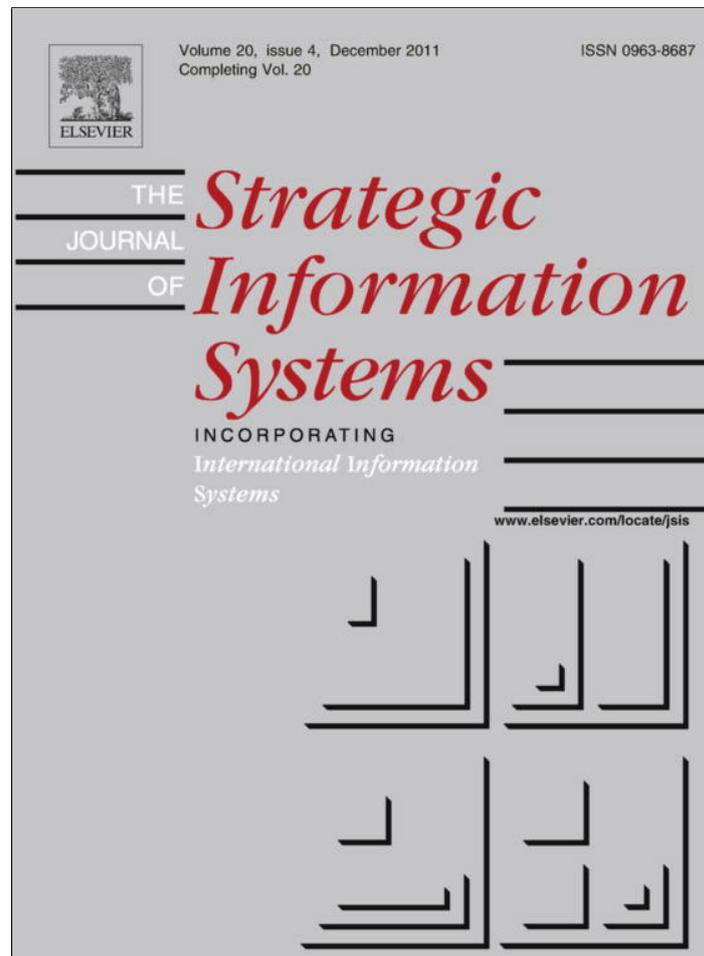


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Barriers to knowledge sharing and stakeholder alignment in solar energy clusters: Learning from other sectors and regions

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ABSTRACT

Regional and national policy makers have invested heavily in the cluster concept as a means of generating value for regions, particularly through the opportunities it may present for small regional enterprises as vehicles for growth and job creation. Economic theorists such as Porter, have shaped many of policies being adopted, from a macro-economic perspective, yet the process by which actors within the group are helped (or hindered) in aligning knowledge, expertise and interests is less well understood. The implementation and development of clusters is subject to a range of local socio-technical and socio-political dynamics, which also need to be taken account of if the anticipated benefits such as wealth creation and competitiveness are to be realised. The paper uses the outcomes of research in several regional clusters to highlight recurring issues associated with the alignment of distributed knowledge and stakeholder interests, and in particular, the interests of small and medium-sized enterprises (SMEs). The paper suggests that such barriers impact on the ability of clusters to create value for regions, particularly in relation to the opportunities for the creation of employment through local SMEs that are often cited as the basis for such investment. The authors argue for the provision of opportunities to sharing knowledge and expertise within and between clusters, to ensure early identification and collective engagement of stakeholders with issues on the ground, given the evidence that SME are under-represented in policy and strategy development, and that this undermines the competitiveness and the benefits of investment in regional clusters.

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1. Introduction

Regional clusters provide a geographical concentration of sector-specific companies, suppliers, service providers and associated institutions (e.g. universities, research institutes, funding bodies) which can share expertise and create value in inter-organisational supply chain networks and are central to regional development in a variety of ways, closely associated with the work Porter (1996) which offers an economic policy framework intended to support regions to develop competitive advantage. There is now a renewed focus of interest in the more local dynamics of clusters as a means of leveraging the economy from a regional base in difficult times. While classical top-down economic approaches to policy have played a dominant role, there has always been an argument for the need to have a more in depth understanding of the more grounded, socio-technical factors in clusters, and this is now the focus of attention in the effort to revive regional economies.

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There is an increasing acknowledgement of the need for economic policy to take better account of the importance of more locally grounded socio-technical and socio-political factors, and these if investment in such clusters is realised in practice, in terms of regional wealth creation. Porter (2009), Atkinson and Audretsch (2008), Atkinson and Wial (2008) highlight the role of recurring communication issues, poorly aligned incentives and a lack of understanding of the very context specific issues which are more typically the focus of sociological and socio-technical analysis of work processes outlined in the next section. Muro and Katz (2010) speak of a greater focus by policymakers on 'the grainier real-world dynamics of regional economies' and 'a timely new focus for policy (on clusters) after years of disdain for the messier practical processes by which value and advantage are created'.

If clusters are to realize their objective in practice and create wealth for the region, there is a need for a better understanding of the barriers to knowledge sharing and alignment between stakeholders on the ground, particularly in relation to SMEs as the engine of the growth and job creation that clusters aim to generate. They represent 99 per cent of all European enterprises, contribute two thirds of European GDP and provide 75 million jobs in the private sector (Europe, 2009). Yet they are often poorly represented and integrated in supply chains and clusters (Estimè, 2008; Wong, 2009; Jaegersberg et al., 2007; Ure et al., 2007).

The research carried out on this programme, and reported in part in this paper, highlights the gaps and barriers faced by SMEs in five regional solar energy clusters – two early stage clusters (Portugal and the USA), two growth stage clusters (Italy, Spain) and one mature cluster (Germany). These are a subset of the ten clusters reviewed, where the study is now complete. It and considers some of the implications for managers and policymakers if the aspirations for innovation and employment are to be realised in the way intended, using qualitative field studies with stakeholders, and validating this with more quantitative surveys of a wider group. We report here on one strand of this research, looking at barriers to communication between stakeholders with the cluster as a key interface for design and implementation. The guiding research question of this study is: What are the recurring barriers to the alignment of knowledge and interests which impact on the competitiveness of clusters in relation to SMEs in the solar energy supply chain?

2. Theoretical context

2.1. A macro-economic perspective on clusters

Clusters can be seen through many different lenses. From the point of view of economists aiming to design a competitive business model for regions, theory has historically been dominated by Porter (1996) who introduced cluster theory in the context of early debates on globalisation. Although clusters had long been a feature of the economic geography and the British economist A. Marshall discussed the phenomenon using the term industrial districts as early as 1890 (Marshall, 1890), their influence on regional policy and strategy has grown steadily as the nature of competition has evolved, and as companies restructured their approach in response to the threats presented by cross-border networked markets (Porter, 2003). According to this view, for a cluster to evolve there must be critical mass of companies that agglomerate along a value chain in geographical proximity to each other. Clusters can share expertise and create value in inter-organisational supply chain networks. Physical proximity in clusters can benefit from the generation of positive externalities in terms of benefits between firms and overlapping clusters, e.g. knowledge spillovers, sourcing opportunities and specialized infrastructure, increase productivity and prosperity and fertilize overlapping clusters (as with the clusters in Central Germany, California and Italy which will be discussed later). Numerous authors have discussed the interfaces where this can add value in clusters (Carbonara, 2004), the potential benefits in terms of competitiveness and speed of innovation (Vaccaro et al., 2010; Kodama, 2005), and the knowledge management strategies which may be adopted (Evrard Samuel et al., 2011), however the barriers to communication and collaboration which SMEs feel they face, are less evident in the research literature.

Porter (2009) and others (Atkinson and Audrete, 2008) now acknowledge that, in practice, there are many more context specific barriers to communication and collaboration which need to be better understood, to complement current theories of cluster economics and public policy. Research with stakeholders can inform policy makers about the gaps and barriers to the

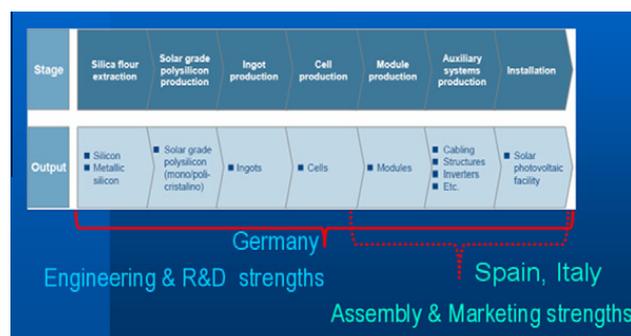


Fig. 1. The process of producing and installing solar energy modules (adapted from Little, 2007).

aims of clusters as a focus for the strategic alignment of interests and resources to common ends in a competitive market, where the strategic alignment of knowledge and resources to common ends is paramount (Lyytinen and Damsgaard, 1998; Alt and Fleisch, 2000; Evrard Samuel et al., 2011; Reimers et al., 2010). There is increasing awareness that this is a particular issue in large scale socio-technical complexes, such as supply chains, and supply chain clusters, where there is growing evidence of lack of support for SMEs that can result in problems for both SMEs themselves, and for the cluster as a whole in innovation and job creation (Dainty et al., 2001; Gray et al., 1995).

Our earlier work with oil and gas clusters in the UK and in Western Australia (Ure et al., 2007; Jaegersberg et al., 2007) suggest that SMEs are often poorly represented in policy making, and poorly integrated into the historical and the digital communication infrastructure in the implementation phase, with significant impact on the competitiveness of cluster as a consequence – particularly with regard to innovation.

2.2. Solar energy clusters in context

The cluster-based business model is more community-based, and collaboration is a pre-requisite, in contrast to the traditional leadership-centred paradigm of many other especially large enterprises, where communication is more top-down. This is particularly so in the context of the solar energy supply chain cluster, which is highly dependent on collaboration with different suppliers, and with other entities supplying services, products, information and expertise. A look at the nature of the process of producing solar panels makes the critical nature of communication between players clearer (see Fig. 1).

The process of producing and installing solar energy modules requires a range of different kinds of expertise at different stages, with the latter stages providing the most opportunity for SME involvement. Different problems and opportunities arise at each stage, from the acquisition and production of the silicon for use in the photovoltaic cells, to the production of the modules, and at the end of the chain to the tailoring and installation of particular solutions by mainly regional SMEs.

Much of the value sought for the region from such initiatives comes from the opportunities for SMEs to provide employment and expertise by bringing together the elements to meet individual requirements - from arranging the licensing and certification process to installation and maintenance. There is also the value of the production of energy itself, again very dependent on the success of small scale producers themselves. In addition there is the expectation of benefits accruing from the demand this creates for solar energy, and the additional employment opportunities for project developers, architects, designers, and companies qualified to do cabling, installation and maintenance.

The latter two stages of the process promise many of the benefits for the production of both energy and downstream products by SMEs but are self-evidently dependent on the collaboration of multiple players, including those from other sectors such as the construction industry. However, this is predicated on the coordination of knowledge, services and disparate stakeholder interests to enhance cluster competitiveness.

2.3. A socio-technical perspective on clusters

Many of these are socio-technical or socio-political issues in the communication and coordination of disparate interests. It is here that knowledge transfer is most crucial, and depends in part on the ability of policy makers and regional economic development entities to facilitate a collaboration and communication infrastructure that allows for representation of their interests as the cluster evolves. Our earlier work with oil and gas clusters in the UK and Western Australia (Ure et al., 2007; Jaegersberg et al., 2007) prompted a focus on the representation of SMEs in policymaking, and their experiences of collaboration and communication with other players, where power relationships, access to information and resources and representation with other stake-holding players appeared to be problematic.

This research is intended to provide a more detailed focus of some of the very recurring barriers SME managers report, particularly with regard to communication infrastructure in this paper. In this we draw on a range of studies that take a largely socio-technical perspective on clusters, as distributed organizations where the technical and the human infrastructure can be aligned or misaligned, with significant consequences for performance as a whole (Ure and Jaegersberg, 2005).

The increasingly digital mediation of work processes in eBusiness and eHealth contexts has provided a broader stage for observing the reconfiguring of digital territories by both technical and human actors. Bowker et al. (forthcoming), Castells (2004), Bourdieu (2005), Orlikowski and Yates (1998), Weick (1995) and Bijker et al. (1989) all refer to this process of collaborative structuration by stakeholders, drawing on Giddens' initial work in this area of sociology (1993).

The social shaping of technology and the alignment of technical and human infrastructure (Williams, 1995; Molina and Michilli, 2002; Kinder and Molina, 2001; Wong, 2009; Fountain, 2008) features strongly in social studies of science and technology, in computer-supported collaborative work (Ribes et al., 2008; Dourish, 2004; Ackerman, 2000), and in actor network theory (Callon and Latour, 1981; Latour, 2005).

Mumford and Trist's work on socio-technical systems in early industry contexts also provides a useful framework for understanding the importance of identifying the critical interfaces where technical and human infrastructure need to be aligned, and where recurring problems may arise.

As distributed digital infrastructure has scaled up in HealthGrids, extended enterprises and in large scale eScience infrastructure, socio-technical approaches have provided a useful framework for understanding how the grounded interaction of actors in context impact on the performance of large, distributed entities (Jackson et al., 2007; Edwards et al., 2007; Baxter and Sommerville, 2011; Ure and Jaegersberg, 2005; Ure et al., 2009b).

2.4. The crucial role of communication infrastructure

Studies of strong clusters suggest these foster innovation through knowledge exchange and access to related services and expertise, and in this, the communication structure – both real and virtual plays a key role (Won Sonn and Storper, 2008; Audretsch and Feldman, 2004). It is the barriers to effective communication that is the focus of this paper, and in particular, the barriers to effective communication with other stakeholders within the cluster – what Muro (2010) describes as the ‘missing middle’.

Substantial investments in innovation have not always achieved their objectives, and interest is now more focussed on the local dynamics that underpin this, and on the problems and approaches adopted in other regions, both for local policy decisions, but also to inform national programmes.

Our early work in growing oil and gas and automotive clusters (Ure and Jaegersberg, 2005) suggested that (local) SMEs are often disadvantaged in the context of clusters and strategic alliances, and that the social and digital communication infrastructure they inherited was not designed to facilitate their inclusion.

2.5. The implications for theory and practice

The more extensive nature of the research – across multiple regions – has provided us with an opportunity to explore these barriers in more depth, and to contribute to both a theoretical and a practical understanding of the recurring issues of alignment between the different stake-holding communities, at different stages, particularly from the perspective of SMEs, and particularly where this is mediated by information systems. In this sense, the more contextually-grounded theories of socio-technical infrastructure development can complement the more generic principles of macro-economic theory. The wider study also has implications for trans-regional collaboration between clusters, in relation to the management of very recurrent problem scenarios.

3. Research methodology

We have used both qualitative and quantitative approaches in complementary ways, but concentrate particularly on the qualitative feedback, as only regional stakeholders themselves are able to provide the insights about the barriers which impact on work processes, and which can inform better policy and strategy development. Qualitative research (Lewin, 1946; Denzin and Lincoln, 1994) was seen as an appropriate methodology to adopt and can of itself often act as a catalyst for both knowledge transfer and change, providing opportunities for exchange and re-alignment often not available between communities in a rapidly evolving and distributed network. (This is an aspect we will return to in the discussion in relation to the alignment of SMEs and Universities’ interests and resources.)

Table 1
Country cluster × research activities.

Regional clusters	Research activities			
	Cluster mapping	Semi-structured interviews	Questionnaires circulated	Survey return rate (%)
Italy Lombardy, Veneto, Emilio Romagna	✓	36	256	22
Spain Valencia	✓	15	-	-
Portugal Baijo Alentejo	✓	11	339	16.8
UK Scotland	✓	16	266	15.4
Germany Saxony, Thuringia, Saxony AH	✓	12	297	21.5
South Africa Johannesburg	✓	11	251	21.5
Chile Antofagasta	✓	12	272	15.4
USA California	✓	17	252	23.4
Brazil Rio Grande del Sul, Ceara	✓	2 ongoing	Ongoing	Ongoing
Canada B.Columbia Alberta, Ontario	✓	5 ongoing	Ongoing	Ongoing
N=	✓	137	1933	Av. 19.4

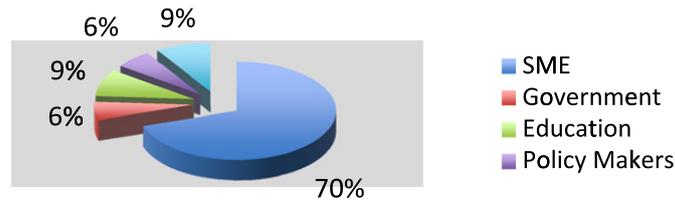


Fig. 2. An overall breakdown of stakeholders interviewed in the five target regions.

3.1. Research aims

The research aimed to

- Explore the recurring barriers that SMEs perceive as impacting on their ability to incorporate effectively into the cluster as a whole, where they are widely seen as crucial to innovation, competitiveness and the ultimate goal of many regional clusters – wealth and job creation within the region.
- Highlight the implications for policymakers, and other stakeholders in the region to facilitate the provision of more dynamic processes for collaborative exploration and engagement with emerging issues, and for learning also from other clusters at different stages of evolution who may have addressed some of these issues.

Given limitations of space we focus here on one of the key barriers that users identified, in the communication/coordination infrastructure to exemplify this approach. The full study of the issues, across all 10 clusters in Table 1 will be available in book form in 2011/12.

Clusters in each of the five regions included in this paper were mapped using desktop research and interviews to generate a digital representation of the key players, and where possible to the nature and frequency of communication between stakeholders. Semi-structured qualitative interviews were carried out with 136 stakeholders (see Table 1). These were transcribed and coded until the stage of saturation (no new issues emerging) and the next step was the circulation of a questionnaire with the critical issues to validate the interview findings with a larger group of SMEs in the region, based a database of 300 organisation in each region. The average return rate for this was 19.4%.

3.2. Sample

While the focus was on SMEs, and these formed the bulk of the interviews and questionnaire follow ups, we also interviewed other stakeholders from industry, government and academia. These are presented in Fig. 2. There is an extensive breakdown for each cluster available from the authors.

3.3. Research questions (communication with other stakeholders)

We present the results of one subset of the research here – in relation to communication. Within this, context we asked interviewees about their experience of communication and collaboration in clusters at different stages.

4. Qualitative results

The interviews provided an insight into a number of problems faced by SMEs in attempting to take successfully forward innovative developments in the regions, and shed light on barriers to the policies in place. The following recurring problems perceived by SMEs were detected.

4.1. Communication barriers associated with IT mediated services

The interviews underlined significant communication barriers with IT infrastructure. In particular, they highlighted the role of information systems, and especially portals in facilitating or hindering some of the core processes where actors in the cluster must cooperate in the exchange of information and services.

The market isn't functioning because of the failure of the registration system. . . There are more clients than capacity due to the faulty functioning of the registration site."

As for the dispute about registration in the field of microgeneration, there exists a monopoly . . . there is a procedure at the beginning of the process here that benefits some and prejudices others.

If all companies had equal access, there would be competition based on technologies and sales and not on a question of who has the best access. . .

SMEs, Portugal, Emerging Cluster

Significant differences between clusters at different stages of development were also evident. In less mature clusters, poor access to information and services were seen as leading to unnecessary delays and difficulties for SMEs as a major concern – leading to loss of clients, and in a number of cases, insolvency. This was not as a function of lack of demand for their products and services in the market, but as a function of the unnecessary delays and constraints in both the inter-organisational processes, and particularly, in the online processes (typically a portal) which SMEs were required to engage with to access the information and services (e.g. licensing) which they needed.

This was most frequently raised in relation to the management of feed-in-tariffs (FITS) used to incentivise the adoption of small scale solar solution, under licence, by SMEs. This is a key process – the engine of the cluster dynamics – and the difficulties many managers describe provide a microcosm of how local dynamics on the ground impacted on the effectiveness of a key area of policy.

We always have problems of an administrative and bureaucratic nature because the process of licensing and authorization are always lengthy...

SME, Portugal, Emerging Cluster

Bureaucracy is a big showstopper sometimes and it costs a lot of money.

SME, California, Early Stage Cluster

(Need for) simplifying the authorization procedure, accelerating the mechanism of the procedure to license and install, is one of the principal barriers to SME innovation...

SME, Italy, Growth Stage Cluster

What the EEG rules – this feed in tariff – that's what drives the whole thing.

SME, Germany, Mature Cluster

Managers of SMEs in *mature clusters*, such as the solar cluster in Central Germany (Saxony, Thuringia and Saxony AH), spoke of streamlined and expeditious processes, while those in *emerging clusters*, particularly in rural areas with no indigenous business culture, often felt the communication infrastructure did not meet their needs, and in some cases, had been designed and implemented by larger companies in ways that were prejudicial to their commercial interests.

While SMEs in all clusters spoke of bureaucracy in relation to accessing of funding and permits, the impact was highest in emerging clusters, where other networks and channels of communication and collaboration were not present. In more established clusters, this was mitigated by the existence of pre-existing or overlapping networks.

Emerging or early stage clusters, such as Baixo Alentejo in Portugal, are often rural and sparsely populated regions with a lack of industry, little established business culture, limited links between business, Universities and government organizations, and very few international links. SMEs in these contexts felt particularly poorly integrated into the cluster at a real as well as a virtual level, with little representation in regional decision-making that shaped this environment (We discuss communication with other stakeholders later in this section).

Some emerging clusters, such as the Californian solar cluster, however, were able to leverage the existing technical, social and organizational networks of other overlapping clusters and networks (in particular from semi-conductor, optics and nanotechnology industries). They had access to a dense concentration of specialized services, an extensive R&D infrastructure, and a shared culture of innovation, and the availability of venture capital (Rolletschke 2010).

In *Growth Stage clusters*, such as Italy and Spain, which are beginning to mobilize resources, and where a number of incentives and policy measures are in place to stimulate activity, the representation and inclusion of SMEs is still seen as very limited, with many examples of bureaucratic barriers to work processes, and limited opportunities to represent concerns about barriers or issues. Many of the processes and practices (real and virtual) within the cluster were seen as being designed and managed by and for the interest of other, better connected players in the cluster. Often these were larger companies attracted to the region by favourable incentives offered by the region.

In Spain, in the Valencia region, for example, the cluster is dominated by small family-run companies with strong, culturally-rooted networking skills and supported by high feed-in-tariffs. This speedily attracted foreign companies investing in large scale photovoltaic plants. The management of that policy in practice led to an overheated market that was over-exploited by LMEs but did little to benefit SMEs. Government introduced a cap in 2009 leading to a downturn in the industry, withdrawal of many investors, and a consequent failure in the socio-economic development that cluster policies had been designed to foster. (Brunner 2009).

In Italy, in the regions of Lombardy, Veneto and Emilia Romagna, the overlapping clusters (automotive, motorcycle, chemistry, optics, shipyards, banking sector) are highly networked, and also reflect the family based business culture for which the region is famous. However, political instability has contributed to a lack of clear overarching policy to support the development of the industry on the ground, and particularly in relation to these SMEs (Jaegersberg and Ure, 2008a).

Mature clusters, on the other hand, had typically developed a rich and highly networked set of actors with well established vehicles (social, organizational and digital) for engaging with other actors, and representing their various interests. The solar cluster in Central Germany for example, benefits from a long-standing tradition in engineering and in particular from the overlap of the microelectronic cluster in the Silicon Saxony/Cool Silicon triangle, and from the resources of 30 businesses, ten research centers, and four universities that represent the entire value chain.

The mapping of the clusters top-down combined with exploring comments of interviewees bottom-up threw into relief the importance of implementing policies in ways that reflected (a) the requirements of SMEs in that context (b) the particular barriers and opportunities in terms of the characteristics of the cluster, and its stage of development.

4.2. Communication barriers between SMEs and policymakers

SMEs felt that they were disadvantaged as stakeholders –. They felt that their voice was not heard by policymakers and nor were their needs taken account of.

Many of the funding programmes for SMEs are well designed in theory, but normally the bigger companies benefit from these programmes, ...because, in theory things function well, but in practice they don't ...

There are good technologies that should be used on certain occasions because they are simply better, but they are not sold because the company selling them is very small and doesn't know anybody from ...the big family...

There is lack of dialogue in areas of mutual interest [between SMEs and policymakers] to speak about what people think.
SMEs, Portugal, Emerging Cluster

Policymakers are not interested in talking to small companies. They just talk to companies which have deep pockets

Policymakers seem to listen a little more to the big guys ... and ... utilities of course.
SMEs, California, Early Stage Cluster

Generally, it can be said that it is much more difficult for SMEs to have representations with policymakers than for LMEs, however, at a municipal level SMEs are given a lot of possibilities to participate.
SME 1, California, Early Stage Cluster

In general, in Italy there is little attention to SMEs, ...I'd say it's almost only an issue when there are elections.
SME, Italy, Growth Stage Cluster

The basic conditions ...with regard to the Economic Development Corporation and also of policies ...are very good here. Right from scratch ...we've been supported on the business and the policy side.
SME1, Germany, Mature Cluster

SMEs in emerging and developing clusters lacked fora (real or virtual) to represent their interests, develop or promote their innovations, and their requirements at a senior level where policy or practice was being determined. This impacted on their survival in and integration with the cluster as a whole. A lack of vehicles for communicating their interests at a senior level impacted on basic issues such as fair payment practices, risk and liability, and access to the services and resources other stakeholders held in early stage and developing clusters. Policy implementation (from an SME perspective) lacked a grounded understanding of the factors on the ground to ensure that regional clusters are successful.

The results across clusters highlighted the need for a more focused analysis of where and how SME interests and requirements could be fed back into the decision-making process, and the implementation of regional policy initiatives in the context of individual clusters. By contrast, SME managers in successful, mature clusters pointed to a range of opportunities for exchange with other stakeholders afforded by the cluster, and expeditious processes in core areas such as registration, licensing and collaborative working and research agreements.

SME associations in many of these emerging or developing regions were also seen as having very limited influence with policymakers.

The ASIF (Asociación de la Industria Fotovoltaica) doesn't have a lot of power against the government. So they can not push this sector properly... We need a more powerful association.
SME1, Spain, Growth Stage Cluste

In Italy, policy is a delicate issue... It is difficult in Italy, the PV (photovoltaic) lobby is not very big... so that one cannot exercise a lot of pressure.

There is a lack of political will. Basically the law is good, but with the lack of functioning and political vision it's not functioning the way it should. This must be changed rapidly... [otherwise a great number of recently established SMEs] must close down.
SME 3, Portugal, Emerging Cluster

SMEs in all clusters also felt that they were less well connected to some extent, particularly with regard to information about funding or incentives.

People are limited on their information about the stimulus package. . . nobody really knows how to use it properly. I do not know if it is just not enough initiative by them or a lack of information provided.

SME 2, California, Early Stage Cluster

4.3. Communication between SMEs and Universities

The interview results revealed a series of difficulties at the interface between SMEs and Universities/R&D Institutions. Across the areas of research, training and innovation they were regarded as unsatisfactory partners by SMEs in all the emerging and developing regions. Also concerns about ownership of the fruits of collaboration were expressed. SME experiences in attempting to engage/align their interests with Universities in their regions were problematic in all the regions. In mature clusters the picture was different with clear benefits being attributed to the collaboration with SMEs.

4.3.1. Difficulty/bureaucratic complexity of collaboration

Research and development are difficult to do in Italy – even if it is important. Have you ever seen a contract of R&D collaboration with a University? It would be less complicated with NASA.

SME2, Italy, Growth Stage Cluster

4.3.2. Lack of relevant skills in research and in training

It is absolutely impossible to find anyone who has been studying anything related to renewable. . . who has been working before in a solar industry company or has been studying solar theoretical or calculation studies.

SME3, Spain, Growth Stage Cluster

One of the principal barriers to SME innovation. . . is the lack of University researchers specialized in the sector.

SME2, Italy, Growth Stage Cluster

At the moment, there's no basic course. . . in renewable energies.

SME4, Portugal, Emerging Cluster

This was at its most obvious in emerging and developing clusters, where it was clear that regional universities were not providing the skills or training required by the sector. This provided an artificial break in a sector where demand was high. Additionally, it meant that far from providing regional employment, skills had to be sought from outwith the region – quite the opposite of the professed aims of the cluster.

4.3.3. Problems with IP

SMEs cannot benefit from research results - University of CA wants to keep IP.

SME3, California, Early Stage Cluster

University of California has been taking the stance for a very long time that they should have the full ownership of all of the IP. And that really hurts the UC because it is a killer for start-up companies.

University project manager, California

The competitiveness in clusters is correlated with its ability to innovate, with patent applications being one indicator of this. A significant barrier in developing clusters was the issue of ownership of IP, which mitigated against the kind of alignment and strategic alliances that clusters aim to foster.

There were therefore quite clear implications here for policymakers seeking to enhance the potential for innovation, and the development of relevant skills in the region, as well as issues of copyright, and with regard to the difficulties of collaboration with entities with such different objective.

4.3.4. Barriers to research collaboration

As indicated earlier, mature clusters identified real benefits from collaborative alignments with Universities in the context of research, emerging and clusters found these relationships difficult if not impossible to initiate, and unsatisfactory in their outcomes. Managers of SMEs in Portugal pointed to a lack of relevant research opportunities with Universities, and difficulty accessing funding for that research.

Government doesn't conduct any basic research, and this is needed for making progress in general in the field of technology. Also practice-based research is needed. But without basic research you'll get nowhere.

SME4, Portugal Emerging Cluster

Normally, for some reason, the money ends up in the pockets of large companies, when it comes to research. Because it's distributed through big programmes. . . and for some reason, it's normally large companies winning projects.

SME5, Portugal Emerging Cluster

By contrast, in mature clusters that have developed successfully the comments are more positive, and point to a range of facilitating activities in all of these areas.

The readiness of research institutions to cooperate is definitely praiseworthy. Universities, we work with, it all works fine.
SME 2, Germany, Mature Cluster

We've had quite excellent experiences here in Saxony. We are in contact with different Fraunhofer research Institutes. We are in contact with Technical Universities and other Universities. . . there we have very good contacts.

SME 3, Germany, Mature Cluster

The basic conditions are excellent in Saxony, and it is always up to you yourself if you use them or not. . . we are very well networked, have all sorts of relationships and have running research projects in Saxony.

SME 4, Germany, Mature Cluster

5. Discussion

5.1. Summary of findings

It is generally accepted that for a cluster/economy to prosper, SMEs must be well integrated (Estimè, 2008; Europe, 2009), yet it was evident that SME managers in the emerging and developing clusters felt neither the real nor the virtual communication infrastructure were designed to facilitate strategic alliances. On the contrary, many felt disenfranchised, and constrained in their ability to operate, or to shape the operating environment. Integrating and sustaining small scale producers falls at the first hurdle if the central licensing process for generating and feeding in electricity to the Grid is hard to negotiate, or limits access to some players.

The comments of interviewees, substantiated by the questionnaires, highlight the constraints that the communication infrastructure (or lack of it) could have on the communication and collaboration that underpinned the working of the cluster as a whole, and the benefits accruing to particular stake holding groups.

In the successful mature clusters such as Saxony, SME managers highlighted the number of opportunities to engage with other actors, and the ease and expeditiousness of collaborative processes, and services. The process of moving from the early stages, where SMEs are typically poorly represented and supported, to this stage, is not certain, and this research suggests that active measures to better integrate SMEs into that process can be a factor (Vaccaro et al., 2010; Kodama, 2005). If clusters are to realize their objective in practice and create wealth for the region, these results suggest a better theoretical understanding for processes on the ground should also inform policy implementation particularly in relation to SMEs as the engine of the growth and job creation that clusters aim to generate (Estimè, 2008; Wong, 2009).

SME managers in some clusters perceived their lack of representation and influence in decision-making at cluster level allowed other players to shape the environment in ways that constrained full, timely and equitable access to key information, services and resources. The opportunity to be represented in the ongoing shaping of roles and relations in these new digital territories was seen as an influential part of the accommodation and the reconfiguring process required to stabilise the implementation of new infrastructure. This is consistent with the literature, which suggests that changes in inter-organisational infrastructure – both real and virtual – may be to the advantage of some stakeholders over others (Callon and Latour, 1981; Gray et al., 1995), and may generate opportunities for different value propositions (Bourdieu, 2005), particularly in the context of digital infrastructure.

5.2. Implications for theory, policy and practice

Much of the discussion in renewable energy to date has centred on more macro-economic policy issues of cluster development (Mendonça, 2010). The paper contributes to both theory and practice in highlighting the complementary nature of traditional economic theories of cluster development, with socio-technical theory, grounded theory and collaborative action research as a basis for better informing policy and practice.

The authors suggest that there are recurring problems at different evolutionary stages which can (and should be) anticipated in the design and implementation of policy measures and other incentives, either through

- pro-active efforts to ensure that there are opportunities in early stage clusters for the kind of social or socio-technical interaction through which knowledge is created,
- better vehicles for the representation of SMEs in the development of policies and practices,
- collaborative research and development with stakeholders,
- sharing knowledge and experience of recurring problem solution scenarios between regional clusters at different stages.

The potential for learning across regions is consonant with suggestions by the EU Cluster Observatory, and the spirit of the Aho (2006) enjoining regions to leverage the diversity of expertise in Europe as a resource in itself.

The collaborative action research process used in our initial pilot studies, acted as catalysts for this process, and provided a bridge between policymakers, players Inc., SMEs and Universities providing training and research support (Ure and Jaegersberg, 2005; Ure et al., 2007; Jaegersberg et al., 2007).

While technical infrastructure may scale, the social infrastructure of multiple linked communities rarely does. The alignment of distributed technical and human infrastructure here invokes many of the challenges found in other socio-technical complexes – in large scale eHealth infrastructure (Nicolini, 2010; Ure, 2010) and in software applications (Dourish, 2004). The different value proposition of Web-2.0/social networking is reflected in the design of the communication and coordination infrastructure that leverages the knowledge of local communities (Sawhney and Parikh, 2001; Tapscott and Williams, 2007).

5.2.1. Learning from clusters at different stages, in different regions and in different sectors

The recurring nature of the issues identified suggest that potential for early and growth stage clusters to learn from the experience of other more mature clusters, in this sector, and in others. The traditional energy sector has already provided examples of how clusters can learn from each other in relation to similar issues relating to SME support. In the North Sea oil and gas supply chain for example, the use of a model of competitiveness based on cost-cutting and economies of scale under-mined regional SMEs and impacted on innovation capacity. As a result, strategies were developed to provide better support and better for SMEs in the development and implementation of policy and practice.

Facilitating video-conference based exchanges with representatives of the supply chain in both countries allowed a less mature region to avoid some of the known risks and adapt strategies identified in more mature clusters for supporting SME integration within the supply chain cluster (Ure et al., 2007; Jaegersberg et al., 2007). They included strategies such as (a) mentoring between SMEs and LMEs, facilitating opportunities for benchmarking with other regions (b) communicating future development plans of large and medium sized operators in the region at Share Fairs with coordination of direct contacts and support from funding agencies and knowledge transfer partnerships with regional Universities (c) enhancing support infrastructure for SMEs including implementation of good practice in contracting and payment that do not penalise SMEs (d) providing opportunities for brokering and coordination of the efforts of education, industry and government at a senior level where SMEs have better opportunities to shape policy with other players (e) providing better representation at a policy level for SMEs in terms of interfacing with policy makers, (f) mentoring between SMEs and LMEs in the supply chain, and with financial and research support organisations to align product development and innovation.

5.2.2. Using collaborative research to (a) inform policy implementation and (b) as a catalyst for change

Collaborative action research with stakeholders was a useful strategy in this regard, in previous work in automotive and oil & gas clusters, (Jaegersberg et al., 2002; Jaegersberg and Ure, 2005, 2007, Jaegersberg and Ure, 2008b; Jaegersberg and Ure, 2010; Ure et al., 2007). This approach is also increasingly evident in the collaborative design and development of other kinds of distributed infrastructure where new platforms for collaboration need to be developed to represent disparate interests, to reconfigure roles, risks and resources, and to generate the kind of value associated with strategic alignment in eBusiness and in eScience (Ure and Jaegersberg, 2005; Ure et al., 2009a,b; Tan, 2005; Andersson et al., 2008; Hammer and Champy, 1993; Nicolini, 2010).

Collaborative representation by this, or other means, is not only more democratic, it is arguably a good business model, mobilizing crucial local knowledge and agency in the design of usable systems, with synergies between stakeholders, and a vehicle for the constitution of new roles, rights, access to resources and liability for risks (Ure et al., 2007).

6. Conclusion

Porter (2009), Atkinson and Audretsch (2008), Atkinson and Wial (2008) point to the role of recurring communication issues, poorly aligned incentives and a lack of understanding of context specific issues in regional clusters. Muro and Katz (2010) identify a greater focus by policymakers on 'the grainier real-world dynamics of regional economies' and 'a timely new focus for policy (on clusters) after years of disdain for the messier practical processes by which value and advantage are created'.

Many of the issues identified were evident across regions and sectors, suggesting there is a case for (a) anticipating and learning from the problems and the solutions experienced in other clusters at different stages of maturity as in the oil and gas sector studies cited (b) involving stakeholders and SMEs in particular in collaborative research and development in a rapidly changing business environment.

As Kolb and Fry (1975) and Freire (1970) have both suggested in different contexts, empowering under-represented stakeholders on the ground generates change, and the evolution of clusters is dependent on real and virtual communication infrastructure to facilitate that. Supplementing the more generic, top-down approach of economic theory with the more bottom up approaches The community-based cluster model can only function in practice if communication also works bottom up.

In the extended supply chain there are many interfaces, local, and global, where co-evolution of knowledge can take place, and regional clusters are key emerging interfaces where policy makers and managers have a key role in creating the scaffolding and fostering the processes that can support it.

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