Valuing Knowledge Assets in Renewable Energy SMEs: Some Early Evidence

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Abstract: It is widely recognized that knowledge-based resources and assets are fundamental to performance improvement and organizational value creation. Limited progress has been made, however, in valuing and managing organizational knowledge in Small and Medium Enterprises (SMEs) operating in the renewable energy sector. This paper provides first insights of an ongoing research project managed by the Intellectual Assets Centre in Scotland, in order to support the adoption of knowledge asset management initiatives for driving the improvement of value creation mechanisms of SMEs operating in the renewable energy sector. We employ research related to resource-based and knowledge-based theory and performance measurement and management, to gain a better understanding of how Scottish SMEs operating in the renewable energy industry acquire and manage knowledge assets in their bid to improve performance and value creation. Using a sample of organizations from the Scottish renewable energy sector we draw first insights about their perception and orientation to identifying, measuring and managing knowledge, and to qualitatively identify a feasible set of knowledge resources and assets potentially driving performance improvement. The first evidence indicates an awareness of the relevance of the knowledge-based factors, and engagement in knowledge acquisition and creation processes. These firms possess a good endowment of knowledge assets, with significant internal knowledge management processes, but also external inflows from agents such as firms and education or research institutions. However, the visible lag in the exploitation of knowledge assets and processes, together with observed under-financing of the sector and difficulty in accessing skilled labor, indicates the need for efforts to better address specific needs of renewable energy sector SMEs.

Keywords: renewable energy, renewables, intellectual capital, knowledge asset management, Scotland, SMEs

1. Introduction

Great attention has increasingly been placed on the role and relevance of the Knowledge Asset Management (KAM) to support and drive the improvement of organizational performance in the energy industry (Edwards 2007; Foxon et al. 2005). However most of the interest has been developed by big oil companies searching for improvements in their efficiency (Etkind et al. 2003; Nelson 1997; Smith and Farquhar 2000). On the other hand, SMEs operating in the energy industry, and particularly in the renewables sector, are increasingly recognizing the relevance of KAM, even if they still do not have formal KAM initiatives in place within the organization. Indeed, SMEs' knowledge and intangible assets are fundamentally managed implicitly, i.e. without the use of formal approaches and tools (Weir et al. 2009). Moreover, although knowledge—based resources and assets are recognized as being fundamental to organizational success (Carlucci et al. 2004; Schiuma and Lerro 2008; Schiuma et al. 2008), the tools for valuing organizational knowledge in renewable energy industry are still crude and often inadequate.

In this paper, we suggest a process for valuing organizational knowledge that can be effectively applied in the energy industry and specifically in renewable sector. On the basis of a literature review (Wilcox King and Zeithaml 2003), Using a sample of organizations from the Scottish Small and Medium Enterprises (SMEs) in the renewable energy sector, we draw first insights about their perceptions and orientations to identifying, measuring and managing knowledge. Following this discussion, the paper defines the next steps of the research, which, moving from the recognition of an awareness of the relevance of the knowledge assets as key-source of organizational value creation dynamics, advocates efforts to better address specific needs of renewable energy sector SMEs.

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2. A methodology for valuing organizational knowledge assets

To achieve a more fine-grained insight into knowledge resources and assets, we present a four-step methodology for valuing organizational knowledge in renewable energy industry constructed from practicing owners and managers' perspectives, and we test it with 8 Scottish organizations.

2.1 Step 1 - defining scope: Industry and organization selection

Industry and organization selection was driven by the aims of an ongoing research project managed by the Intellectual Assets Center in Scotland, in order to support the adoption of knowledge asset management initiatives for driving the improvement of value creation mechanisms of SMEs operating in the renewable energy sector. In particular, we selected established SME companies having well-defined boundaries and operating in: *solar energy*, i.e. the energy of the sun's rays that can be converted into other forms of energy, such as heat or electricity; *wind power (onshore and offshore)*, i.e. the harnessing of wind by turbines that convert the energy into electricity; *hydrogen*, as potential use in the operation of hydrogen-powered automobiles; *biomass*, which includes plants grown for the production of fuels; and *hydro-power (wave and tidal)*, harnessing of the sea or river water by turbines that convert the water energy into electricity.

Similarities in the competitive environment and value chains suggest consistency in industry context across competing organizations (Porac et al. 1995). Established industry boundaries reduce potential delineation issues that often arise when industry boundaries are fuzzier, or when an industry's competitive dynamics are influenced by different configurations of strategic groups (Porac et al. 1989; Mehra 1996). This control increases the likelihood that we can identify a relatively comprehensive inventory of knowledge resources and assets, and that owners and managers in the industry could evaluate their perceptions of the knowledge factors' importance to their companies' strategic success. In this case, we restricted the renewable energy by geography, domain, ownership and size (Graeff 1980). We solicited more than one hundred renewable energy industry companies and drew together a complementary cohort. We sent letters to these companies describing the project, requesting a participation in the research project and an interview with the owners or top-managers as well as inviting them to participate in a series of Workshops and Masterclasses about the project. In this paper we focus on our interactions with eight organizations. The involved companies had different core-business but by comparing key-variables for the sample of organizations we recognized no significant differences. These organizations include:

- Organization A a major regional market player in the civil engineering and construction sector, also recycling materials and supplies through its subsidiary business – Highland Recycling Limited.
- Organization B an environmental consultancy specializing in renewable energy, environmental
 and planning services for organisations investing in renewable energy and environmental
 projects.
- Organization C a firm promoting better use of energy and energy resources available locally through provision of education for local schools and communities on energy and energy efficiency, and acting as a promoter of developing renewable energy sources dominating in the locality of Argyll.
- Organization D a firm that concentrates its operations on servicing and operation of wind turbines and towers.
- **Organization E** a firm founded with an aim to help reduce the carbon footprint of buildings through improvements to the fabric and internal equipment.
- Organization F a specialist in the provision of equipment and services for renewable energy projects.
- Organization G a specialist in IP development and consultancy.
- Organization H a private membership body for the companies and organisations working and/or interested in energy sector.

2.2 Step 2 - research and protocol design: Building scholars knowledge

The next step began with in-depth research. On the basis of insights from a literature review (Weir et al. 2009) we improved our familiarity with industry-specific issues and terminology. This

understanding enhanced our credibility and enabled us to investigate richer and more probing questions when conducting the interviews. To structure the interviews with the owners or top managers, we developed a protocol that included an overview letter and a broad outline of questions. The protocol was pre-tested on a panel of academics and experts of knowledge management, performance management and energy industry, soliciting feedback regarding clarity, overall impressions and terminology to be used to improve organizations' participation. Based on their feedback, we decided to use the label "knowledge" as broadly consisting of research and development, ideas, skills, expertise and other information that is, or potentially can be, used to make the operation of a company more effective, "knowledge management" (KM) as the group of approaches, methodologies and tools used in an organisation to identify, create, represent and exploit knowledge to improve organisational performance and value creation, and "knowledge assets" as any resource made of, or incorporating, knowledge which provides an ability to carry out a process or an activity aimed to create and/or deliver value.

2.3 Step 3 - data collection: Survey of owners and top management to identify organizational knowledge resources and assets

To identify an inventory of organizational knowledge resources and assets we interviewed a range of renewable energy companies' owners and top-managers. Prior to each interview, we faxed and emailed the overview to the owners and top-managers to establish expectations for the meeting and provide initial guidance in scoping the knowledge resources and assets. During each interview, we asked respondents to identify the "knowledge or skills that may provide competitiveness" at their organization and in the industry. The interview involved an iterative process as the respondents talked through the sources of competitive advantage at the company and worked to articulate organizational knowledge on an appropriate scale, specific enough to clearly relate to ways organizational knowledge can add value in the industry, and general enough to allow for reapplication to support value in future endeavours. Interviewers used a line-by-line open coding method to generate a list of the knowledge resources and assets discussed during that interview (Strauss and Corbin 1990). For each organization, we then compared our lists and our notes for content, tone and accuracy and, following a discussion, determined a final company-specific list.

Based on these interviews, we identified 15 knowledge assets, 5 dimensions of knowledge assets, and 7 knowledge management processes in the renewable energy industry. In particular, about the dimensions of knowledge assets, it emerged the relevance of Human Capital (HC), i.e. competences, skills, abilities, know-how and leadership of their employees, Relational Capital (RC), i.e. relationships with customers, suppliers, community, regulators and other stakeholders, Organizational Capital (OC), i.e. all those assets tangible and intangible in nature characterizing companies' business model and relevant for creation, acquisition, use and diffusion of knowledge across organizational structure, Intellectual Properties (IP), i.e all codified knowledge protected by law such as copyrights, patents, ecc., and Technological Capital (TC), i.e. all those assets characterized by a technology-intensive knowledge. We made every effort to describe knowledge-based factors that were simple, not ambiguous and not "double-barreled" (DeVellis 1991). External readers familiar with the issues reviewed the final list of knowledge assets, dimensions and processes to confirm their clarity and comprehensiveness as well as the capacity of these assets to adequately define the business. These insights were incorporated into an explorative survey.

2.4 Step 4 - data collection: Explorative survey of owners and top managers to value organizational knowledge resources and assets

In order to value organizational knowledge resources and assets, a questionnaire was administered with owners and managers of twenty-four companies. These teams completed surveys appraising the knowledge factors generated through the interviews. The questionnaire was divided in four main sections for a total of 13 questions, 9 of which were using a 5-point Likert scale (Q1, Q3, Q5-10, Q13). In the Likert scale we used, point 1 means "unimportant" or "never" and point 5 means "very important" or "very frequently". Other questions (Q2, Q11) offered multiple choice answers with tick boxes, and included two variants: a) "Yes", "No", "Don't know" answers (Q4); b) "Yes", "No" answers (first parts of: Q9 and Q11). Finally, Q12 asked an open-end question where expected input data format was a number.

Data obtained were not manipulated and were reported as collected. The aim of the first section (Q1-Q3) was to investigate the level of awareness of the importance to effectively manage knowledge

within the organizations, identifying the ways by which knowledge is important to the renewables SME companies as well as the most important knowledge dimensions for maintaining or improving the competitiveness of the organization. The second section (Q4-Q7) was finalized to better understand the state-of-the art about the possession and the exploitation of knowledge assets by companies and the knowledge management processes organizations consider most important for their competitiveness. Specific attention was paid to investigate the knowledge sources that organizations use to undertake their innovation dynamics.

The third section (Q8-Q11) aimed to explore the knowledge flows and the relationships system in the renewable energy industry, in terms of collaboration engaged with universities or research centres around specific activities, relationships with the big energy companies, emergence of supply-chains among renewable energy industry companies, nature and characteristics of these relationships. Finally, the fourth section (Q12-Q13) was aimed to investigate the issue of the new products or services or adaptations to existing products and services made by the companies in the last three years as well as the most important constraints that the companies face in acquiring or creating the knowledge required to maintain or improve innovation dynamics and competitiveness. The questionnaires were treated confidentially. A total of eight usable surveys were returned, reflecting a response rate of 33%. The low level of the sample and the response rate determined that the survey was considered as a pre-test survey mainly based on qualitative data supported by the first empirical investigation to be further developed in the next steps of the ongoing research. Additionally, the data on companies was supported by the qualitative information.

3. First evidence and implications of organizational knowledge in Scottish renewable energy industry SMEs

Energy industry companies, and in particular SMEs in the renewable energy sector, are increasingly asked to create and support competitive advantages, especially in situations of rapid and unpredictable market and normative change, pressures about environmental issues, and increase of energy demand from developing nations. The knowledge asset management represents a fundamental way to improve and develop organizational value creation capacity. This methodology for valuing owners and managers' perceptions of knowledge assets makes a novel and important contributions to the Knowledge Management research streams. The level of awareness of the importance to effectively manage knowledge within the organizations is relatively high, scoring 4.37 on a 5-point Likert scale as indicated by companies. However, the identification of the ways by which knowledge is important to the renewable energy SMEs shows that companies still do not address some specific mechanisms enhancing their performance dimensions. In particular, SMEs do not recognize specific stronger impact of knowledge assets in terms of innovation, organizational value creation, competitors differentiation, strategic planning, finance, but attribute the same importance to all of these.

Regarding the most important knowledge dimensions for maintaining or improving the competitiveness of the organization, as shown in Figure 1, it emerges that SMEs pay particular attention to the Relational Capital (RC), i.e. relationships with customers, suppliers, community, regulators and other stakeholders (4.37), as, for instance, one interviewed does with its involvement in educating the local schools and communities on energy and energy efficiency. Moreover, the SMEs consider the Human Capital (HC), i.e. competences, skills, abilities, know-how and leadership of their employees, also very significant (4.25), what could be best shown by the example of a consulting firm employing well experienced staff, many of whom belong to specialist chartered bodies, such as Royal Town Planning Institute. However, competitive factors linked to Intellectual Properties (IP) and Organizational Capital (OC) have good relevance (respectively 3.12 and 3.00), while, surprisingly, the importance assigned to the Technological Capital (TC) has a lower value (2.50). This is a first aspect of difference in respect to the big energy companies that traditionally pay particular attention to the technological dimension of knowledge management (Weir et al. 2009). Moreover, at an aggregate level, renewable energy SMEs consider to possess a good endowment of knowledge assets, particularly in terms of reputation of the organization, organization's customers databases, organization name and logo, processes and technological know-how, relationships and quality of the human capital. As firm outlined:

'[Our] Major skills base is in the planning, in the technological bits and also in project management... It's a competitive market but not many companies actually specialize in the same way.'

'Currently, at this stage I suppose we've got a bit of a mix of consultancy with contractor... Depending on our client... we fulfil a consultancy role, supply, installation...essentially some contractor, but we're a manufacturer as well. And some of that we outsource so that's a combination we're using just now.'

'Well, we're first and foremost a consultancy, but about 30% of our sales come through subcontracted work... so it's quite a bit of outsourcing. They're all suppliers that we know.'

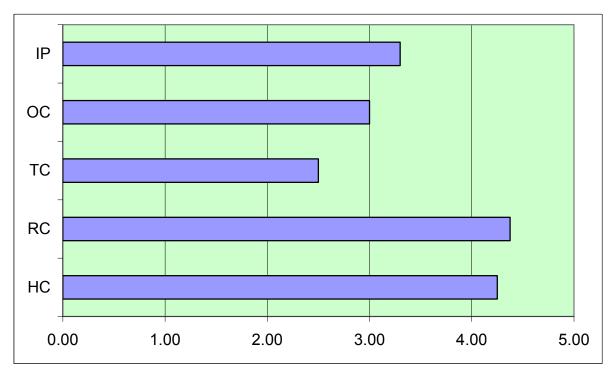


Figure 1: Importance of the organizational factors for competitiveness

However, most of the organizations from the sample are aware that for majority of these assets they have not taken steps to fully exploit or manage them and recognize the wide space for improvement in these areas in order to gain new sustainable competitive advantages in their industry:

'There's an awful lot of noise in the market about being the first wave business] or the first person to build a wave farm, the first person to build a prototype grid connected for. None of that matters if the devices actually don't deliver what the client's expected.'

'We are brand led but I think our model has to change to adapt to the market...if you're totally brand led then the brand should be strong.'

Figure 2a and Figure 2b depicts the levels of possession and exploitation of knowledge assets from Scottish renewable energy companies, taking into account that the respondents had the opportunity to select multiple choices in the questionnaire. For this reason, the scale of the graphs in the figures represents the cumulative responses for each item.

In terms of the importance of knowledge management processes for organizational competitiveness, as shown in Figure 3, the sampled renewable energy SMEs pay particular attention to the knowledge sharing within the organization (4.12), - i.e. the creation of organizational capital - are best pictured by the example of NSIG where all members (companies and organizations) have access to a wide range of skills and services. In addition to that knowledge transfer to the organization (3.87) - through the formation of relational capital - and the codification of know-how (3.75) - the transfer of human capital to organizational capital - are also significant knowledge management processes, as has emerged from the focus group for Scottish renewable energy SMEs:

'Certainly, the wind industry is still evolving. [But] the feedback [about specific installations] from the performance in the field back to the manufacturers is huge.'

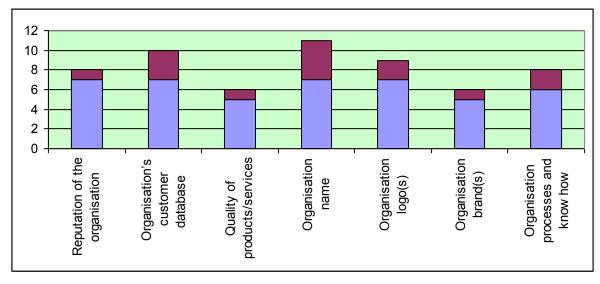


Figure 2a: Possession (in blue) and exploitation (in red) of knowledge assets

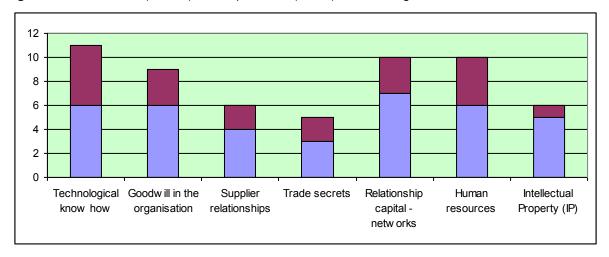


Figure 2b: Possession (in blue) and exploitation (in red) of the knowledge assets

Regarding the process of knowledge creation through learning mechanisms (3.12) facilitated by organizational capital, most of the respondents underline again the importance of the relationships with other firms, universities and research centers and institutions, as in the case of a firm associated with the University of the Highlands and Islands, while limited attention is paid to communities of practice. Decision Support Systems are not considered particularly relevant for competitiveness and this aspect can be a second element of differentiation in respect to the traditional energy industry companies. However, it is important to underline that companies do not still have explicit awareness about how knowledge assets are affected by each process and in what way.

Regarding the sources of knowledge for undertaking innovation, as shown in Figure 4, at the aggregate level, SMEs effectively use a wide spectrum of modalities. According to a Likert scale 1-5, strong relevance is assigned to the external dimension of sourcing knowledge, in terms of analysis of the competitors (3.75), conference, trade fairs and exhibitions (3.62), scientific journals and trade and technical publications (3.50), suppliers and customers (3.12). However, internal sources (3.25) are still important at the same level as the external ones, while potentialities still not fully exploited stand in building better collaborations with commercial laboratories, institutions, research centers and universities as well as with consultants highly-skilled in KM in renewables. Moreover, it emerges that SMEs source knowledge mainly from organizations and companies located in Scotland, and then in UK, while contacts overseas are very limited. This insight highlights a possible need for a stronger internationalization of the SMEs and alliances to search new inspiring sources of knowledge driving their value creation dynamics:

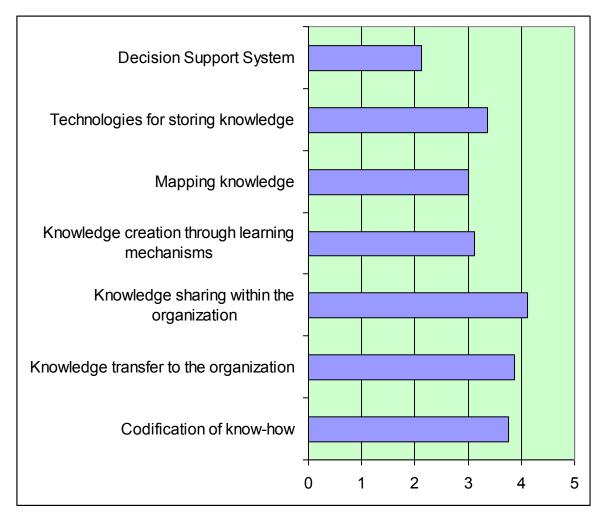


Figure 3: Importance of the knowledge management processes for competitiveness

'Certainly the wind industry is still evolving....we're heading towards a sort of combination of licensing and joint venture.'

'We've got a series of VC investors, and we're developing technology which will eventually allow us to become an infrastructure development company.'

'We may want to enter emerging markets through license agreements or franchising, although there must be a fair package in place.'

However, the routes to knowledge and new markets are not without their own problems:

'The franchise model didn't work for us because the market in which our technology provider was operating wasn't quite the same.'

'Scottish Power should bring us their competence as an organisation, but the problem is that they are operating in slightly different markets and looking at different models.'

The latter evidence is supported by the evidence emerging from the engagement of the companies with universities and research centres in the past three years. These are presented in Figure 5 according to a Likert scale 1-5. The main collaboration activities are mostly concentrated on the recruitment of highly-skilled people, although with a relative low level of importance (2.75), while other activities, such as patents development, contract research, and knowledge transfer partnerships are still in exploration stage (Figure 5). One example of such weak performance in collaborations is a firm which as a major regional market player owns a reasonable amount of Intellectual Capital, however it does not protect it or exploit well:

'We have accumulated quite a lot of Intellectual Capital, but none of that [is] really captured or registered...at the moment.'

Nevertheless, this kind of relationship is not considered strategically relevant for the SMEs.

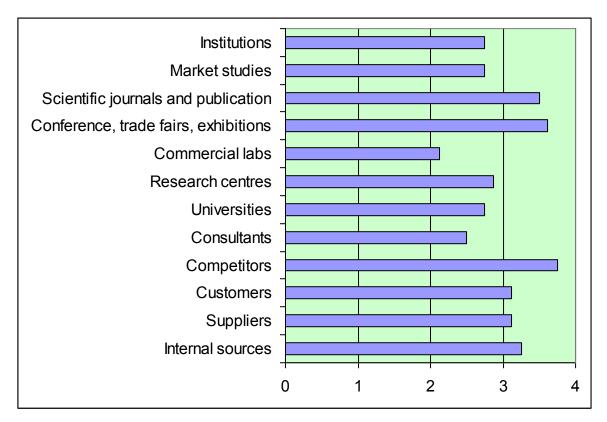


Figure 4: Sources of knowledge for undertaking innovation

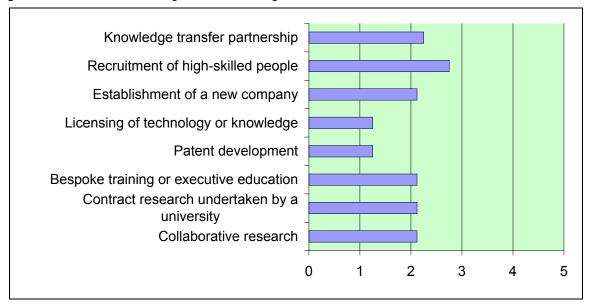


Figure 5: Activities of engagement of SMEs with universities and research centers

In contrast with the importance of the relationships with universities and research centers, SMEs consider the relationships with big and/or multinational energy companies strategically important for their current and future competitiveness. In particular, the big energy companies are a means for SMEs to access market or competitor intelligence, professional information, skills and expertise, and results of research and development activities.

'We have major intellectual assets in the form of the collection of other people's information.'

Although this is not always the case in such collaborations:

'Our friends E.On said: "no, we're not going to tell you that [marketing strategy]. We're just not going to tell you that.""

'I think sometimes they [large energy company] see us as being a pain in the backside.'

Nevertheless, this evidence could strongly drive a better definition and implementation of the policies aimed to support the growth of the renewable energy industry in Scotland, in terms of enhancing collaborative dynamics and investments attractions from big energy companies. Figure 6 depicts these aspects according to a Likert scale 1-5.

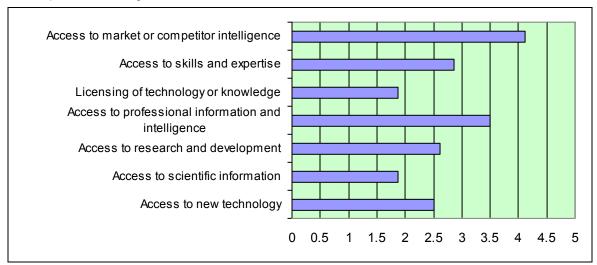
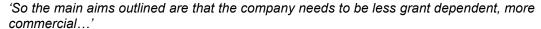


Figure 6: Types of knowledge frequently accessed from big energy companies

Moreover, it emerges that the supply chains of the renewable energy industry companies are still evolving, and that the nature of the relationships is mainly based on competitive dynamics, despite considering the limited number of the companies operating until today in the renewable energy industry. Finally, as shown in Figure 7, according to a Likert scale 1-5, it emerges that the most important barriers that the SMEs face in acquiring or creating the knowledge they require to maintain or improve competitiveness are mainly linked to the inability to access suitable finance to plan investments in knowledge assets, and to access to skilled labour (3.12 and 2.75 respectively), to the quality or applicability of available business support or advice (3.12), as well as to issues related to training and education. An illustration to these results is a firm highly dependent on grants, but plans to switch its financing model to for-profit business to achieve a higher degree of commercialization:



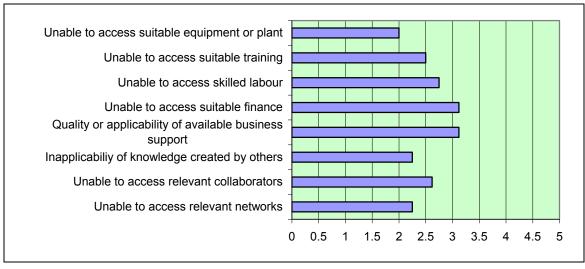


Figure 7: Barriers for acquiring or creating knowledge in renewables

4. Closing remarks

In this paper we have presented a research protocol to identify a domain of organizational knowledge resources and assets within SMEs operating in the renewable energy industry. Using a sample of

organizations from the Scottish renewable energy sector SMEs, we draw first insights about their perceptions and orientations to identifying, measuring and managing knowledge, and to qualitatively identify a feasible set of knowledge resources and assets potentially driving performance improvement. This first evidence shows an awareness of the relevance of the knowledge-based factors. Since energy industry has been traditionally focused on tangible assets and renewable energy industry is still in its infancy regarding the business model definition and knowledge assets management, the emergence of an awareness of these issues is a relevant insight in respect to the traditional approaches applied until recent years. Generally, firms possess a good endowment of knowledge assets and perceive their organizational competitiveness to be attributed typically to the knowledge management of relational and human dimensions.

The highly significant knowledge management processes are considered to be internal, i.e. knowledge sharing within the organization, but also a knowledge flow from external agents has emerged as important, and is mainly attributed to relationships with other firms and education or research institutions. Furthermore, this exploratory study has shown that firms access a wide range of knowledge sources for undertaking innovation activities. Nevertheless, there are apparent deficiencies in the exploitation of knowledge assets and knowledge management processes, as well as a limited access to suitable finance and skilled labor, which suggests the need for efforts to better address the development requirements of renewable energy sector SMEs.

In this paper we have defined a first empirical base for further developing an ongoing investigation, led by the Intellectual Assets Centre, aimed at targeting a larger sample, firms in the Highlands and Islands renewable energy sector. In particular, on the basis of the first insights, we have outlined some key research and policy issues which will drive the design and implementation of a more extended survey for exploring at both micro and macro level the main knowledge asset management issues grounding organizational performance improvement and value creation dynamics.

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