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## **A question of impact: Exploring knowledge utilisation within the UK low carbon innovation system**

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# A Question of Impact: Exploring Knowledge Utilisation Within the UK low Carbon Innovation System

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**Abstract:** Successful innovation requires organisations to promote the utilisation of both technology and knowledge amongst the diverse actors who operate within innovation eco-systems. Many of these programmes utilise public funds to drive innovation and engage stakeholders. These public funded programmes come under increasing scrutiny to demonstrate impact as a return on research investment. Knowledge generated within the UK low carbon energy innovation system has the potential to facilitate the achievement of national and supra-national emission targets. Research and practical application in this field has historically centred on technology transfer whilst under-emphasising the crucial role of knowledge within this complex, socio-technical innovation system. This paper presents the results of a qualitative case study undertaken within a knowledge intensive public-private partnership as a component of its knowledge management strategy. The study aimed to explore the perceptions of staff relating to the organisation's knowledge activities prior to a planned stakeholder engagement event. Fourteen semi-structured interviews were undertaken, and thematic network analysis applied to reveal four major themes. The analysis shows that wider system influences affect how actors perceive their role within the innovation system. Implications for the organisation's managers are herein suggested which could add value to the organisation and increase knowledge utilisation amongst stakeholder groups. Implications include: clarifying utilisation objectives; tailoring knowledge activities; and introducing ongoing feedback cycles. This paper provides a foundation for future empirical work, which aims to compare knowledge utilisation within different organisational structures and identify best practice within the UK low carbon innovation system.

**Keywords:** knowledge utilisation, innovation, low carbon energy, thematic network analysis, case study

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## 1. Introduction

Creating new knowledge is a critical component of the innovation process; however this must lead to products and processes which are economically viable (Edquist, 1997). Current literature principally explores the enablers and inhibitors of knowledge transfer. Knowledge utilisation (KU) research is concentrated in health care and policy environments, with no application in low carbon innovation. Concurrently the low carbon innovation literature is primarily concerned with techno-economic analysis positioned within positivist philosophical paradigms. However, there are no studies which investigate the knowledge flows which underpin successful low carbon innovation from an explicitly interpretivist stance.

This paper aims to address these gaps by empirically investigating how staff in a knowledge intensive, low carbon, public private partnership (PPP) perceive their role in the innovation system. It is guided by the question: how is knowledge utilisation perceived within the UK low carbon innovation system? Additionally it aims to provide managerial implications which add value to the organisation through potentially increasing KU amongst stakeholders. This study is part of the PPP's knowledge management strategy which emphasises the importance of delivering impact. Thematic network analysis reveals a number of factors that could add value to the PPP, including clarifying knowledge utilisation objectives and introducing ongoing feedback cycles to monitor and measure KU.

The paper is structured as follows: firstly a literature review is conducted before discussing the study's context and research design. The themes identified during the analysis are explored, before presenting the implications for managers and, finally, concluding.

## 2. Literature review

The following review analyses the KU literature in the context of innovation, and sets the scene for the study.

## 2.1 Innovation

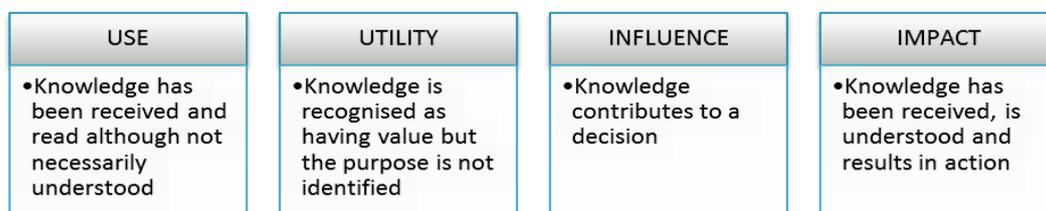
Innovation is an enabler of national competitiveness (Drucker, 1969; Nonaka and Takeuchi, 1995; Swan et al., 2010) and underpinned by the availability of knowledge (Du Plessis, 2007). Increased innovation complexity has caused a departure away from the previously assumed linear innovation models, towards more systems perspectives (Chiva, Ghauri and Alegre, 2014; Edquist, 1997; Newell et al., 2009). Systems approaches are characterised by interdependence, where the interactions between actors become as vital as the actors themselves (Edquist, 1997). A systems perspective is therefore useful for investigating wider systems influences.

Fender (2010) proposes that innovation encompasses more than the management of technical knowledge: rather it is concerned with the conversion of innovation outputs into value creating mechanisms. Technologies may create value, but successful KU captures value (Robertson and Jacobson, 2011; Wood, 2004). In the low carbon innovation system, an over emphasis on the techno-economic factors distorts the role of institutional behaviour by assuming bounded rationality and perfect knowledge. This results in a lack of understanding of human influences in innovation (Rutten and Boekema, 2007).

## 2.2 Knowledge utilisation

Extant literature contains many terms with overlapping constructs concerning the use of knowledge including: knowledge implementation, knowledge utilisation, knowledge uptake and knowledge integration. For the purposes of this paper, the term knowledge utilisation is employed throughout and is defined as “activities aimed at increasing the use of knowledge to solve a human problem” (Backer, 1991:226). This is distinguished from knowledge dissemination which is the “conscious effort to spread new knowledge...to specific target audiences” (Green et al., 2009:152). Whilst both dissemination and utilisation are interpersonal processes, KU incorporates the motivations and cognitive abilities of the user (Aita, Richer and Héon, 2007). Subsequently, non-utilisation can occur when knowledge does not reach intended users or users are unable or unwilling to apply it (Knott and Wildavsky, 1980; Weiss, 1979).

Rich (1997) suggests different conceptualisations for knowledge use (see figure 1). Importantly, this proposes differing goals of KU, which must be clearly understood in order to plan appropriate activities and measure effectiveness.



**Figure 1:** Four distinctions of knowledge utilisation (adapted from Rich, 1997:15)

It is a challenge to succinctly map any cause and effect relationships between specific knowledge inputs and specific outcomes. This is due to: various types of knowledge (Gredig and Sommerfeld, 2008; Lomas, 2005) the non-linear path of knowledge, non-rational use of knowledge (Rich, 1997); differences in user preferences, cultural influences (Head, 2010); irrationality in decision making (Foxton and Pearson, 2008); and institutional influences (Dunlop, 2014; Jordan and Russel, 2014). In political environs, knowledge is more likely to inform policy rather than be a pre-requisite for policy formation, due to the strong influence of political alliances and risk mitigation on policy formation (Head, 2010).

KU can be science driven emphasising the delivery of robust technical evidence which will be adopted by end users (Gano, Crowley and Guston, 2006; Landry, Amara, and Lamari 2001). This approach suggests a linear process where knowledge is an object which will be transferred and utilised. Empirical evidence from the health sciences suggests this linear approach does not contribute to practice changes (Best et al., 2008). Subsequently there is growing realisation of the importance of social factors to KU (Heinsch, Gray and Sharland, 2016). This relational outlook generates iterative process models of KU, influenced by system dynamics and context (Best et al., 2008; Dobrow et al., 2006; Green et al., 2009; Nutley, Walter and Davies, 2003). Despite this, empirical studies within the energy sector are sparse, and limited primarily to techno-economic analysis underpinned by positivist foundations; there are no studies which adopt an explicitly interpretivist philosophy which explore

these relational aspects. The need for such studies is particularly crucial given: the complexity of socio-technical innovation systems (Chmutina and Goodier, 2014); the greater accountability on innovation mechanisms which utilise public funds (Belkhodja et al., 2007); and the urgency of action needed to be taken by wide-ranging stakeholders to achieve national emissions targets (Vincent, 2012).

This review illustrates the importance of integrating relational models into the exploration of low carbon innovation. It proposes that KU objectives need to be understood to effectively plan and monitor knowledge activities.

### **3. Research context**

The aim of this section is to present the contextual factors of the study. The level of detail provided represents a balance between sufficiently illustrating the system under investigation, whilst concurrently maintaining organisational confidentiality.

#### **3.1 The UK low carbon innovation system**

The fundamental importance of low carbon innovation is evidenced by the UK government's ambitious commitments to energy and emission targets. These are to be achieved by 2050 through a system of evolving policy, institutional and economic mechanisms which aim to drive innovation and engage stakeholders (van der Schoor and Scholtens, 2015). The system has unique characteristics which complicate innovation: a diverse technology portfolio with many knowledge requirements (Foxon et al., 2005); short-term, unstable policy (Grubler, 2012); and the need for policy measures which address innovation generation (Fankhauser, 2013) and demand side factors (Byrne et al., 2012; Chmutina and Goodier, 2014; Heffron, 2013; Ockwell and Mallett, 2012; Vincent, 2012).

#### **3.2 The research organisation**

The research organisation is a public-private partnership (PPP) established by the UK government and major industrial companies. Its purpose is to accelerate low carbon technologies to deliver both near term and longer term benefits. Strategic objectives include: building research capacity; producing nationwide economic benefits; and facilitating the attainment of national and supra-national energy targets. The project work is completed via a network of academic, government and private actors, with the organisation's funding provided by contributions from its public and private membership. The PPP operates through strategic, programme delivery, operational and stakeholder engagement functions. Its knowledge management strategy identifies knowledge as a key product and recognises that knowledge needs to go to, and be received from stakeholders to add value. Knowledge management objectives include: actively seeking feedback from stakeholders; strengthening organisational credibility and capabilities; and supporting staff in knowledge activities.

### **4. Research design and approach**

The literature review revealed the need to explore the human influences on innovation systems. This is one of the first case studies to adopt an explicitly interpretivist stance in order to achieve this. Additionally this philosophical underpinning best facilitates the research aims, and attempts to re-balance the reliance on positivist approaches within this field. Although there are well-cited limitations of a case study approach (e.g. Flyvbjerg, 2006), in line with the aims of this paper, case studies can influence organisational actions (Ragsdell, 2009). Case studies are useful when "the focus is on a contemporary phenomenon within some real-life context" (Yin, 2003:1) and where an understanding of organisational processes is needed, whilst considering the wider environment (Hartley, 2004). This study explores staff expectations of knowledge activities at a one day stakeholder event, prior to the event taking place. The event was an opportunity for the PPP to showcase its work portfolio to a range of stakeholders. Staff from all functions within the PPP would be in attendance, but primarily the authors of a number of recently published reports by the PPP.

### **5. Data collection and analysis**

Purposeful sampling methods were used and an interview schedule comprising of ten questions was designed which centred on the aims, benefits, activities and success measures of the above mentioned event. Fourteen semi-structured interviews were undertaken in compliance with the University's established ethical Codes of Practice. Participants represented the different organisational functions (strategic, delivery, operational and stakeholder engagement) and hierarchical levels (up to executive level). The initial two interviews acted as a

pilot; feedback was sought on the appropriateness of the questions. All interviews lasted between forty and fifty minutes, and were subsequently transcribed using Nvivo10 software. Notes were made immediately after each interview, whilst code, theory and operational memos were recorded as analysis progressed (Corbin and Strauss, 2008). Thematic network analysis (Attride-Stirling, 2001) was used as a basis for methodically analysing the textual data. This facilitates exploration of underlying metaphors beyond the purely descriptive themes in line with the interpretivist position. The systematic nature of the analysis facilitates the identification of meaningful results in a bottom up approach (see Figure 2).

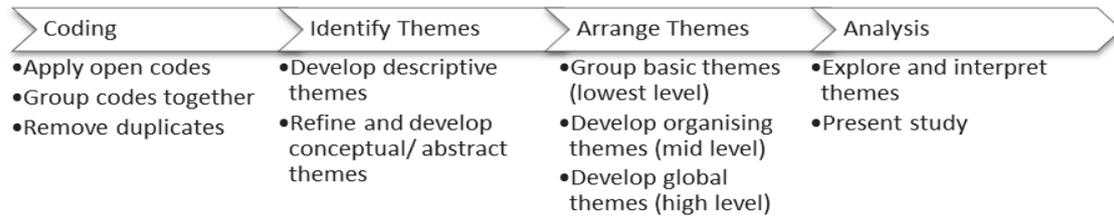


Figure 2: The coding and analysis process (adapted from Attride-Stirling, 2001: 388)

## 6. Empirical research findings

This section presents the four main themes which were revealed by the analysis. The resulting thematic network is shown in Figure 3. The themes that emerged from the data were: context, target audience, aims and activities, and measurements of success.

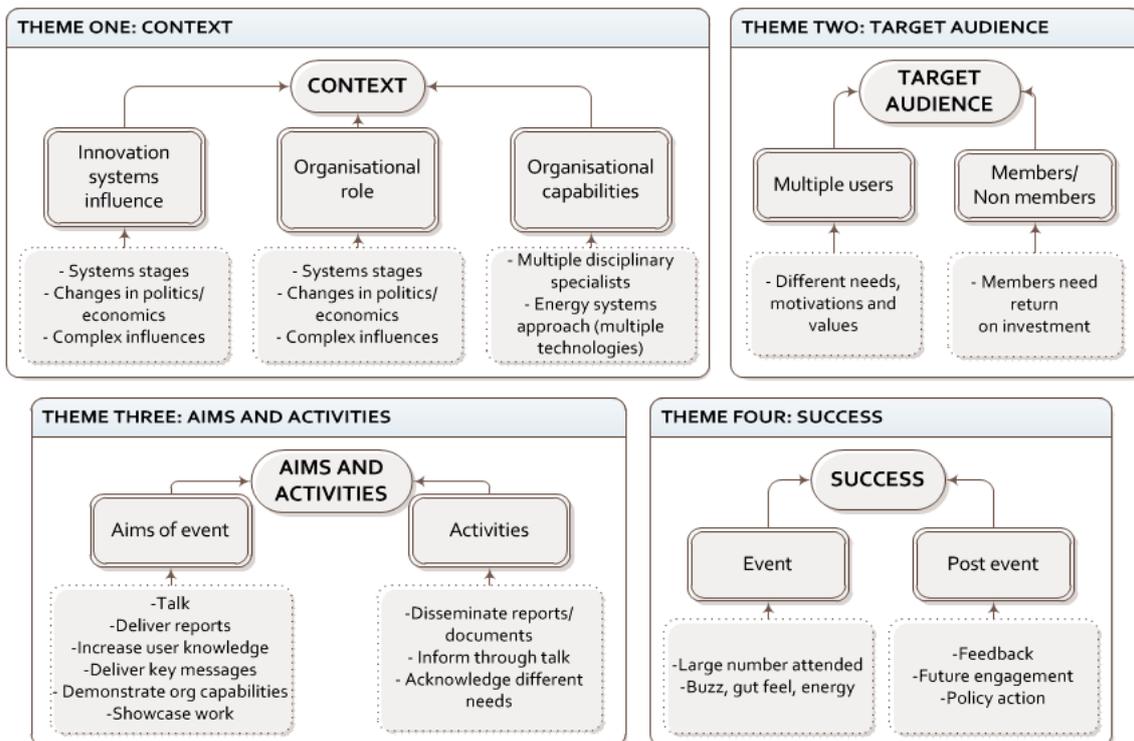


Figure 3: Thematic network analysis of the identified themes

### 6.1 Innovation system context

The first theme to emerge was the innovation system context, including the role and capabilities of the PPP and other actors within the system. Participants suggested the PPP's role was that of an informer, with the overall goal of aiding the achievement of 2050 emissions targets. The innovation system was deemed to be complex and dominated by economic-political decisions. There was a distinction between the PPP's role as informer (passive) and other actors who make the decisions (action orientated). Participant A07 suggested "[We can] say these are the areas that are going to matter, and this is the evidence...we can't make the decision, because many of the decisions are governed by policy decisions".

Participants suggested organisational capabilities consisted of being evidence based and working with multiple technologies and stakeholder groups. However, it was suggested that the PPP adopts a predominantly technical focus which does not facilitate knowledge use beyond technical audiences. Participant A04 stated:

*There's lots of work that needs to be done beyond just the pure generation of the underlying techno-economic insight. Traditionally we love to create models... but how do you actually turn that into [an impact on] reality?*

This theme suggests a linear and technically focussed model of KU is perceived to be operating. This focuses on influencing through evidence delivery, rather than generating impact through relational processes.

## **6.2 Target audience**

The engagement of broader stakeholders was widely associated with delivering impact. Stakeholders were seen to include industry, government and academics. Those who had invested financially in membership of the PPP were seen as 'important stakeholders' who need a return on their investment. It was suggested that the membership model facilitated the influencing agenda: "[Members] see that they get more value from influencing the landscape than they do from holding the knowledge to themselves" (Participant A10).

Historically the organisation has predominantly engaged technical audiences. The progressive move from technology development to deployment requires appropriate engagement of audiences beyond technical communities. Participant A05 suggested this is slowly happening but "we should be constantly challenging ourselves to do more of it". A recent portfolio of non-technical reports was seen to be delivering more impact by "painting a broader picture" to reach more decision makers. This alludes to an emerging paradigm shift which embraces different world views as a means to create impact.

## **6.3 Aims and activities**

The majority of participants suggested that talking to people or demonstrating technologies would be the predominant activities. Participant A09 stated: "If [the stakeholders] are interested in the subject...they'll come to that area on the day and I'll talk...about the projects we've done".

Emphasis was placed on the dissemination of reports. Participant A05 stated "I've got two science reports that I'll be there...to talk to people about". Participant A14 showed concern about this:

*If you think about reports... when something goes on a shelf it rarely gets picked up again, and you need to keep it alive to make people keep referring back... what you want them to do is change their opinions, change their values, change their direction.*

The PPP's knowledge management strategy recognises that value can be gained from seeking and obtaining knowledge from stakeholders (i.e. exchanging knowledge). However, the analysis showed that stakeholder engagement was predominantly perceived to be one-way dissemination. This further emphasises a knowledge transfer mind-set, rather than as a relational process where utilisation is the goal. A minority of participants mentioned obtaining knowledge from stakeholders. Participant A14 suggested: "I will go and see people I know...and find out what they're doing [and] tell them what we've been doing".

## **6.4 Measuring success**

Participants perceived the number of attendees and length of stay to be indicators of success. One participant suggested that the event could be considered a success already because of the number of people registered. However, this may be a reflection of the fact that a broader audience has been invited. More subjective dimensions of success were identified, with phrases such as 'energy' and 'buzz' used frequently: "I'll measure it by gut feel...it will be the number and the quality of the conversations" (Participant A04).

Measures of success were seen by some to only be visible in future activity which results as a direct consequence of the event: "[It's] not 'what did people think of the event itself', it's the uptake of the messages after" (Participant A10). Particular value was seen to be created if invitations were received to attend other broader audience events, as evidence that the organisation is moving beyond a predominantly technical audience.

Interestingly there were only limited responses which linked success with a reflective process which led to internal change:

*There is another level of success, in terms of how effectively we use the event to establish where to go next. If we do something different as a result of the event...then I think there's success (Participant A01).*

This section has identified a number of themes. It is evident that the knowledge management strategy is known throughout all functions. Staff can identify the need to increase stakeholder engagement in order to meet organisational objectives (and subsequently impact national emission targets). Staff espouse the need to move beyond a technical focus so to deliver greater impact. Despite this, the organisation occupies a position of a knowledge generator and informer, whilst perceiving the ability to create action as something relating to other actors in the system. In line with this, the activities undertaken strongly revolve around a one-way generator-to-user model, dominated by information dissemination and technology demonstration, which may be caused by unclear utilisation goals. Whilst no previous studies have investigated this field empirically, these findings align with similar work in the medical field which suggest that linear modules of knowledge use do not effectively generate impact on practice (Best et al., 2008). Similarly the literature suggests that usage goals need to be clear in order to design knowledge activities for each specific goal (Rich, 1997).

In order to address these challenges, the next section presents implications for managers in the PPP. These aim to: reduce any ambiguity; move the organisation to a more proactive position; and ultimately maximise opportunities for KU that lead to impact. Overall they aim to provide a practical framework from which to view knowledge utilisation less as a linear transfer model, and more from a relational systematic perspective.

## **7. Implications for managers**

The thematic network analysis attempts to meet the first objective of this paper (i.e. to explore perceptions of knowledge utilisation). This section contributes to the attainment of the second objective (i.e. to provide implications which add value). These implications are underpinned by the literature review and the themes identified in the analysis, and focus on creating value through KU.

### **7.1 Clarification of goals**

Firstly, a clarification of KU objectives should be made. A clear understanding of the success measures aids the planning of effective KU activities directed to a particular goal (Rich, 1997). Currently there is ambiguity about KU objectives including passive orientated dissemination or action orientated impact creation. The focus is also on long term larger targets, but lacks attention on specific actions which deliver nearer term benefits.

### **7.2 Increasing knowledge utilisation**

Secondly, the process of influencing KU to generate impact is a continuous, complex process and consists of many interdependent factors (Green et al., 2009). The model in figure 4 has been constructed from the literature review and in response to the themes identified in the analysis. It consists of a number of iterative steps which consider individual knowledge user requirements (Map), the conveyance of knowledge (Message) and the integration of feedback cycles to actively monitor these (Monitor and Maintain). It is underpinned by organisational support mechanisms (Objectives, Skills and Support).

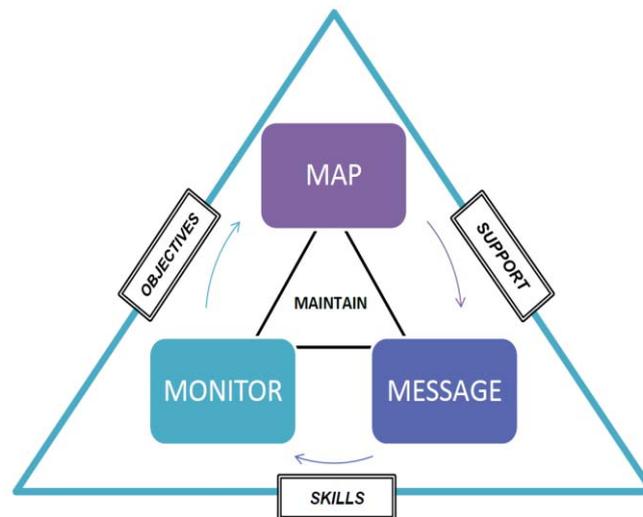
#### *7.2.1 Map: Mapping stakeholders and their environment*

Stakeholders should continue to be mapped and their practical needs, commitments, values, objectives, resources, culture and other institutional influences established. This includes: understanding the linkages and networks which exist between different stakeholders; and instigating ongoing personal contact with the stakeholders to seek their input and build relationships.

#### *7.2.2 Message: Using appropriate and effective content and medium*

The key messages the PPP wish to deliver must be accessible, understandable and beneficial to stakeholders. The messages should be congruent with the needs, values and objectives of the stakeholders and delivered in a timely manner. The PPP has a strong reputation for being credible and evidence based which can be used as a foundation for sending messages. However, this foundation needs to be considered within the context of the

other institutional influences mapped (e.g. organisational and individual level commitments, objectives and irrational constraints).



**Figure 4:** Influencing knowledge utilisation framework

### 7.2.3 Monitor: Continuous feedback and measurement of activities

It is essential that feedback is sought on the usefulness, accessibility and other 'fit for purpose' criteria with all stakeholders. This can be achieved through the building of long term and interactive relationships throughout the stakeholder network (including opportunities for building inter-network relationships). Adjustments should be made based on this feedback and any other changes that occur within the evolving environment.

### 7.2.4 Maintain: Sustained engagement supported by appropriate internal resources

The 'map, message and monitor' cycle needs to be maintained as an ongoing process to maximise potential for KU, particularly given the complexity of the innovation environment.

### 7.2.5 Support mechanisms

The above model is underpinned by a triad of support mechanisms:

- Clear objectives: establish the expected outcomes of knowledge activities and corresponding reward instruments which monitor and encourage the achievement of these objectives.
- Leadership support and sufficient resources: leadership need to fully engage with these objectives. The interpersonal nature of KU activities means that it is a time consuming challenge. Adequate resources must therefore be provided for this purpose.
- Skills development: technical and 'soft' abilities are underpinned by different skills sets. Therefore staff must receive adequate training and development to ensure relevant activities are undertaken.

## 8. Conclusion

This paper aimed to gain an understanding how staff in a knowledge intensive, low carbon PPP perceive their role in the innovation system. It was guided by the question: how is knowledge utilisation perceived within the UK low carbon innovation system? Additionally it aimed to develop managerial implications aligning KU activities with organisational strategic objectives.

The literature review recognised the need to expand on the predominant positivist studies and explore the interactions, interdependences and human influences that occur within innovation systems. This study is first which explicitly adopts an interpretivist position to achieve this. The thematic network analysis revealed that the organisation has potentially ambiguous aims regarding what it intends to achieve through its KU programme. The perceptions of the wider system influences, has led to the organisation to occupy the passive role of knowledge generator and informer, which undertakes knowledge transfer activities. However, a potential

paradigm shift is potentially underway which begins to recognise the relational aspects of knowledge activities. In order to facilitate action orientated goals, a framework was provided for managers, which supports an ongoing cycle of tailored knowledge activities, interpersonal activities and feedback cycles to monitor KU. Whilst this study focusses on one organisation, future work will explore other publicly funded mechanisms within energy research. This will give the opportunity to compare and contrast the different influences on KU within the innovation system.

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