a parliamentary committee said on Tuesday (Reuters, August 6, 2013).[1]

In approaching the challenge of sustainable energy management where the built environment is concerned, a consensus has been building around the need for a hybrid system that involves at least some degree of decentralised energy (GOS, 2008). In response we are seeing a proliferation of diverse local energy projects that are seeking to embed themselves within the energy economy, creating multiple pathways in a period of some considerable dynamism (Rydin et al., 2013). These new initiatives need to jump a number of hurdles if they are to succeed individually and further be replicated so as to establish new options for the energy system. Clearly each project needs to work in technological terms and be socially accepted in terms of both being considered legitimate and supporting social practices that operationalise the technology in desired directions. But the projects also need to be viable. This can all too readily be seen as simply a matter of income exceeding expenditure but Callon has alerted us to the bigger programme involved here, one of economiziation, of rendering the projects 'economic' in terms of being part of an economy and hence of a society dependent on economic processes. This paper looks at a selection of local energy initiatives from this perspective, asking: what are the dynamics by which these projects are rendered economic? The answer to this question holds the key to turning an innovative project into a conventional one and making it part of established modes of energy production, distribution and consumption.

The first part of the paper outlines the relevant work of Callon and his collaborators in establishing a research programme for understanding economization. After a brief methodology section, the remainder of the paper analyses four local energy projects from this theoretical perspective. A conclusion draws together the main insights and implications of this research.

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[1] http://uk.reuters.com/article/2013/08/05/uk-britain-renewables-idUKBRE97412C20130805.

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Economization and local energy projects

As our opening quote suggests, there is widespread recognition of the role of finance in new decentralised energy projects. Rydin et al. (op. cit.) identified the number of potential pathways of urban energy change that involve a reliance on grants and subsidies while Sherriff (2013) has reported on a Delphi study suggesting the prominence of economic concerns and the identification of access to funding as a key barrier to innovation, alongside economic short-termism and doubts about energy prices rising sufficiently to incentivise investment. There is a wide range of references where finance generally is presented as either a barrier to or driver for the success of individual energy projects and energy innovation more broadly (for example, Dyer et al., 2008; Kann, 2009; Mezher et al., 2012; Peterman et al., 2012; Rohdin et al., 2007; Rösch and Kaltschmitt, 1999; Walker, 2008).

Interesting as these conclusions are, they derive from a narrow conceptualisation of how finance operates in relation to local energy projects, one that is based (sometimes implicitly) in the neo-classical framework of financial incentives driving supply and demand and hence change. There are two limitations to this. First, it ignores the active role of neo-classical economic thinking in actively constructing the economy that it claims objectively to study. Callon (1998) argues that neo-classical economics has presented an academic construction of what a market is, which has performatively helped to create markets. Similarly Mackenzie, Muniesa and Siu emphasise that such economics is not "a form of knowledge that depicts an already existing state of affairs but a set of instruments and practices that contribute to the construction of economic settings, actors and institutions" (2007, p. 4). Second, as a result, this approach renders the economy and the economic as a separate sphere; it creates a conceptual divide between social and economic processes. As Pryke and du Gay note: "the economic is always identifiable and locatable, as it were, far from the social or the cultural" (2002, p. 267). So 'finance' is often viewed as playing a distinct, limited and instrumental role as either a project constraint or enabler.

The new economic sociology (also termed the cultural economy approach) seeks to present an alternative perspective, one in which the construction of the 'economic', of 'markets' and the 'economy' is problematised. Inspired by the work of Callon's study of 'The Laws of Markets' (1998), scholars such as Du Gay and Pryke (2002), Thrift (2002) and Miller and Rose (2008) have been developing an relational perspective on the making of 'markets' and the 'doing ' of economics as social and cultural practices. Du Gay and Pryke argue that an understanding of economics as culture highlights how the 'making-up' or 'construction' of economic realities is "undertaken and achieved" (2002, p. 5). But Callon and Calişkan (2009) emphasise that this goes beyond a *social* constructivist perspective. Following the insights of Actor-Network Theory, it involves, the myriad ways or 'practices' through which markets are reshaped by "performing calculations, monetary inter-changes, transactions and relations of all kinds", including recognition of the role of the material in creating and sustaining market processes (Law, 2002, p. 25). For Law, understanding 'economics' or 'markets' becomes an "investigation of the ordering of materially heterogeneous socio-technical economically relevant relations, their enactment and performance" (ibid).

From this perspective, the 'economic' does not therefore stand apart from local energy projects as a vital or missing ingredient, but rather flows through the design, development, implementation, operation and maintenance of such infrastructures, showing up in various forms as subsidies, models, leases, bonds, contracts, investments, risk calculations etc. In doing so it performs a variety of roles; providing investment benchmarks, linking private and public interests, directing expertise, enabling ownership patterns, bridging interests, ensuring stability, extending relationships over space and time, reducing risk, raising value and so on.

Here it can be helpful to follow the lead of Lovell and Smith and distinguish between market arrangements as a whole set within the wider economy – which Lovell and Smith (2010) following Callon use the term *agencement* to describe – and the specific mixes of technology, social and economic dynamics in projects operating within existing markets – which they discuss in terms of assemblages. They see markets as "complex entanglements or networks of humans, materials, institutions, politics and technologies" (p. 458) but note a difference between the inter-related processes at macro and micro scales. This is helpful because at the scale of the particular local project, specific actors, aspects of technology and artefacts can be identified and relationships across actants – material and social – traced in detail (see also Murray Li, 2007; Farias and Bender, 2009; Guy et al., 2011).

However, the distinction should not be over-drawn. A focus on projects should not be at the expense of the consideration of markets; rather these remain always interconnected, as will be seen. The concepts that help bridge the project and market scales can be found in Callon and Calişkan's economization agenda (2009, 2010) and its identification of the importance of tracing flows of exchanges within institutional arrangements and identifying modalities of valuation. For Callon and Calişkan "the establishment of an economy involves institutional arrangements and material assemblages, without which nothing economic could exist or be sustained" (2009, p. 371). Institutions are here seen as "devices for coordination" (2009, p. 379), which make up for the deficiencies of currently bounded calculative capacities and strategic competences (2009, p. 380). Interestingly they are also testimony to "the inventiveness of human beings, capable of reflection and innovation" (2009, p. 379). New institutional arrangements can afford new capacities and competencies the possibility of being enacted. This opens up the prospects for innovation and change to occur as new conventions emerge and are stabilised. This approach has much to offer the study of new models of energy production and distribution, drawing attention to the role of economization in stabilising these new modes of coordination.

The key turns out to be the way that exchanges of goods or services for money and the associated calculative processes of valuation create new institutional arrangements and the potential for new modes of socio-material relationships to become stabilised. For local energy projects involve a variety of exchanges, not just the 'sale' of energy but a sequence of inter-connected exchanges of financial and material elements. What we focus on here is the way that particular institutional arrangements associated with innovative energy projects allow exchanges to occur (principally of energy/electricity/heat with money but also involving landed property of sites, buildings and rooftops). Furthermore we look at the modalities of valuation that are required to enable the exchanges to proceed – to turn monetary capital and material elements into equivalences that can be exchanged. The importance of calculative processes such as valuation is a key theme of Callon and Calişkan's take on the new economic sociology: "the decisive role played by techniques, sciences, standards, calculating instruments, metrology and, more generally, material infrastructure in market formation" (2009, p. 384; see also Guy, 2002; Lapsley et al., 2010). The flows of finance, energy in all its forms and other material elements within local energy projects is only possible through institutionally-sanctioned valuation processes. Circulation, valuation and institutional arrangements all co-constitute each other and are necessary for the local energy initiative to function. What the focus on institutions, valuation and circulation offers is the possibility of understanding how the urban energy project may be stabilised and then capable of replication in other contexts. The important point that Callon and Calişkan make is that "the values of things are not determined by regimes or exchange systems, but they emerge from sequences of transformations, initiated by people, that modify their status" (2009, p. 386). We seek to trace these sequences and flows in the case of four local energy projects.

In the following analysis we focus on the interactions between the heterogeneous elements of these projects and pay particular attention to the 'economic' in terms of financial flows within the projects and to the work of valuation processes often captured in material artefacts or market devices. Specifically, we want to consider how such artefacts exercise agency within network relationships and also how they are co-involved in shaping the relationships of 'human' actors with the 'non-human' actants of the energy system and building technologies. These market devices can be defined as "a simple way of referring to the material and discursive assemblages that intervene in the construction of markets" (Muniesa et al., 2007, p. 2; see also Callon, 1998; Callon et al., 2007) but there is a particular emphasis on the calculative nature of such devices (ibid, p. 4):

> "Market socio-technical agencements are cluttered with a variety of abstractive calculative devices: pricing techniques, accounting methods, monitoring instruments, trading protocols and benchmarking procedures are abstractors then enter into the construction of economic agencement."

As we shall see, it is important to trace the nature of such calculation within specific projects – and not just the frame of the market device – to understand the way coordination is stabilised.

Methodology

The research which underpins the paper was undertaken within the EPSRC funded CLUES project, which looked more broadly at the role of local energy initiatives in reshaping urban energy systems and urban areas.[2] As part of this project, a series of 13 case studies – both in the UK and abroad – were undertaken (Chmutina et al., 2012; Devine-Wright and Wiersma, 2012, 2013; Goodier and Chmutina, 2013). This paper takes four diverse cases from the CLUES project each of which demonstrated economic viability in particularly interesting ways. The four case studies discussed involve two private sector-driven examples of new development: a commercial office development in central Stockholm, Sweden and small-scale wind turbine infrastructure in Newport, Wales; and also two examples of retrofit: the installation of PVs on schools in New Jersey, USA and energy efficiency improvements in the public government buildings in Berlin, Germany.

The data collection methodologies involved document analysis, in-depth, semi-structured interviews with key actors conducted face-to-face, by telephone and by Skype, site visits where possible and, in the case of the overseas projects, comparative workshops to identify the distinctive features compared to UK practice. The Stockholm case also benefitted from a series of supplementary interviews with local real estate professionals and the Newport case from additional document analysis of online local planning department records. The interview transcripts were coded according to a pre-agreed common coding scheme derived from a co-evolutionary perspective (see GOS, 2008) that encompassed technological, economic, social and governance dimensions. This enabled a wide range of aspects of the project to be recorded for later analysis and allowed the particular questions about exchange flows and modalities of valuation arising from the economization programme to be addressed. Quotes from transcripts could be readily retrieved to understand the discursive constructions and the information derived enabled the socio-technical assemblages to be mapped.

For each project we have provided a simplified sketch of relationships between social actors to help the reader, supplemented with a more detailed table setting out the key exchange flows and associated artefacts/market devices and modalities of valuation that were involved.

Newport wind turbines, wales

The first project considered is a private-sector sponsored meso-wind turbine installation in Newport, Wales, worth around £6 million. Here, on the site of a chemical company, Solutia, two grid-connected 2.5 MW wind turbines were installed in 2009 by developers Wind Direct, part of the Wind Prospect Group. The developer leased the turbine site from Solutia and they now own, operate and maintain the turbines. The turbines are connected to Solutia's own internal grid, which has a connection to the district network operator's (DNO) grid. Most of the electricity produced is consumed on-site by Solutia, with any excess then sold on to the grid.

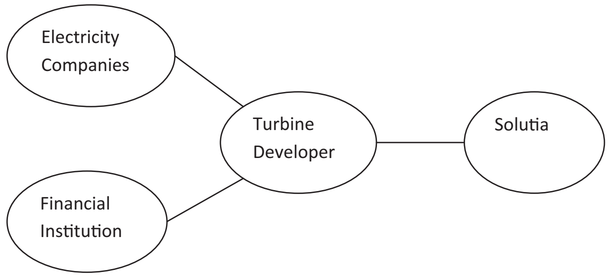
Although a local project and an example of decentralised energy generation, this was not framed in localist terms and the local community were relatively passive. Local residents were consulted through a pre-existing community liaison panel but as the development is at least 500 m from the nearest residential area and there is existing industrial development in the locality, there were no substantial objections. Furthermore, as the electricity is mainly used on-site and then exported to the grid rather than to specific local consumers (say through a local grid or private wire arrangement), local electricity users have little reason to treat any energy generated by this turbine differently from that coming from any other source; this is not 'local' energy from the community's point of view.

The funding was provided by pension fund investment with a specific specialist renewables fund in anticipation of income from two sources. First, there is the income from the supply of electricity both to Solutia and, for any surplus, to the grid. Solutia are paying less than they would have otherwise and this acted as a major incentive to host the turbines in the first place. Nevertheless electricity generation also provides an income stream to the turbine developer. The key artefacts here are the Power Purchase Agreement with Solutia and the contracts with energy companies underpinned by the connections agreement with the district network operator. These establish the parallel but contrary flows of money and electricity. Second, income also arose from the Renewable Obligation. This obligation requires energy companies to supply a certain proportion of their energy from renewable sources. Renewable energy generators are awarded Renewable Obligation Certificates or ROCs to certify their supply and such ROCs can be traded in the ROCs market or contracted to a company in need of ROCs to meet their renewable obligation. ROCs are thus an asset that can be sold for income.

Fig. 1 thus shows the multiple exchanges that occur within this project, money for money but also money for property rights, for electricity flows and for the artefact of ROCs. Devising the sets of socio-technical relationships that enabled these flows required creativity: "It was kind of an innovative construction, the funding" (Interview WP4:NP:1). And essential to this creativity was creating a mutual commercial interest, partly in terms of direct financial benefit but also due to improved reputation and competitive advantage:

> "*Interviewer*: So do the financial benefits go to you then or do they go back to the third party?
> The contract is arranged that they are shared.

[2] See www.ucl.ac.uk/CLUES.



Exchange	To/from	Artefact or Market Device	Modality of valuation of flow
Capital investment ***for*** Return	Financial Institution & Turbine Developer	Investment vehicle	Negotiated return based on profitability of electricity sales
Use of Site ***for*** Rent	Turbine Developer & Solutia	Lease	Negotiated rent based on profitability of electricity sales
Electricity ***for*** Per Unit Price	Turbine Developer & Solutia	Power Purchase Agreement	Negotiated price below market price
Electricity ***for*** Per Unit Price	Turbine Developer & Energy Companies	Electricity Supply Contract; DNO Connection Agreement	Market price for renewably generated electricity
Electricity ***for*** ROCs	Turbine Developer & Energy Companies	Renewable Energy Certificate (ROC)	Market price for ROCs

Fig. 1. Newport wind turbine.

Interviewer: Shared, okay.

Yes.
Interviewer: So that is quite a good deal then, isn't it?
Absolutely, yes." (Interview WP4:NP:2)

These aims could only be achieved by activating certain market devices or artefacts, notably the contracts and associated bills for electricity supply and the ROCs as tradable permits. The former allowed the material flows of electrical power to be transformed into financial flows over time and the latter created a paper asset that generated a capital value in the ROC market place based on certified electricity generation. These artefacts are essential in assembling the network of actors and technology into a viable and effective set of relationships and they tied the social actors – the developer, the grid, the consumers – into relationships of energy supply and payment for that supply.

While there are links through to market valuation processes that established a price to the project for renewably generated electricity and for ROCs, the financial value of many other flows was negotiated rather than 'taken' from market evidence. This included the return on the capital investment, the rent for the site and the price of power supplied to Solutia, all of which were negotiated. The way that the negotiations created fixed and certain valuations further underpinned the framing of the project as a long term investment with high certainty of returns and low risk.

"when a client signs up they have a clear expectation of what the prices of the electricity will be sort of from day one really, and that doesn't really change. So they know, when they're signing up, that the potential three or four years later is to have a wind turbine on their site at X pence per kilowatt." (Interview WP4:NP:3)

This in turn supported the long term involvement of funding actors which enabled the investment and inception of the project in the first place. The whole project was viewed from a 25 year timescale, so that the financial ties within the network had to be stable and capable of longevity: "it's a long term investment for us; it's a 25 year investment." (Interview WP4:NP:3)

This case study shows the role of key artefacts such as energy contracts and ROCs in rendering visible the material flows of electricity and enabling their transformation into financial resources, both of which were essential for the cementing of the social actors and the technology into a viable and effective project. The exchanges supported by these artefacts were negotiated rather than 'taken' from the market and these negotiations further created some certainty for the monetary flows, thereby reducing risk and encouraging investment. They also enabled actors to see themselves in a mutually beneficial commercial relationship to each other and to the technology of the project.

Kungsbrohuset, Stockholm, Sweden

Kungsbrohuset is a major redevelopment project just opposite the central railway station in Stockholm, Sweden completed in 2010. It comprises 27,000 m^2 of commercial space in a 13 storey building, including shops, restaurant, cafes as well as a hotel and offices. The building is promoted as a 'green' development with the emphasis on high standards of energy efficiency. It carries three different brands of green certification: Green Building, P-Mark and Eco-Class.

There are a variety of green technologies deployed such as a highly energy efficient facade, triple glazing to a high standard of thermal efficiency and heating using thermal gains from the neighbouring railway station. Technology that interfaces more directly with occupiers includes the provision of a 'green' shut-off button that puts all systems into low-energy mode and the support of all tenants by a dedicated expert who helps them to minimise their environmental impact through their engagement with the building's technologies and behavioural change. Weather forecasting is also used to help regulate energy settings for internal comfort.

The developer was Concept Jernhusen, who wished to utilise green technology within this development to market the building in a distinctive way, as "eco-smart". It must be recognised that building standards in Sweden generally and Stockholm specifically are already stringent. All new building projects are carried out to a very high standard of environmental efficiency, but this development clearly wanted to project itself as something beyond the usual standard of green building. The aim was to let the space to companies that wished to boost their own image as environmentally-friendly.

As Fig. 2 summarises, the flows within this project were relatively straight-forward with rental agreements and energy contacts establishing financial and socio-technological relationships between the three key social actors over building use and electricity consumption. But the flows were shaped by the socio-materiality of the building and the institutional arrangements captured in the 'green lease', which established contractual relations between the landlord/developer and tenants. The building design and ongoing management led to reduced electricity consumption due to a mix of infrastructure for heating scavenging, energy efficiency measures and changed occupier practices. At the same time, the green lease tied the landlord and tenant into working together to reduce energy consumption. This also needs to be seen in the context of an ongoing shift occurring within the Swedish commercial rental market from a situation where the landlord paid all energy bills and recovered them through the rent (which was fixed for a term of 3–5 years and then renegotiated) to one where tenants are picking up these costs directly. This shift, while not necessarily changing the actual level of payments, is changing the visibility of energy costs to occupiers.

The valuation of the flows in this case was strongly related to how prices were being set in the broader Swedish energy and commercial property markets. Taking the energy price-setting first, in Sweden, the market price of electricity varies considerably from the hours of peak demand (when the country has to import electricity) to low demand hours (when there is a considerable surplus). In Kungsbrohuset, the owner sells electricity to their tenants at a price that is fixed for three to four years. This provides the tenant with certainty and buffers them from price variations due to the time of consumption or, in addition, medium-term market variations. This certainty for tenants also enables them to foresee the financial benefits of energy saving measures that they as occupiers undertake.

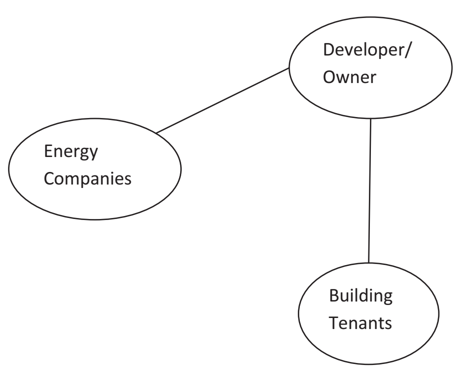
The rental valuation depends on how the actors in the commercial property market are reacting to the emergence of branded 'green' buildings and whether any price or rent differential to 'normal' buildings can be justified. There is ongoing debate within the Stockholm property sector about the financial benefits of such green marketing in terms of higher rental levels and capital values. However interviews with local commercial estate agents reveal a general agreement that green buildings tend to let more readily and avoid vacancies because tenants will – all other things being equal (including the rent) – favour a more environmentally-efficient building. This is particularly the case if there are reputational benefits to be gained from the occupancy of such a building.

> "*Interviewer*: Are you getting profit from it now?
> Yes. We wouldn't do it otherwise. We earn money on the tenants because they pay us money to rent the letting. We don't earn money on the energy efficiency. That's just a bonus kind of. We earn more money because it's energy efficient, but we don't earn money only because it's energy efficient." (Interview WP5:KBH:1)

Indeed the developer rejected financial subsidies in the case of this project because he wanted to demonstrate the market value of green development practices:

> "*Interviewer*: Do you get any subsidies for geothermal let's say or for water cooling systems?
> We could probably have them, but we don't want them because we want to build this project on solely an economic base." (Interview WP5:KBH:1)

In this case the exchanges were strongly connected to broader market exchanges for energy and commercial property but the nature of that connection was shaped by the socio-technology of the building (the infrastructure, built fabric and associated practices)



Exchange	To/from	Artefact or Market Device	Modality of valuation of flow
Property Rights ***for*** Rent	Developer/Owner & Building Tenants	Green Lease	Market rent for 'green building'
Electricity and heat ***for*** Per Unit Price	Developer/Owner & Building Tenants	Lease; Energy Bill	Stabilised price for electricity; Value of heat included in rent
Electricity ***for*** Per Unit Price	Developer/Owner & Energy Companies	Electricity Supply Contract	Market price for electricity

Fig. 2. Kungbrohuset.

and how that reduced energy consumption and costs, the artefact of the green lease and changing institutional relationships between landlords and tenants over energy costs that made such costs more visible to tenants, and the decision of the developer as building owner to provide medium-term certainty to tenants on energy costs. These all rendered the development project an intervention in the socio-material construction of a 'green building' market in which environmental features commanded value premiums and reduced risk yields.

Berlin Energy Saving Partnership, Germany

The Berlin Energy Saving Partnership is an example of energy performance contracting (EPC). This form of contracting represents a move onwards from an energy services supply model (in which energy services are sold), itself a shift on from the model of just selling quantities of energy. Energy performance contracting is about supplying a service which delivers, through a variety of technological investments and coordination measures, a saving in energy consumption.

In the Berlin case, the core actor is the Berlin Energy Agency (BEA) and its range of subsidiary Energy Services Companies or ESCOs. BEA was established in 1992 as a public-private partnership of the Federal State of Berlin, Vattenfall Europe (an energy supply company with a considerable renewables portfolio), GASAG and KfW Banking Group. The specific purpose of the Berlin Energy Saving Partnership (BESP) is to raise finance for retrofit of commercial properties within the public estate in Berlin: that is, schools and nurseries, universities, the opera house, swimming pools and offices.

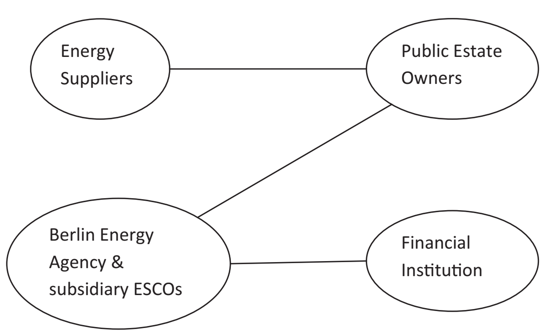
BEA, through an ESCO, raises money from banks as a loan on the collateral of repayments from the energy savings. The customer, here the public estate in Berlin, pays the ESCO for energy saving and optimisation services delivering guaranteed energy savings. These energy savings pay back the bank loan and are also intended to generate a further net saving for the ESCO and the public sector. The financial risks are borne by the ESCO if savings fall below the guaranteed level set within the contract.

> "*Interviewer*: How does that financial picture work?
> This is regulated in a contract and, as I told you, for political reasons I think we have more or less all the contract share of saving goes to the customer which is so-called shared savings, more you could say. And usually we have something that 80% goes to the ESCO and 20% to the customer, but sometimes we have 90% and 10%. This also depends on when the customer said 'Okay'. ... But this is given with the tender documents, so it is pre-defined you could say.
>
> *Interviewer*: So does the ESCO make a profit on that?
>
> Yes." (Interview WP5:BESP:1)

The investments needed to deliver energy improvements are refinanced through the 'guaranteed' cost savings over the lifetime of the contract, usually 12–15 years: "we have the concept that the total repayment of the investment has to be done with the savings" (Interview WP5:BESP:1). At the end of the contract, the aim is that the public sector has buildings that will continue to provide energy savings: "The contract is then terminated and there's a final audit of the project and then the energy savings come back to the building owner and all the savings remain with the building owner." (Interview WP5:BESP:1)

As Fig. 3 summarises, the central artefact in this set of institutional arrangements coordinating the actions of the four key actors is the Energy Performance Contact (EPC) and the main modality of valuation is negotiation of the financial shares of energy savings resulting from investments by BEA and their associated ESCOs. In Germany there is an established legal framework for EPC and appropriate standards, including standards for contracting models. EPC is defined as: "a comprehensive energy service (planning, implementation, operation and optimisation of building installations) that aims to achieve guaranteed improvements" (VDMA Standard 24198); the artefact of the contract, by which payments from energy savings are recouped and distributed, is central to making EPC work.

Within this, the issue of the cost of maintenance and, more importantly, who pays for these costs is a central issue. Part of the returns have to cover maintenance and operational costs, the exact share being determined in the EPC contract: "The main share



Exchange	To/from	Artefact or Market Device	Modality of valuation of flow
Capital Investment ***for*** Return	Financial Institution BEA/subsidiary ESCOs	Investment Vehicle	Negotiated return based on return from energy saving measures
Energy Saving Measures ***for*** Fees and Income	Public Estate Owners & BEA/subsidiary ESCOs	Energy Performance Contract (EPC)	Negotiated share of financial value of energy savings
Energy ***for*** Per Unit Price	Public Estate Owners & Energy Companies	Energy Supply Contract	Market price for energy

Fig. 3. Berlin energy saving partnership.

of the contract is about the investment and 80% of the future payments go just to repayment of the installations of the investment and the other 20% is services as in operational maintenance and control.'' (Interview WP5:BESP:1)

Originally BEA had a contract whereby they were responsible for all maintenance, servicing etc.:

> ''BEA has this full service contract that the ESCO also has to do the maintenance of all devices, all technical installations as in heating, cooling and ventilation and this, of course, is costly. Maintenance is costly and that's why today usually the contracts have just a share of the maintenance has to be done as responsibility of the ESCO.'' (Interview WP5:BESP:1)

This was only possible in the BESP case because of the scale of savings that would result from improving a very low, energy-inefficient base:

> ''For example, if the cost of operation, maintenance and service is 100,000 p.a. for one building pool and there is a saving of 1 million Euros per year, then of course there's potential to do a full service contract. But if there's just 300,000 savings, then more or less the main share of this goes to the bank for the payment of the credit and maybe there's then just 50,000 left to do operation, maintenance and service and then of course there has to be a margin then.'' (Interview WP5:BESP:1)

Here BEA was estimating the energy savings at, on average, 26%.

The main ways these savings were achieved were through fairly simple socio-technical measures that gave a good, immediate return. Under the first phase of the programme, the energy efficiency measures that have been implemented include refurbishment of heating and lighting technology and better energy management including changed occupier behaviour. Replacement of windows and insulation was not part of the first phase but is in a planned programme of works. This, however, requires a different financial model;

> ''The main reason is the payback time. Because with a 10 year contract, you know there has to be a share for the customer. So it's not the total savings going to the financing of the measures and that's why you cannot... well, window replacement but also insulation and so on, they have paybacks of 15, 20, 25 years and it's not feasible with the financing concept of the classical energy saving partnerships.'' (Interview WP5:BESP:1)

Window replacement, for example, only becomes a possibility if there is shared financing from the client, here the Berlin public estate, as well as via the ESCO.

One other key feature of the BESP project is that it is framed as a portfolio approach. Buildings are 'pooled' so that average energy savings across the portfolio reach the necessary level to make the contract work. Some of the public estate offered very considerable savings indeed, particularly the larger buildings, while others – such as, say, nurseries – offered much lower savings rates. So: ''We are doing this pooling of buildings. Of course, there's a cross-financing between the buildings'' and ''high consuming and large saving potential buildings are somehow co-financing the smaller and not so attractive'' (Interview WP5:BESP:1).

BEA plays a vital role in making EPC work. It is an essential intermediary, the corporate embodiment of the contract. Across Berlin, BEA has been involved in 25 contracts operated by 16 different ESCOs and involving some 100 subcontractors in implementation work. While the ESCOs bear any risk of failure to deliver energy savings, BEA takes its return from its fees: ''Well we don't have risks of the saving guarantees because our consultancy service is more or less a fixed amount.'' (Interview WP5:BESP:1)

The ESCOs carry the risk but this is low given the potential for energy savings in the Berlin public estate. Savings of up to 35% are stipulated in the EPC contracts and have been consistently achieved. The ESCOs generally work on a margin of at least 10% to cover any risk. In addition, ESCOs have adopted a forfeiting model to optimise their balance sheets through the way that the EPC contracts are structured:

> ''usually total 100% financing comes from the ESCO usually as a credit, but in the latest – I think starting in the past 10 years – we have more or less [the] forfeiting model. ... It's a section of the contract. So the future receivables are sold to a bank. ... This is about the balance sheet of the ESCOs because when you're doing credit financing they have the credit on their balance sheet and that's why this forfeiting is a kind of model to have the assets on the client's balance sheet.'' (Interview WP5:BESP:1)

Here the role of the key artefact – the EPC contract between the owners of the public estate and BEA or its subsidiary ESCO – is clear. This is a case where an artefact *is* the energy project; it would have no existence without this contract as its genesis. It plays the key role in coordinating actors and in supporting the negotiation of the value of the exchange flows within the project. The framing of the project as pooling energy savings through a portfolio approach, the design of the project in terms of identifying the 'low hanging fruit' of energy saving technology and the identity of BEA as a key intermediary all stem from the nature of this contract.

Morris model, New Jersey, USA

The final case study concerns the implementation of a financial model devised by Stephen Pearlman, a New Jersey lawyer, to enable the financing of renewable technology in local schools. The essence of this model is the arrangement of ownership of assets so that full advantage can be taken of tax breaks.

Usually local governments in USA have two ways of financing solar programmes: either with tax exempt bonds or by entering into turnkey relationships with private solar developers. In the former case, local government issues debt that typically has to be repaid over the life of the project. The local authority owns the solar system as well as retaining all the benefits of this ownership other than the federal tax benefits (which it is not entitled to under this arrangement). However the debt adds to the financial burden of local government and requires a procurement process to design, acquire and install the solar project. A turnkey developer-owned solar scheme is typically used when local government lacks knowledge or experience of solar project development. In such schemes the private developer designs, finances, installs, operates and maintains the solar system and then sells the renewable energy back to the local authority through a Power Purchase Agreement (PPA) (Pearlman and Scerbo, 2010).

The Morris Model is a hybrid that incorporates elements of both these approaches, maximising benefits and minimizing drawbacks (Chegwidden et al., 2010). The idea of the hybrid approach is that the county provides the financing through a bond issue. A county-based agency issues bonds supported by the credit of the county; this significantly lowers the costs of capital for the project. The project then uses a turnkey approach with the difference that the financing is being provided at low cost by the local authority. This allows for cheaper financing as well as preserving the developers' capacity to borrow from private lending sources for other projects and take advantage of tax breaks (Pearlman and Scerbo, 2010). The occupiers of the sites where the solar panels were installed did not have to bear any out-of-pocket costs.

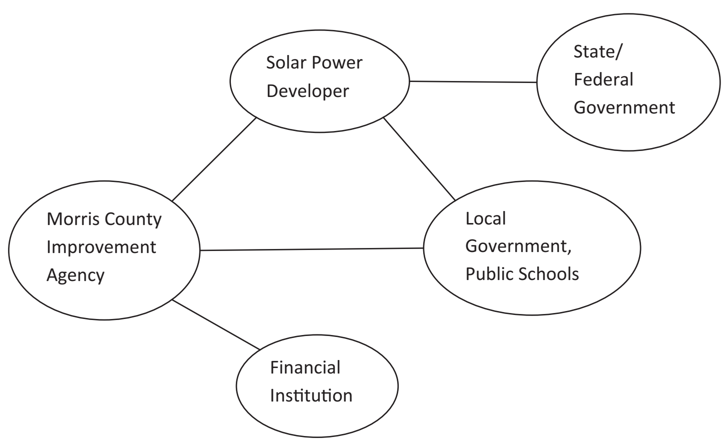
"The way we structure these deals we make the developer pay the debt service by entering into a lease purchase agreement with the improvement authority. So the improvement authority floats the debt, the county guarantees it, the improvement authority takes the money and gives it to the developer and the developer buys the panels but, when those panels come in, they're owned by the improvement authority. The improvement authority leases them to the developer and over the 15 year the developer makes lease payments. Those lease payments equal the debt service on the improvement authority bonds. So the county guarantee will only get called on if the developer does not live up what they said they would do. And the reason the developer will offer that lower PPA price is because they're getting all those benefits I mentioned earlier – federal tax benefits, the state SREC benefits – and so they feel that this is something they can handle." (Interview WP5:MM:3)

Fig. 4 shows that the exchange flows are more complex that in the other three cases with multiple artefacts involved. The valuation of the flows is highly dependent on negotiation with reference back to market price-setting in investment and energy markets but with discounting to share out the financial benefits of the coordinated arrangement. There are three key elements that create these financial benefits for sharing: the tax breaks (including SREC benefits – see below), the reduction in risk and borrowing costs, and the reduced energy costs to the school bill which is paid by the county.

Taking the tax breaks first, these operate at both Federal and state-level and are only available to private sector organisations: "in the public sector here in New Jersey, if we installed our own system the public sector had no benefit of any of the federal tax benefits" (Interview WP5:MM:2). In addition, in New Jersey they operate an SREC system: "Those are the tax credits based upon installing energy efficiency systems where a company coming in, installing a solar system let's say has a tax benefit. They place a value on these credits which immediately began depreciating the cost of the project" (Interview WP5:MM:2).

Furthermore: "Washington's tax code, ... gives a 30% investment tax credit for PV along with a 5 year accelerated, what they call MACRS depreciation. Those benefits exist anywhere in the country. In addition, in the stimulus legislation in Febuary 2009, when our economy was somewhat stalled and Congress passed an $800 billion plus stimulus bill, expiring this year is a provision called the 1603 Grant Programme that allows PV developers to take a 30% ... instead of taking a tax credit, they actually get a cheque from our United States Treasury for 30%. ... So 30% is not 30% when you're done. It could be 25% or 24%. Whereas cash, a cheque from the United States Treasury, is fully 30%" (Interview WP5:MM:3)

Turning to the reduced cost of credit, a key factor is the reduction in risk that this model creates. This is because "the bonds would be based on the credit of the towns" (Interview WP5:MM:3) and this credit was good: "We have a Triple A bond rating with Standard and Poor's and, you know, Moody's. So we're, you know,



Exchange	To/from	Artefact or Market Device	Modality of valuation of flow
Capital Investment ***for*** Return	Financial Institutions & MCIA	Tax-exempt Bond	Market yield discounted for tax exemption
Use of Roofs ***for*** Rent	Local Government, Public Schools & MCIA	Licence	Negotiated rent based on profitability of electricity sales
Use of Solar Panels ***for*** Rent	Solar Power Developer & MCIA	Lease	Negotiated rent based on profitability of electricity sales
Electricity ***for*** Per Unit Price	Solar Power Developer & Local Government, Public Schools	Power Purchase Agreement	Negotiated price at discount to market price
Evidence of Solar Power Investment ***for*** Tax Credit	Solar Power Developer & State/Federal Government	Tax Accounts	Established by government policy

Fig. 4. Morris model.

one of the richest counties in the United States, so when we went in and we presented this project to them I think that they realised that yes, we were backing it" Interview WP5:MM:4). As another interview said:

> "it put the county guarantee on the bonds that were issued by the County Improvement Authority and, with that country guarantee, was able to get much lower cost of capital than the private solar developer could get on their own. And in return the county improvement authority said to the developer: We'll give you this in effect cheaper money. We'll be your bank. We'll provide you with this cheaper source of capital that you don't have access to and in return we want you to give us a much lower PPA." (Interview WP5:MM:3)

And the structure of the model makes it very unlikely that the county's guarantee will be called upon because the debt was reduced "to just an amount that can be covered from PPA and some minimum SREC value; that's given them a lot of comfort that their guarantee, if it was ever called upon, would be repaid, if not fully, close to fully." (Interview WP5:MM:3)

The artefact of the Power Purchase Agreement (PPA) sets out the price to be paid for electricity by the consumer, here the schools:

> "So the company that came in to install the solar panels was also the company that was going to be providing [electricity] to the country. Under the auspices of the Improvement Authority, a [PPA] ... was established at year-one-beginning kilowatt rate, increasing 3% each year over the 15 year life of the programme and that was the most important component of the analysis of whether this project was fruitful. "(Interview WP5:MM:2)

In Morris County, the operation of this quite complex model worked out as follows. The local government leased roof space (including car ports in car parks) on schools and sports arenas to an agency, the Morris County Improvement Authority. The MCIA raised funding from investors by issuing low-interest bonds which were backed by Morris County. This finance was used to install solar panels on the roof spaces through the involvement of solar power developer, Tioga Energy with the design and installation services of SunDurance Energy. The solar panels were then leased to Tioga, transferring ownership and providing a revenue stream to the MCIA to service the bonds. The solar developer, Tioga Energy, then entered into 15 year contract (the PPAs) with Morris County to supply electricity to their schools. The whole scheme was underwritten by a letter of credit from the solar power developer to ensure that if the county guarantee on the bonds was ever called upon, the local authority was repaid in full.

The first installation began in June 2010 at the William G. Mennen Sports Arena amounting to 6838 solar modules and producing a saving of about $50,200 p.a. Thereafter a variety of school boards and districts have used the model to finance solar panel installations at a number of schools with considerable savings per annum per school:

> "It appears that we're right on track for savings actually a little higher than what we anticipated; an annual saving somewhere around $18,000 a year where we had projected potentially $15,000." (Interview WP5:MM:1)

> "In the end they were able to get that rate down to 10 cents. So it was a penny less than what we were paying at the time and so then it became beneficial for us to be part of the project. ...and my budget for this one site, the benefit of having solar provided reduces our electric bill by about $42,000 a year for this first year. This'll be our first year and there's a report schedule that shows over 15 years we'll actually gain a better benefit." (Interview WP5:MM:2)

The key to this scheme is the way that the artefacts structure the exchange flows of finance (capital and revenue/cost), property rights (to sites and solar panels) and renewable electricity. There are five artefacts involved: the licence for the roof space; the issue of bonds; the lease of the solar panels; the electricity contract or PPA; and the returns in which the tax credit is claimed. These arrangements, and their inter-connection, ensure that net financial benefits are maximised providing a value surplus for negotiation. In particular the taxable ownership of these solar panels is transferred to the solar power developer through leases, ensuring taxation benefits are maximised. Due to these benefits, the electricity is sold to the schools via Morris County at low cost, estimated on average at about 35% below the prices of the local energy utility and risk is reduced.

The institutional arrangements and socio-material assemblage provides effective coordination so that the different actors can exercise their capacities. The schools offer their under-utilised real estate space on building and carport roofs while suffering no disruption. The project design itself emphasises the unobtrusive retrofit of the PVs so as not to interfere with the operation of the schools. Some schools have even built new roofs or car-ports to accommodate the PVs. The county brings its Triple A rating to guarantee the bonds and benefits from a reduced utilities bill: "it will reduce the utility bill we pay for no infrastructure cost and no maintenance cost" (Interview WP5:MM:2). The solar developer brings their technological and market expertise in return for commercial profit. And the broker, the MCIA "take an administrative fee to cover their costs" (Interview WP5:MM:3).

The whole Morris Model project is essentially constructed as a hybrid aggregation of existing financial models that creates mutual value benefits through a mesh of exchange flows, with the additional value then split in negotiated portions between the actors. This hybridity is encapsulated in the five artefacts that together make up the model and coordinate the actors, their engagement with the socio-technology of solar electricity generation and their negotiation over the share of value created.

Conclusions – rendering local energy projects economic

In this paper we have attempted a 'reframing' of the concept of financial barriers and incentives to the pursuit of local energy projects. Returning to the work of Michel Callon and colleagues in the new economization programme, we have resisted viewing the 'economic' as fixed and easily located in distinction to the socio-technical aspects of each project. Similarly we have avoided the temptation to assume the contents of the 'economic' dimension as ready-made and easily transported into or out of each project. Rather we have tried to unpick and unpack the multiple dimensions of the different socio-material actants involved in each project and the diverse roles they play in helping to assemble, cohere and sustain each energy project. We have paid particular attention to the exchange flows – of money for money, and of money for material goods and services – and considered how artefacts or market devices form institutional arrangements to coordinate these different elements in a project. We have looked at the modalities of valuation of these flows and the way that the material is implicated in generating financial value, as well as the importance of inter-actor negotiation in the share of this value with reference to, but not determined by price setting in the broader market-place.

From this analysis there are a number of points that we wish to bring out. First, these cases confirm Callon and Calişkan's emphasis on inventiveness on the part of social actors in devising new means of coordination. While the BESP model was more well-established, we could identify the human creativity involved in imagining the Morris Model, Kungsbrohuset and the Newport wind development. These innovative local energy projects would not have occurred without such inventiveness.

Our next conclusion is the importance of identifying all the multiple flows associated with exchanges within a local energy project and not just focusing on the end point-of-sale of electricity or energy. It is the overall pattern of flows that represents the coordination of exchanges and that binds together the ensemble of social and material actants into a project assemblage. And it is the collective of all the relationships within the assemblage that is generative, that produces the prototype of a new form of local energy system. We have also seen how a mixture of modalities of valuation are involved in calculating the worth of these exchange flows, including reliance on prices set in a broader market but also discounting from these market prices and negotiating shares of value generated. Furthermore multiple modalities will be involved in any one project so that valuation can be seen to be a process of layering and inter-leaving different modalities into a (semi)stable arrangement.

We have particularly noted the importance of artefacts, of market devices such as energy supply contracts, Power Purchase Agreements, property leases, investment vehicles, Renewable Obligation Certificates and even tax returns. It is these artefacts that 'hold' the exchange relations in some degree of stability and structure the modalities of valuation. How a contract or agreement is drawn up makes a difference to the way an exchange is valued and how it can be shared between parties. But this is not a purely social process – the materiality of the socio-technical infrastructure and built form is always implicated in the way that an artefact is able to generate values through institutional coordination of actors. A more energy efficient and heat scavenging building reduces energy costs and this shapes the exchange flows between energy supplier, building owner and tenants in conjunction with the terms of the key market device, the green lease.

While we consider that Callon et al.'s concept of market device has proved very fruitful in identifying the role of specific artefacts in coordinating socio-material entities – actors and technology – within innovative local energy projects, we identified two features of such coordination that have not been emphasised sufficiently to date. First, each of these cases involved negotiation between social actors over the financial surplus generated by the associations between these social actors and also the technologies of energy systems and the built environment. While market pricing set the backdrop for these negotiations, valuations were not 'drawn down' but rather recalibrated through engagements between actants. This suggests that, at least in such innovative projects, valuation is not the codified results of 'disentangled' exchanges in the market place but rather remain contested and the result of agency in specific institutional and local contexts. Miller (2002) has also argued against the view of market transactions as 'disentangled' from the specifics of certain cases of exchange; he goes further in suggesting that such exchanges entangle multiple aspects of actors' personal lives, set within the context of cultural and moral norms. We would not go so far; the negotiations we found in these cases of innovative local energy projects were set against the backdrop of disentangled market pricing (for energy, for ROCs, for property) but they involved an additional dynamic, the negotiation between parties of how the financial shares should be split up *in this case*.

Second, we would draw attention to the importance of finding means to reduce risk in such projects. In all our cases, institutional arrangements were put in place to create some degree of certainly with regard to exchange flows – for electricity, for rent, for returns on investment. This is important because the timescales of both the technologies and actors' horizons in these projects is often longer than the expected stability within market pricing. Only by creating some certainty can the project attract the necessary investment (financial but also in terms of time, commitment, trust) to enable the project to proceed.

These kinds of detail only become apparent when specific cases are studied. In a review of the usefulness of the new economic sociology McFall argues that the"thick description of the situated, distributed and material character" of markets enables an understanding of "how the different priorities and purposes of different market devices format the dispositions and skills of the people who encounter them (2009, p. 279). This emphasis on the 'encounter' between material elements, technologies, institutions, places and people, 'formated' by key artefacts is key to understanding the processes and practices of assembly and the success and failure of local energy projects. Muniesa et al. (2007, p. 1) also acknowledge the value of such cases which are "attentive to the empirical intricacies of agency [and] ... pay particular attention to the trials in which actors test the resistance that defines the reality of the world surrounding them".

We would argue that the processes of negotiation over financial value and creating some certainty in exchange flows are essential for stabilizing "the forms and meanings of what is to be considered economic in a particular site and at a particular time" (ibid, p. 3). Furthermore, this is a necessary pre-requisite for an innovative project in one site to evolve into a market-place of many such projects. By focussing just on the level of the 'market' and how established calculations occur within that market, Callon and his co-researchers miss the importance of the innovative project in creating new market possibilities and the work that goes into the first calculations within that project. More recently, in response to that criticism that his work is a-political, Callon has looked at the development of new products and suggested that their design, qualification and commodification "imply cooperation between multifarious agents and institutions" and that this "implies complex, changing and evolving partnerships necessitating specific modalities of intellectual property and contractual arrangements" (2010, p. 166). This is the point at which the market is 'caught' between exploration (or innovation) and exploitation (or established market practices).

We consider that it is particularly relevant for future change in energy systems whether these cases can move from innovation to exploitation and become 'conventional'. Energy performance contracting has become so in Germany on the basis of government efforts to standardise and institutionalise this form of market device and associated contractual arrangements. The clear demonstration of exchange flows to the negotiated, mutual benefit of all actors would also underpin the shift from one-off to conventional. Where market-wide modes of valuation act as signals of such mutual benefits, as with the emerging green buildings market in Sweden, then that shift will be further embedded. But this requires, as de Landa (2006) emphasises, repetition. The combination of institutional arrangements – supported by key artefacts – and socio-technical infrastructure – combining technology and new practices – needs to be tried again and again in different projects, different sites. The demonstrated ability of the institutional arrangements to quantify the exchange flows with some certainty is important here as a project with reduced risk is more likely to be repeated. Only then may the assemblage of specific projects become the agencement of new energy and urban property market processes.

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