Tyndall Centre for Climate Change Research

A Dynamic Typology of Stakeholder Engagement within Climate Change Research

Sebastian Carney, Lorraine Whitmarsh,
Sophie A. Nicholson-Cole and Simon Shackley

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Abstract

This paper offers a descriptive overview of Stakeholder Engagement (ShE) within climate change research at the Tyndall Centre for Climate Change Research. Its aims are twofold: firstly, to offer insights into methodologies, practice and outputs for researchers embarking on ShE in the course of their work; secondly, to help researchers gain a greater understanding of the value of ShE in climate change research, both in terms of the ways in which it influences their research and how it can be used to maximise mutual learning and knowledge exchange between researchers and their stakeholder community. This paper reports on a 2007 review of ShE activities conducted amongst the community of research staff within the Tyndall Centre. The three key findings are that ShE is widespread but often ad hoc and unplanned; that ShE may be a significant component throughout an entire research process – in its design, process and outputs, or at various stages; and that researchers have a wide range of experience in terms of the balance of control and stakeholder involvement and influence on their research. The paper identifies a range of ways in which ShE can be categorised according to a new typology, which relates to different types of involvement. It also discusses ways in which value can be added to interdisciplinary research at the science: policy interface by carefully considering the nature and role of ShE in the process. This typology is intended for use by both academics and practitioners.

1 Introduction

Stakeholder engagement (ShE) within academic practice is particularly noticeable in complex, trans-disciplinary research that is associated with high levels of uncertainties and complexities, such as climate change research (Blackmore, 2007). Depending on the project, research may necessitate studies that span the academic, policy, economic, and civic communities (Pohl, 2007; Papdopolous and Warin, 2007). The rationale behind this engagement may include, amongst other issues, compliance with a funder's request; a need to add legitimacy to the research; the wish to incorporate the values of people who in some ways 'represent' (a section of) the wider public; and the desire to reduce stakeholder scepticism in the science, when forming, assessing and disseminating research (Norgaard & Baer, 2005). There are a wide range of actors who may be included as stakeholders for example: policy makers, members of the public, governmental agencies, and non-governmental organisations (NGOs), and these are frequently engaged in the process and outcomes of climate change research[1].

This paper presents a centre based study that looks at ShE within the Tyndall Centre for Climate Change Research. The focus of Tyndall's research is creating new knowledge, with an eye to informing climate change policy. The purpose of this paper is to explore - through a series of centre-based interviews, workshops, questionnaires, and case studies - interactions that have taken place between stakeholders and climate change researchers within the Tyndall Centre, in

[1] We also consider consultancy as well as academic research within this term.

order to offer a descriptive typology of ShE in climate change research. This proposed typology identifies 8 different types of ShE that may take place during a research process.

Through this discussion and the proposed typology we seek, firstly, to improve the quality and credibility of ShE in future research processes. In particular, we wish to encourage researchers to plan the stakeholder engagement element of their research in a strategic and transparent manner. Secondly, the paper also seeks to aid academics, and hopefully others (for example, governmental departments as research funders), to be more precise in communicating the way that stakeholders have been (or will be) engaged in the formation, execution and dissemination of research. Thirdly, it seeks to build upon the currently sparse literature on stakeholder engagement in research, from a research centre perspective (Chilvers 2008). Overall, it is hoped that by considering this typology, stakeholder expectations can be better understood and managed by researchers.

We begin by presenting the current understanding of ShE in research; we then present the rationale of this study, followed by a presentation of our research findings and our proposed 'Typology of Stakeholder Engagement'. Finally we apply this typology to three different Tyndall projects as an example of how it can be used in practice.

Who or what is a stakeholder?

There is a degree of discrepancy within the literature as to what defines a 'stakeholder'. Van de Kerkhof (2006), for example, defines stakeholders as 'actors from society who have an interest (a stake) in a specific policy issue' (after Renn et al, 1993, von Winterfeldt, 1992; Mason and Mitroff, 1981). The Intergovernmental Panel on Climate Change (IPCC) defines a stakeholder as 'a person or an organisation that has a legitimate interest in a project or entity, or would be affected by a particular action or policy' (IPCC, 2007). Furthermore, the World Bank defines a stakeholder as 'any entity with a declared or conceivable interest or stake in a policy concern' (www.worldbank.org, 2008).

All of these definitions are broad. The first definition, implies that a stakeholder must have an awareness of a specific policy (or research issue) and, crucially, an interest in its impact. This may imply a degree of 'up front' awareness and / or knowledge on behalf of the stakeholder. This presents a potential issue of equity, as scientific and technical information whilst a public good, is not in practice a free good (Callon, 1995). This suggests there is a barrier to entry, on knowledge, time or financial grounds. However, this first definition may be interpreted in a wider capacity – to include conceivable interest (as the World Bank does). Under this first interpretation, there are a limited number of stakeholders with whom the research can engage. The second definition is

also broad and it likewise introduces a requirement - *a legitimate interest* - of a person or organisation who is to become a stakeholder in research. Yet who is to define 'legitimate interests' and what happens when the range of legitimate interests changes over time? Furthermore, Latour would consider non-human 'actants' to be stakeholders. With regard to climate change, the practical implication is that specialists who can tell us what the non-human *stakeholder* might be or how they are affected are also important. For example, regarding who and what is affected by run-off after intensive rain (Latour, 2005)? These non-human actors have an intrinsic value, and rights. The final definition from the World Bank distinguishes between an interest and a stake, and recognises that this may be either declared - by the stakeholder - or indeed conceivable by another. However, different entities may view 'conceivable interest' in differing ways. Indeed, some entities may over- or under-estimate another's level of 'interest' or 'stake'.

Other literature illustrates that the term 'stakeholder' has been used to categorise a group that is separate to 'members of the public', and 'specialists' (Davies and Burgess, 2004, Chilvers, 2005). However, to distinguish in this manner, as these writers have done, would appear at odds to the above definitions of a stakeholder, as it would suggest that a specialist in an area is not a stakeholder. Therefore, if they are a specialist who is not a stakeholder, they are a specialist with no interest (or stake) in their subject, which we doubt was the intention of the authors.

Meanwhile, given that all public policies impact upon the public purse, it could be argued that 'members of the public' also have a legitimate interest in all policy-relevant research. The answer to this point might be that the interests of members of the public are represented and expressed through the election of representatives, i.e. Members of Parliament and local Councillors or Mayors. But, in that case, why can such elected members not also represent the interests of members of the public (who hold a stake in a policy issue) in the political process, rather than, the individuals or groups being contacted separately? To fully address this point would require a lengthy discourse on notions of democracy. Suffice it to say here that there is a very real tension between representative notions of democracy and deliberative notions of democracy, the latter accommodating ShE practices more readily than the former.

These examples of ambiguity in conceptualising ShE makes determining the depth and extent of stakeholder engagement, together with how and where a stakeholder's inputs are used within a research process, a difficult task to assess, value and, ultimately, compare between projects.

We do not wish to contest the definitions of van de Kerkhof, the IPCC or the World Bank - rather we recognise that they present common themes. For example, each definition makes a judgement about the stakeholder, in that the stakeholder is viewed as potentially influencing or

being affected by the work or its conclusions. This leads to the question, not necessarily peculiar to climate change research, of who is *not* a stakeholder in research? Due to the diverse and complex nature of climate change (both its causes and impacts), how can a researcher exclude a person or an organisation, as a stakeholder when researching issues surrounding climate change? Should it be only the individual or organisation that defines themselves as either being or not being a stakeholder? In each case, are these either equitable or ethical models of defining stakeholders? If left to the individual or organisation to identify themselves as stakeholders, how do they find out about the research and elect to become a stakeholder? If it is up to the researcher to define the stakeholders, upon what basis do they decide who's 'in' and who's 'out'?

Therefore, identifying who the stakeholders of a given research project are presents both an unenviable task and a significant onus on the researcher. Even once this is done, there exists, amongst other issues, inevitable time and budgetary constraints, that govern which stakeholders the researchers choose to deliberately engage with and – equally importantly – which researchers stakeholders decide to co-operate with the research process (Baldwin, 2000). The researchers wish to consider the interest of the stakeholders engaged in the research and also the 'power' that the stakeholder may have in influencing the outcomes. (Mendelow, 1991) This influence may have to be managed so as not to favour one stakeholders input over another.

This question is important philosophically, as from the outset a researcher should be clear as to whom they view the stakeholders of their project to be, and why. This decision should be based on the purpose of the research and where in the research process stakeholder involvement is to be sought. Furthermore, recognition should be given to the fact that the stakeholders engaged in a research project may alter as the project matures (ideally with a budget built in to cover this). Furthermore, managing this process as a researcher can take time and other resources to accommodate.

In this paper we embrace the definitions of van de Kerkhof, the IPCC, and many others in considering a stakeholder to be 'a person or group who influences or is influenced by the research'. However, in our analysis we particularly highlight the *temporal* dimension of stakeholder involvement within the research project and how this, in turn, influences crucial factors like control over the research, learning, and credibility.

What is the purpose of researchers engaging with stakeholders?

There are four main ways in which stakeholders are considered in the literature:

1) Study of the Stakeholders: this is the classical social science tradition where understanding of and characterising the social actors – sometimes called stakeholders – is

the main focus of the work; notably studying their behaviour; perceptions and attitudes and interactions with a particular issue (especially during public consultation) (see, Whitmarsh, 2007; Steyart et al, 2007; Farrell et al, 2001; Fiorino, 1990).

2) Co-production of Knowledge between Researchers and Stakeholders: in this version, it is assumed that good research requires the active input of stakeholders because of the latter's knowledge, insights and ideas. Hence, terms such as 'mutual learning' and 'the co-production of knowledge' are discussed (Pohl, 2007; Chilvers, 2008, Studd 2002);

3) Increasing legitimacy of a research project: researchers can try and enhance the legitimacy of their findings by claiming that they have been generated through ShE with relevant actors. Likewise, public or private entities might wish to add greater weight to their research by pointing to the ShE involved in its production.

4) Study for the Stakeholders: where the stakeholder role is passive in that they are the recipient of findings; in these examples the dissemination of the research work is the principal focus of stakeholder engagement (Pohl, 2007; Studd, 2002; Chilvers, 2008).

Of course some projects combine elements of the four modes: for instance, stakeholders might be interviewed for their perceptions in one part of the study, and those perceptions are then fed back to the same, or to a different set of, stakeholders.

For example, whilst the study might be about the policy-science interface, one of the key issues is that policy making can be improved by stakeholder engagement. For example, Brian Wynne's (1996) study of how MAFF interacted with local farmers following the 1986 fire at Chernobyl nuclear power station and the associated radioactive fall-out that covered a swathe of Europe. Wynne found that MAFF ignored farmers' own local knowledge and that by listening more carefully to the local farmers, MAFF could improve its decision-making. This is an example of a type (1) study, above, and shows the importance of type (2) studies.

When the purpose of the stakeholder engagement is for co-production of knowledge, such engagement may:

1) Encourage a wider input of the different communities (academic, policy, economic and civic);

2) Take account of the significant uncertainties prevalent in climate change research (Functowitz & Ravetz, 1990);

3) Foster buy-in and gain support from stakeholders, and thereby facilitate the research;

4) Expose weakness in beliefs upon which the research is based; and

5) Foster mutual learning on behalf of both the stakeholder and the researcher during the research process (Webler, 1998, Davies & Burgess, 2004; van de Kerkhof, 2006).

Where stakeholder engagement is to provide legitimacy to the research, this may be:

1) To provide legitimacy to the information gathered for the research from both inside and outside of the conducting researchers' domain;

2) To give credibility to the research, particularly imparting the sense that it is relevant to groups outside of academia;

3) To help maintain the policy relevance of the research;

4) To promote the work within a particular organisation or community (e.g. governmental department);

5) To help directly inform policy (e.g. Tyndall's assistance with the UK Climate Change Bill).

There is often a desire to set clear 'boundaries' between the disciplines, in order to identify just who is the authority on any particular discipline within the process, and transcending these boundaries is a difficult task (Farrell, 1990; Jasonoff, 1990). Nonetheless, it is increasingly understood that researchers are required to bridge the gaps between different communities and disciplines (Farrell, 2001). Furthermore, there is a need to recognise the importance of 'different academics working jointly with practitioners to solve a real-world problem' (Klein et al 2001 p.4; cited in Pohl, 2007; Papadopolous & Warin, 2007).

The inclusion of stakeholders in research is due in part to a shift in the literatures towards considering complex environmental problems such as climate change in a more trans-disciplinary, and socially-accountable manner (Gibbons et al., 1994). This is partly due to a recognition that people's values and knowledge should be 'taken into account when considering technical and scientific considerations'[2] (RCEP, 1998, 104 para 7.17).

Stakeholder engagement can improve the quality of research by drawing on diverse knowledge; whilst also allowing a representation of diverse social values and personal preferences; and potentially - through the process itself - foster trust, ownership and learning about the

[2] This partly relates to the perceived efficacy of policy. If academic research doesn't understand 'where people are coming from' (their perspectives), it may well propose inappropriate solutions (assuming there is a solutions-orientation to the study). This tallies with a co-production model but could also relate to a conventional 'study of stakeholders'. For example, research intended to probe how to increase household recycling rates might be based on discussions with, or a survey of, householders. The survey option would likely constitute a 'study of' the target group (householders), while the discussions (e.g., in a focus group format) would likely tend more towards co-production of knowledge, in the sense that qualitative methods provide for a much higher level of detail in understanding people's perspectives.

stakeholders (Newig et al., 2004; Pahl-Wostl, 2006*)*.

What are the challenges when engaging with stakeholders?

Depending on the nature of the stakeholder engagement, researchers may be required:

1) To communicate science to multiple audiences in a clear fashion;

2) To gain the financial resources to engage with a variety of actors;

3) To balance the respective interests of the different stakeholders involved in a process;

4) To act as a credibility-check on the research process (Farell, 2001);

5) To remember that, whilst they are acting as facilitators they are still researchers. Therefore they need to be careful not to allow themselves to be activist[3] in their approach (Quinlan & Scogings, 2004), as this may shape the responses of the stakeholders and undermine the credibility of the research; and

6) To recognise knowledge disparities between stakeholders when assessing their inputs – so as not to favour one stakeholder's arguments over another (Agrawala et al, 2001).

A researcher, when facilitating an exercise involving stakeholders, may have to switch between observing it in a constructivist fashion (i.e. with an awareness that different stakeholders have different understandings of 'reality'), whilst also being essentialist actors in the research (Quinlan and Scogings, 2004). For example Blackmore, when discussing the European SLIM programme, discussed how, during research exercises with stakeholders, the same researchers took on the roles of being observers, participant-observers and co-researchers (Blackmore, 2007; Webler, 1998, Norgaard & Baer, 2005).

In addressing the issues outlined over the past 3 sections we have examined relevant literature and have identified the different forms stakeholder engagement can take, the reasons for engaging with stakeholders and the challenges that such engagement creates for the researcher. We now turn our attention to the nature of the engagement, and look at how others have categorised stakeholders.

How can stakeholders be categorised?

Farrell et al (2001) refer to 'nominal' participation and 'engaged' participation. Nominal participants may form an active part of an assessment process – however the participants may not have a great understanding of, interest in or influence over the issues at hand. Engaged

[3] This issue is considered further at the end of this paper under 'further work'.

participants however are actively engaged in meetings, influencing decisions which may result from the project, and contributing to reports.

Previous work has also endeavoured to categorise stakeholders, for example: *Primary, Secondary and Key stakeholders* (ODA, 1995); *Active and Passive Stakeholders* (Grimble and Wellhard 1997); *Internal and External Stakeholders* (Gass et al, 1997). We feel that these clusters are potentially narrow in focus, in that they refer less to the nature of the engagement in the research and more to an imposed value, often by the instigating researchers, of the research to the stakeholder. This desire in the literature to place a value on the stakeholder is widespread e.g. *key stakeholders* (Steyaert et al , 2007; Turnpenny et al, 2004); *low level stakeholders* (van de Kerkhof, 2005); and *strongly concerned stakeholders* (Papadopoulos & Warin, 2007).

In contrast, we find the proposed 'typology of coastal modes of stakeholder interactions' proposed by Milligan et al., (2004) and Sidaway's (1998) typology (adapted from the well established Arnstein's ladder of participation (Arnstein, 1969) of decision-making to be more useful. Milligan et al. consider stakeholder engagement as *limited interaction, full interaction, mediator achieved, key stakeholders, full interaction (face to face)*. However, there is again a desire to place a value on the stakeholder. This typology goes some way to distinguish the nature of involvement of stakeholders with researchers: it identifies that sometimes stakeholder engagement is limited, and sometimes it is intensive. This paper goes further to compare these *modes* of stakeholder interaction with a *perceived value* of the interaction. We consider this to be a helpful way of distinguishing between different mechanisms of stakeholder engagement. The typology that we present is novel as it is focused on stakeholder engagement in research, is specific to climate change research and considers stakeholders in terms of when in the research process they are engaged and the role that they take.

The reason for distinguishing between stakeholders in this way and developing a new typology is because of the different types of stakeholder that may be engaged (e.g., public, industry, policy maker), their perceived technical competence and reason for selection. (Farell et al, 2001). Furthermore, by using a typology when inviting individuals or organisations to be a stakeholder in a research project, the extent of their required involvement can be made clear. This is helpful when there may be an unintentional danger of over- or under-stating the level of involvement required by the research of the stakeholder. This is partly a function of the ambiguous nature of the term 'stakeholder'.

What is the context of this stakeholder study?

The fieldwork that is the focus of this paper has been conducted at the Tyndall Centre, the UK's

leading Climate Change research centre. A centre-focused study was chosen based on Chilvers (2008) conclusion that 'a situated study of participatory appraisal in action is crucial'. The Tyndall Centre's focus, stated below, added credence to its selection for this study.

'To research, assess and communicate from a distinct trans-disciplinary perspective, the options to mitigate, and the necessities to adapt to, climate change, and to integrate these into the global, UK and local contexts of sustainable development.' (www.tyndall.ac.uk)

The Tyndall Centre for Climate Change Research is a virtual centre that strives for interdisciplinary research. Established in 2000, it is now comprised of several UK universities with researchers working at East Anglia, Manchester, Southampton, Oxford, Cambridge, UCL, Newcastle, Loughborough, Sussex and Leeds Universities, with close links and involvement with a variety of research centres at these sites including Institute of Transport Studies (ITS), Climate Research Unit (CRU), Centre for Advanced Spatial Analysis (CASA), Cambridge Econometrics, Environmental Change Institute (ECI) and Science and Policy Research Unit (SPRU). These established Universities and research centres each have an excellent track record of research within the climate change field, and have all engaged with stakeholders in the course of their research. This makes them a highly suitable subject of this study.

What was the methodology that was used for this study?

The empirical research underlying this paper was undertaken as a multi-stage and reflexive process, with each stage building on the previous one. The methodological steps are outlined here:

1. Semi-structured interviews with 8 researchers identified as being particularly active in ShE (specifically in scenario work, which has a high level of stakeholder interaction). The key aim of these interviews was to identify what these researchers felt were the most important factors to consider when working with stakeholders in the course of their research in order to provide a structure to the approach undertaken in stage 4. These interviews took between 1-1.5 hours, the questions focused on the depth and frequency of stakeholder involvement within the researchers' work.

2. Researchers' workshop: The same researchers were then invited to present their research, specifically addressing these issues in Manchester in March 2007 with a question and answer session following each presentation.

3. Open-ended questionnaire: At a Tyndall Centre researchers' network[4] meeting (May

[4] This is a bi-annual meeting of all researchers and PhD students linked to the Tyndall Centre.

2007) involving 30 researchers representing a mix of disciplines (e.g. engineers, modellers, social scientists), a brief qualitative questionnaire was completed, addressing the various mechanisms through which researchers engage with stakeholders, and the different types of stakeholders that had been engaged. Responses were coded thematically (Miles and Huberman 1984).

4. Online quantitative questionnaire: The previous data informed the design of a structured online questionnaire survey which was sent to all researchers associated with the Tyndall Centre. The questionnaire used a deliberately broad definition of a stakeholder in order to maintain consistency of responses. The respondents were offered the opportunity to comment on this definition at the end of the questionnaire. Respondents were asked to complete the questionnaire in respect of the 'last research project that they worked on, which involved stakeholders'.

What were the results?

In this section we report on the key findings from stages 1-4.

Interview and workshop findings

The semi-structured interviews (stage 1) identified four areas of importance to researchers when considering ShE; these were translated into a set of 4 questions that formed the structure for the presentations in stage 2, where researchers were asked to present on their engagement with stakeholders (see Table 1).

Table 1: Key Issues in Stakeholder Engagement

1) Why do you believe stakeholders participate in academic exercises?
2) In your exercise was the stakeholder more of an audience or a participant – or to what degree did both take place? 2a) Did you try to gain information from them, or did you intend to provide them with information for dissemination?
3) To what extent did you recognise the stakeholders as individuals? How necessary do you believe this is? 3a) Did you check out their backgrounds? 3b) Did you recognise language issues (not wanting to over or under estimate your audience)? 3c) Did you engage with the stakeholders as representatives of their organisations, as individual experts or indeed as a combination of both?
4) Feedback….

4a) Did you provide feedback? 4b) What form did it take? Was it individual, or group based feedback? Did you provide summary documents and sheets? Was there separate feedback for the stakeholders to that of the academic community?

Stage 2: The Manchester Workshop

The Manchester workshop was introduced by the lead author. It was explained that the workshop would be conducted under 'Chatham House Rules". Therefore, no individual or project is identified within this section. Instead we identify broad issues or topics that were suggested by more than one presenter.

Main Outcomes

Three projects identified that they experienced difficulties when defining a list of 'appropriate stakeholders'. In two examples they worked with external organisations to put together the list; four of the presenters said that their list of stakeholders expanded during the project. Two of the presenters said that the stakeholders in their project did not appreciate the importance of their role until the end of the research, during review. Four of the presenters said that it was important to be doing something that was both useful and important to the stakeholders, and in three of the examples this resulted in an expansion in the scope of the project – in each case this was early on in the process. All participants agreed that the name of the Tyndall Centre was helpful in getting stakeholders to participate in the research. This was particularly helpful due to the large amount of projects, which frequently engage the same stakeholders, in the academic domain. This highlighted the issue of avoiding stakeholder fatigue (both within and outside a research centre). Different forms of stakeholder participation were found to yield more beneficial results, notably face-to-face interviews. Visual cues (in terms of the body language of the stakeholders) were deemed to be particularly helpful in shaping discussions.

The participants discussed the notion that academics were well placed to do research with stakeholders and that the outputs from the research were deemed in general to be trustworthy and unbiased by non-academic audiences. However, two presenters showed how stakeholders became hostile as the results from the project emerged[5]. In both these examples the stakeholders involved issued a press release directly criticising the results of the research. Three presenters identified differences in the interests of the funders of their research, compared to those of the stakeholders with whom engagement was necessary; in each case this resulted in an expansion of

[5] Stakeholders becoming hostile is also identified in the literature – see (Jaeger and Wagner, 1987).

the scope of research in order to achieve engagement. In two of these examples the stakeholders involved were managers, who agreed that their organisation would participate in the research, and provided staff – however they themselves had little further involvement.

Several common themes as to why stakeholders engage in research were identified. These included:

1) Stakeholders engaged because they did not want to appear un-cooperative.
2) They wanted themselves or their organisations to be heard.
3) They felt valued by being asked.
4) They felt that by 'having a voice' they may be able to exert more control.
5) They could find out more about the topic under research.
6) They could promote their organisation.
7) They could make new contacts and network.

'Involving the stakeholders'

The presentations showed that the involvement of the stakeholders took place at different stages during different projects; in some cases this was continuous while in others it was *ad hoc*. Four presenters identified the importance of different forms of communication for different audiences. This they said was because their stakeholders came from a variety of backgrounds, (e.g., government bodies, industry, NGOs, media, the public and academics) and only had a limited amount of time to spend on the engagement. Examples of what were felt to be poor forms of engagement included expecting stakeholders to read large reports and to listen to lengthy oral presentations. Examples of good forms of engagement included: different reporting mechanisms e.g., a report and a brochure; and regular short emailed updates. Members of the public in particular were found to respond best to communication that was primarily visual. This said, it was recognised that this was topic- and context- dependent, e.g., for conveying science and technical ideas.

As projects developed from the conceptual stage, the nature of stakeholder engagement was seen to vary. Two presenters identified that stakeholders expressed concerns over duplicating results of previous projects because they did not want to cause confusion with audiences that they dealt with – potentially stakeholders who were not directly involved with the project. In two projects the stakeholders were deemed to be the drivers of the research and in one of these projects the research instigated bilateral discussions between stakeholders, with the results of the discussion

being a useful 'feed-in' to the research. In both of these examples the stakeholders were felt to be an active part of the whole research process.

The participants all agreed that maintaining a good level of engagement was key to future involvement of the stakeholders. It was also recognised that researchers within the Tyndall Centre were representative of the Tyndall Centre and they therefore had to be careful not to affect the stakeholder interaction in ongoing and future projects of other researchers. This, it was discussed, may affect the manner in which research results and opinions were expressed.

Stage 3: The London Researchers Workshop

Findings from the interviews and the Manchester workshop were considered in terms of previous research (e.g., Turnpenny et al., 2004). These findings were used in a brainstorming exercise to form the qualitative questionnaire used at this stage. Thus, government bodies, industry, NGOs, media, the public and academics were all mentioned by participants in discussions about stakeholders. It was evident from this stage that all of these stakeholders could be involved at any, or all, stages of a research process. These stages were broadly categorised as: before, during and after the core research.

The key findings from this exercise were consistent with the Manchester workshop - in that, when a stakeholder was engaged in the research process was in part be influenced by the type of contribution that they were to make to the research, or, more accurately, were perceived to be able to make. It also appeared that the mechanism for engagement by the stakeholder could vary in intensity – e.g., questionnaire vs. face-to-face interviews vs. workshops vs. meetings (or a combination). Finally, how active the stakeholder engagement, in terms of scales previously discussed, evidently varied between projects.

Findings from this survey are contained in Table 2.

Table 2: Stakeholder Groups and Experience of ShE (from qualitative survey; N=16)

Which stakeholders and stakeholder groups did you work with?	▪ Environment Agency x2 ▪ Defra x3 ▪ Natural England ▪ North Norfolk District Council x2 ▪ Great Yarmouth Borough Council ▪ Government/policy-makers (unspecified) x4 ▪ Green Party MEP ▪ General public/ local people x2 ▪ NGOs; e.g. FoE, WWF, local community action groups x2 ▪ Cp.net (Climate Prediction) members ▪ Energy specialists/ climate scientists/ Philosophers x3 ▪ Communication/ IT/ Finance experts x3 ▪ Royal Society of Arts ▪ Aviation industry reps

	▪ Chelsea flower show ▪ Media x3
What role(s) did the stakeholders play in your research (e.g. funder, advisor, reviewer, providing data)?	▪ Provided data/ interviewee/ participant x11 ▪ Workshops/ focus groups x3 ▪ Advisor/advisory role/ reviewing x4 ▪ Input on participatory methods ▪ Building contacts for future work ▪ Consultancy ▪ Media – wanting information ▪ Knowledge transfer ▪ Funder
Were these expert stakeholders? **If yes, were they in a different field from you?**	▪ Yes x7 ▪ No x2 ▪ Several combined responses x7 ▪ Yes x5 ▪ No x2
When in the research process did you engage with stakeholders?	▪ During research, at the beginning, not always early enough ▪ On and off throughout in planning and doing the research ▪ As and when an intellectual problem arose ▪ Beginning, towards the end, all the way through ▪ So far, before and during the research process ▪ At all stages, but especially when designing the methodology and data collection ▪ Data collection stage and also feedback of research findings to them
How (if at all) did the degree of involvement change over the course of the engagement process?	▪ Most groups were keen to maintain high level of involvement ▪ Fluctuated, highest during planning stage and parts of the research process ▪ Only short interactive sessions – didn't return to participants or consultants though both will receive report of results of the research ▪ From my experience it is too early to see the change at this stage ▪ Did not change x3
How much control did stakeholders have over the research (design of project, methods used, outputs, etc.)?	▪ Variable ▪ Significant control over how the research is applied ▪ Outputs – government ones doctored bits and tried to influence the outcome ▪ Advise and review, methodology and approaches ▪ Very little ▪ None x3
Why do you believe stakeholders participate in academic exercises?	▪ To learn/ receive information from researchers x5 ▪ To influence (e.g., policy agenda) x3 ▪ Beneficial/useful to their work x4 ▪ Personal interest / gain x5 ▪ To raise their profile x1 ▪ To contribute to an issue they see as important x1 ▪ Because expected by funders x1 ▪ They feel it is right thing to do (e.g., public bodies) x1 ▪ For the sake of raising profiles x1 ▪ Because the information is free x1 ▪ To forge links/ build networks x2

The qualitative questionnaire findings highlight the particular importance of the academic

community of stakeholders to researchers' work, fitting Pohl's (2007) Type 1[6] research. Several participants also identified a role for the public, industry, NGOs and the media. In the case of this group of researchers, the stakeholders they engaged with were experts in a field different to that of the researcher. The timing of stakeholder engagements within this group varied; in some cases, there was continuous interaction, while in other cases, researchers engaged only at specific (or ad hoc) times, as follows:

Before the research two different types of stakeholder were identified, namely the 'funders' of the research (an important point, as it is often it is the funder who wants 'stakeholder engagement') as well as 'a figurehead' whose role it was to promote awareness in the research during its launch and implementation. Furthermore, these and other stakeholders were deemed influential in the design and conduct of the research. The level of control exerted by stakeholders at this stage varied widely between projects - ranging from 'significant' control to 'none'. The stage at which stakeholders were engaged appeared to influence their degree of control over the design and execution of the research.

During the research stakeholders' presence was most prevalent; here they are seen to provide information or data (either via interview/survey participation or sharing secondary data). In this sample, this was the most common role played by stakeholders. Sometimes this engagement was deemed to be ad hoc, an unplanned consequence as the research unfolded to reduce uncertainties in the research findings.

After the research process stakeholders were seen to be recipients of findings, from which they may or may not have provided feedback. In some projects, stakeholders attempted to influence the results and content of the research reports.

There were also groups of stakeholders who acted as advisers – throughout the research. They may have helped with research design, data provision and feedback on research outputs. These groups were often called 'advisory groups'.

When asked why they believed stakeholders engaged in research, the researchers told us that this is because stakeholders want: to learn about research, to influence outcomes or agendas, to impose personal or professional interest, and to network. This was broadly in line with the conclusions from the Manchester workshop.

Stage 4: Online questionnaire

[6] Pohl (2007) defines two types of trans-disciplinary research. Type 1 remains within the academic domains, and is focussed on re-organising knowledge. Type 2 is focused on co-production of knowledge, ideally with external communities.

Utilising the results from the first three stages the authors developed a quantitative, online questionnaire which was sent to all researchers within the Tyndall Centre. In total 26 different projects were represented in the response to the internet questionnaire. A summary of responses to the internet survey is shown in Table 3.

Table 3. Summary – internet questionnaire survey to Tyndall researchers (N=26)

Question	Brief overview of responses
Have you ever engaged with stakeholders during your time in Tyndall?	The majority of respondents (96%) had engaged with stakeholders at some point during their research.
Do you agree with how we defined a 'stakeholder' at the start of this survey? (i.e. as 'a person or group who influences, or is influenced by, your research')? If no, please give your definition of a 'stakeholder'	All but three respondents (i.e. 87%) agreed with our definition of a SH. Alternative definitions included: 'Mutual generation or 'co-production' of knowledge/ evidence/ information, and about creating links between academia and practice. A stakeholder is: 'An external party, be it an individual or an organisation for example, which has a 'stake' or 'vested interest' in the field of study, its outputs and its implications''; 'A stakeholder is someone/group who has an issue with the question being dealt with. Stakeholder may or may not influence / be influenced by research'; 'For me stakeholders are actors that have an interest (or stake) in a particular issue that is being debated or researched'.
To what extent was stakeholder involvement in your project planned?	Most (69%) said stakeholder involvement in their project was planned 'a lot'; and 27% said it was planned 'a little'.
Did you engage with more stakeholders than you expected to during the course of the project?	Despite this, just over half the participants (52%) said they'd engaged with more stakeholders than they had expected to during the course of their project.
What stakeholder involvement methods did you use, and when in the research process did you use them?	In terms of methods used, meetings - especially before (22%) and during (46%) the project, informal contact - throughout (21% before, 40% during, 30% after), and academic publications (especially after the project; 53%) were the most commonly-applied. One-to-one interviews (44% during) and workshops (48% during) were also relatively popular during the course of the research.
Which stakeholders, and stakeholder groups, did you work with and what role did they play in your research?	In all cases, stakeholders were most likely to be data/information providers or recipients. Local policy (e.g., city council), Regional policy, National policy, Government agency, and International policy groups were all most likely to be recipients of findings (24%, 22%, 30%, 26% and 19%, respectively). Service sector was most commonly a data provider (15%), energy and other industries were mostly recipients (13% and 17%, respectively).

	NGOs were mostly data providers (22%); while the general public were most commonly recipients (27%). Academics were most commonly data providers (25%) or reviewers (25%).
When in the research have they been involved?	Most common group engaged with at every stage of the research was 'Research/academia' (28% before, 25% during, 32% after); 'NGOs' (11% before, 39% during, 25% after), 'National policy' (14% before, 36% during, 31% after) and 'Government agencies' (19% before, 31% during, 33% after) were the next most popular groups that participants engaged with. 'Utilities' and 'Energy producers' were the groups least engaged with (61% and 64% did not engage with them, respectively).
How beneficial was stakeholder involvement to the project?	The highest proportion of respondents identified stakeholder involvement as beneficial during the project (81%; compared to 59% before the project, and 62% afterwards).
To what extent do you feel that stakeholders' involvement in your project was beneficial for the stakeholders?	We see a different pattern emerging in relation to when respondents felt stakeholders gained from being involved. Most participants felt stakeholders' involvement in their project was beneficial for the stakeholders; although the benefit to stakeholders was felt to increase over the course of research (44% said it was beneficial before the project, 67% during, and 81% after).
How important is it to you that stakeholders benefit from being involved in your research?	Furthermore, all participants felt it was either very important (69%) or quite important (41%) that stakeholders benefit from being involved in research.
Overall, how much control did stakeholders have over the research?	The survey shows stakeholders having greater control earlier on in the research process: 33% said stakeholders had 'a lot' of control before the project started, dropping to 11% saying this after the process. The proportion saying stakeholders had no control ranged from 26% (before), through 30% (during), to 37% (after).
Did you change your research design during the research process as a result of stakeholder interaction?	Evidently, stakeholders were influential in a number of ways: most (59%) said they had changed their research design during the research process as a result of stakeholder interaction.
Over the course of your research career (not only in Tyndall), has your approach to stakeholder engagement changed in any way?	There is also evidence of learning amongst the researchers surveyed: most (63%) said that over the course of their research career (not only in Tyndall) their approach to stakeholder engagement has changed.
Have you ever experienced difficulties in managing stakeholder expectations?	Despite acknowledging the value of ShE, survey suggested it can also be challenging: a significant minority (44%) said they'd experienced difficulties in managing stakeholder expectations.
Have you engaged with any of the stakeholders you've	Stakeholder engagement is often based on (or develops into) a longer-term relationship, beyond the scope of a particular

mentioned here in any other projects? Have you been approached by stakeholders you've worked with to do further work with/for them?	research project: over half the participants (59%) have been approached by the stakeholders they've worked with to do further work with/for them, and a similar proportion (58%) have engaged with stakeholders they mentioned here in any other projects.

Main findings from online survey

Overall, the findings from all stages of our research show a high level of stakeholder interaction amongst researchers within this virtual research Centre, with stakeholder interaction occurring before, during and after the main research. The survey also shows a variation in the engagement methods used, and roles occupied by different stakeholder groups, between projects. The academic community played the most varied and consistent role as stakeholders in climate change research at the Tyndall centre, while policy-makers, NGOs and other groups also play valuable roles as data providers, recipients and reviewers of research findings.

ShE has led to learning amongst Tyndall's climate change researchers, not only about ShE itself but also in respect of stakeholders' views about research design and outputs. The process of ShE in research often involves a significant degree of 'give and take' – with this most noticeable in the research design. Sometimes this 'give and take' created a change in the scope of the research. This tended to happen in order to engage with certain stakeholders who were considered to be particularly important to the research, such changes being implemented after the research had been funded but before the research had commenced. This presents the broader issue of *stakeholder control* which was explored through our research for this paper, and deemed to relate to the timing of ShE. Early ShE in the research process provides stakeholders with greater control over the research direction than engagement that takes place later in the process. However, later engagement did provide future funding ideas.

Furthermore, when considering the value of ShE, this extended beyond the duration of the project's funding – here researchers were approached to discuss research long after it had been completed and reported – by individuals outside of the academic communities (often taking a considerable amount of researchers' time). Evidently, stakeholder contacts are important to maintain in some cases, for example to build future funding opportunities and to foster trust in research outputs.

At the same time, we found that there were difficulties associated with more fully engaging stakeholders in Tyndall research. These difficulties were due to several factors, including: budgetary constraints (it is costly to engage with stakeholders; workshops and other such stakeholder events, for example, can cost thousands of pounds); competing demands on researcher and stakeholder time (engagement with a large stakeholder input often requires work

to be done that is not wholly useful to a given project but is necessary to maintain engagement); competencies (facilitation skills and good planning, and a social science understanding are required to make best use of stakeholder interaction); moreover academic performance requirements vs policy influencing and media dissemination demands (in that the time frame for publishing academic results is often much longer than other avenues of dissemination) were seen to impinge on researcher time. Moreover, the rewards for stakeholders of being involved are hard to quantify and not recognised by university reward system. This has been well documented (Shove and Rip, 2000).

Disseminating climate change research outputs potentially requires a more timely approach than traditional academic disciplines. For example, this may involve more rapid communication of the links between recent increases in the atmospheric concentrations of greenhouse gases, understandings of feedback mechanisms, changes in CO_2 sink absorption rates (e.g., southern ocean CO_2 uptake) in order to influence mitigation and adaptation policy (at all scales).

It is clear from this research that the reasons for engaging stakeholders directly influence the complexity of the research and the methods used within it (budget and time are, of course, additional influences). It may also be a function of the complexities. However, there is also an onus and a drive on behalf of some researchers who recognise the context-relevance of climate change in the wider communities to interact. This is often undertaken in their own time and at their own expense.

The surveys demonstrate that Tyndall researchers identified many reasons for engaging stakeholders in research. The engagement may result in the building and/or the co-production of knowledge by researchers and stakeholders. The ultimate purpose of the engagement may be to bring about change, e.g., to develop policy, theories, approaches, models, methods; to bring in extra funding or to legitimate research. However, there is also the question as to whether the research is truly integrated (appreciating the inevitable uncertainties of such activities).

Referring to a research project as being one that has engaged stakeholders does not indicate the degree of involvement or the role that a stakeholder has had within the exercise. For example, performing an interview with an expert is often considered ShE – rather than an old-fashioned informant interview. However the Tyndall Centre is not alone in this. This presents a question, of how can we identify between different forms of stakeholder engagement?[7]

[7] Shove and Rip (2000) identify a series of categories of users, in what is referred to as 'interactive social science'. This includes user-participators; however it also includes four types of users of the research.

We propose in the following section a Typology of Stakeholder engagement that recognises the different ways stakeholders are engaged within research. This recognises the different roles that have been identified in the studies above. The purpose of this typology is fourfold:

1) To present and compare how stakeholders have been (or could be) involved in different research projects;
2) To communicate with stakeholders and transparently show them the way in which they will be involved in a research project;
3) To compare the different forms of engagement between research projects;
4) To show, in a research proposal, how and when stakeholders are expected to be engaged.

How can we identify different forms of stakeholder engagement? A new typology

The observations above show the level at which stakeholders have been engaged in climate change research by researchers within the Tyndall Centre. Our findings suggest an active engagement with stakeholders on behalf of the researchers consulted. The above observations show that considering research involving stakeholders as comprising three stages (before, during and after) is not wholly representative of research involving stakeholders. As demonstrated previously, a stakeholder can have many roles within a research project, and may affect one, many or all of the following parts of a research project: initial design, development, information provision, steering, revision, dissemination, utilisation (impact) and future research design. Therefore, rather than three defined stages there exists several overlaps between the identified stages, and with this a greater need, on behalf of some researchers in certain projects with intensive stakeholder involvement, for reflexivity in the approach they take in their work.

We have identified eight separate categories of stakeholders[8], according to their roles and the timing of their involvement in a research project. A research project may include one, several or all of these stakeholder categories. It should be noted that the level of inclusion of stakeholders is not necessarily indicative of the standard of research – purely the level and nature of engagement. We present these categories in turn, with reference to a pictorial representation[9]. Subsequently we present this Typology in reference to three Tyndall associated projects to show how it may be used by others.

[8] We would like to thank Kevin Anderson for proposing the 8th.
[9] Artistic improvement by Sophie Nicholson-Cole, based on Sebastian Carney's initial conception.

Figure 1. A new stakeholder engagement cycle / typology

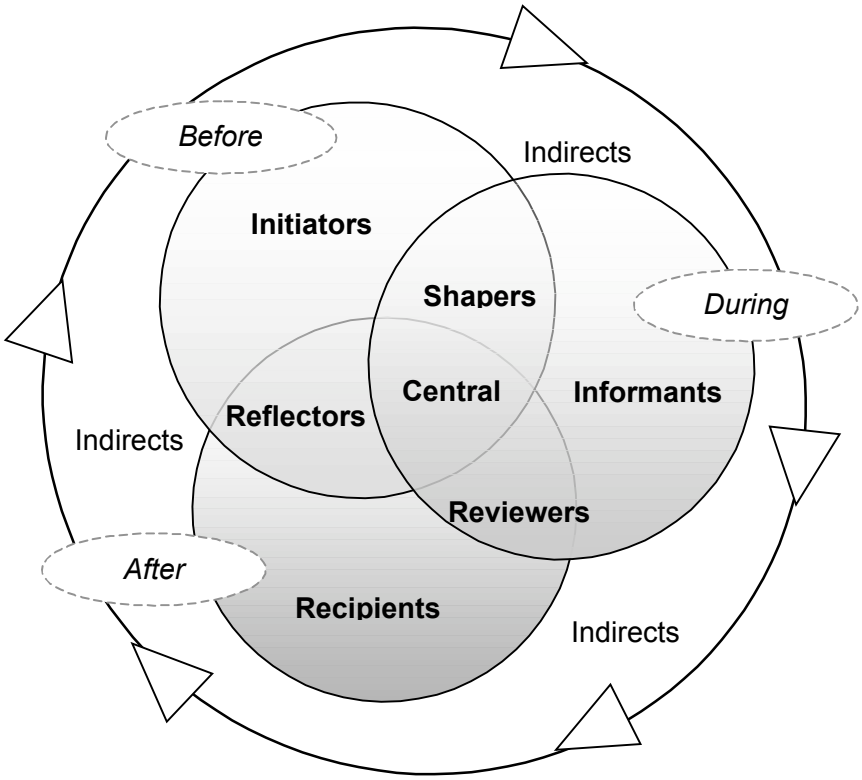

Figure 1 represents the cyclical nature of the different stages of a research process – with each segment loosely representing a different type of stakeholder involvement. The outer circle represents the temporal 'flow' that exists in research – from the formation of a research project, through conducting the research, to the dissemination of the findings and how the experiences and outcomes of the research project affect future research design. The three inner circles represent the identified three stages, namely: before the research, during the research, and after the research. These three circles overlap in four places. These overlaps represent additional stages in research involving stakeholders and are associated with particular types of stakeholder involvement. In total, these three circles represent seven categories of stakeholder (one for each segment). The central stakeholders may take on all of the seven roles. The eighth stakeholder category is represented within the outer circle, and refers to stakeholders who may be affected by the research outcomes, who are considered during the research but not explicitly included in it. The eight groups are summarised in Table 4 and discussed in detail below.

Table 4: Different roles played by stakeholders engaging in a research process

A typology of stakeholder engagement in climate change research	
Role played in the research process	*Description*
Initiators	Stakeholders involved in developing, driving or instigating a piece of research, e.g., funders.
Shapers	Stakeholders who have a role in consolidating a research plan, supporting it or directing it at an early stage. This may include an expansion in the scope of the research to gain buy-in and provide the research with legitimacy.
Informants	Those stakeholders who directly inform a research study, e.g., secondary data providers, interviewees, focus groups, etc.
Central	These stakeholders have an input throughout the research process; they play a focal role. They may take on a multitude of roles, as shapers, informants, reviewers, reflectors, etc. They may be representatives of broader groups or organisations and tend to be close to the research, for example they are often part of an 'advisory group'
Reviewers	Before completion, stakeholders who have a role in reviewing research, responding to it and shaping / contributing to aspects of the final output. This maybe elicited in the form of questionnaires, focus groups, interviews, workshops, etc.
Recipients	Stakeholders who may not have been directly involved with the research but who are deemed to have a specific interest in its findings.
Reflectors	These stakeholders reflect on the research findings and/or the process, providing feedback for development of the research, the methods and providing ideas for further research.
In-directs	This group represents wider stakeholders who are not explicitly included with the research. However, they may be unknowingly or unconsciously contributing to it – or affected by it.

Initiating stakeholders:

'Initiators' are stakeholders who tend to be involved in developing, driving or instigating a piece of research in conjunction with researchers. These stakeholders may play a role in identifying a particular need for the research e.g., funders putting out a call for research; or they may help at a

bid-preparation stage in consolidating the research questions and lending their support in a proposal. They may add policy or industry relevant insights into the needs for certain types of research to inform policy and practice. Their involvement may come through already established working relationships, calls for engagement from the research or stakeholder community (in either direction), or already formally established links.

Shaping stakeholders

In climate change research, different stakeholders (e.g., policy makers, NGOs, academics) may be called upon to engage with research projects at different levels of intensity, depending on the nature of the project. During the early stages of research (but after it has been funded and the rationale agreed), alterations to the research design may be necessary to ensure stakeholders' engagement, e.g. in the Tyndall Cities theme, Thames Water requested a different time horizon for the research. Here, where appropriate to the design of the research, the work may alter to maximise stakeholder involvement. Also, where a stakeholder may have been identified as being particularly important to a project – whether in terms of data provision or legitimacy to its findings – a researcher may seek to modify the research design based upon consultation with that stakeholder to ensure inclusion. These stakeholders may be senior in their organisations, with little direct involvement in the project beyond contributing to its design development whilst potentially benefiting from the outputs (they may also play an advocacy role initially, then pass responsibility for clarifying research data requirements or other aspects to colleagues who liaise more directly with the research team).

Informing stakeholders

These stakeholders directly inform a research project in various ways. They provide input and skilled advice that feeds directly into the research, or act as participants. This input may be realised in a number of ways including: completing questionnaires; participating in interviews, focus groups or workshops; or providing primary data (e.g. from the Environment Agency for coastal modelling work) or secondary data (e.g. Foresight's scientific advisers). Once again, depending on the project in question, there may be many of this type of stakeholder in a given project, with some providing minimal input in temporal terms and others being more involved more intrinsically and/or over the longer term.

Central stakeholders

These stakeholders can be considered to be those heavily involved in a research project throughout its duration. They have particular interest in all stages of the research – from guiding the design to taking on board its outputs. These stakeholders may contribute guidance, advice and input on the research design, project development and dissemination. Such a role means that this kind of stakeholder is often seen as part of steering committees, for example, or they may be associated with ensuring that a funder's interests are being met (e.g., The Cities theme have an advisory board, as did the GRIP project on emissions inventories).

Reviewing stakeholders

When initial findings from a research process are released, they are typically subject to review by individuals or groups external to the research team. For example, results or draft reports may be presented to a 'panel of experts' for consultation, to gain their insights into initial findings and their implications. This process can enrich a project's outputs or assist in developing data analysis or its interpretation. For example, stakeholders may perceive that aspects considered important in the world of policy or practice have been overlooked, or not fully explored, therefore requiring additional attention before the end of a project. So while academic requirements and perceptions of value may not necessarily be the same as those of some stakeholders, where a project seeks to be policy-and practice- relevant, common agendas must be defined in the early stages, and expectations about deliverables managed. Ensuring that the expectations of engaged stakeholders are met is as critical in stakeholder-orientated research as the highly valued academic deliverables. This is also important for building good working relationships for future research partnerships and also to maximise the application of the findings.

Recipient stakeholders

This group of stakeholders is the most commonly identified both in the literature (see Pohl, 2007; Shove & Rip, 2000) and in our study. These stakeholders in any project are those who directly or indirectly receive one or all of the final outputs of a project, e.g., a project report, conference paper or other publication. This may be due to deliberate contact on behalf of the research team or the stakeholder. On one hand, they may be a target interest group whom the research team deem to have potential interest in the research findings. On the other, the stakeholder themselves may seek access to the project outputs, e.g., by choosing to attend a project launch, a conference presentation or download a report. In some cases, through research dissemination exercises, recipient stakeholders may engage indirectly via the mass media (e.g., newspaper articles, radio reports and television news items based on a project's press release).

Reflecting stakeholders

These stakeholders are a key part of a research review (and learning) process, and may include data providers or external reviewers (e.g., Tyndall international science panel). The role of these stakeholders tends generally to be one of providing feedback on what they did or did not like about the research, how they believe it could be improved and how they would like to see it altered. Feedback may be asked for, or indeed it may not, but these stakeholders offer an excellent opportunity for gaining further knowledge and insight. Alternatively, in some instances engaging with stakeholders may be difficult, and active feedback allows researchers to improve the quality of their engagement with stakeholders in future projects.

Indirect stakeholders

These stakeholders are those *ultimately* affected by the results of research – or may be affected by the impacts of anthropogenic climate change. These stakeholders, whilst not directly represented on a project, have their views 'spoken for' by another (e.g., an MP, or a pressure group. How well these 'indirect stakeholders' are represented within research is therefore open to question. However these stakeholders, and how many of them there are, may be key to research outputs, especially if the community (whether this is the public, policy, academic, commercial, industry sectors, or a mixture thereof) is meant to be represented within it. This also extends beyond the policy dimension, and that of appropriately selecting stakeholders. This group may also include people who are affected by the outputs of research, in the form of policy – for example people who drive within London may be affected by the congestion change changing from a blanket charge to one with a CO_2 focus.

What do Stakeholders think of the Typology?

An earlier version of this Typology that used the term 'partner' rather than 'central' was presented to a series of stakeholders with whom established and ongoing links exist with the lead author. These included representatives from Glasgow and the Clyde Valley Joint structure Committee; METREX and the GLA. The feedback received suggested that the typology was helpful. However, the term 'partner' was deemed to be rather ambiguous. This is because a 'partner' in a project is often a funder who may have an otherwise limited role, not necessarily being involved throughout the research. As a consequence the term 'central' was adopted. One of the interviewees, found the typology particularly helpful as they viewed the term stakeholder to be over- and sometimes mis-used. This interviewee said 'there is nothing more irritating then being asked to be a stakeholder in a project, and then turning up – only to discover the research has already been done'.

How may the Typology be applied?

The development of the stakeholder engagement Typology, drawn from Tyndall Centre experience can be re-applied to individual research projects as case-study examples to demonstrate its application. Three examples are presented which demonstrate the interdisciplinary nature of the Tyndall Centre's research and the variety of 'modes' of stakeholder engagement experienced.

Tyndall Centre Coastal Simulator

The Tyndall Centre Coastal Simulator project has been underway since 2000. Its aim is to understand how the coastline may evolve for a range of plausible climate and management scenarios, and hence support strategic coastal and shoreline planning. The simulator takes downscaled climate scenarios and explores their impacts on a discrete coastal sub-cell in East Anglia (Shoreline Management Plan sub-cell 3b – North East Norfolk) including different development pathways and management options (Dawson et al., 2007; Nicholls, et al., 2008). Stakeholders have been involved in different ways since the inception of the project (Table 5).

Table 5: A typology of stakeholder engagement: Tyndall Centre Coastal Simulator	
Initiators	Tyndall Centre (funded by UK Research Councils)
Shapers	The Environment Agency (EA) – key provider of data and fed into the objectives of the project
Informants	A range of informants made up of potential future users via stakeholder workshops to guide the development of the project and its possible user output. These include Defra, Environment Agency, Natural England, Coastal Local Authority officers and members, Utilities companies, Regional Government Office, specialist consultancy firms, NGOs such as the National Trust and RSPB, etc.
Central	An advisory panel to the research programme, comprising potential user interests (e.g. a coastal Local Authority and the Environment Agency). On-going updates via specific meetings with Regional and National representatives.
Reviewers	Environment Agency and other potential users via workshops.
Recipients	The Environment Agency, potential user community (see above), wider academic community with interest in coastal processes and integrated assessment, and other indirects.
Reflectors	Environment Agency, academic interest community.
Indirects	Include coastal communities and action groups within the sub-cell area, and other coastal management related organisations. Also coastal stakeholders in other locations (the methodology is intended to be rolled out elsewhere in future).

ShE has been evident throughout the research. The Environment Agency (EA) for example is a central stakeholder – and has therefore been engaged throughout the research. Other stakeholders (across scales, principally in governmental, statutory and NGO capacities) have been engaged during the research process most specifically as informants and in a reviewing role. The latter have had little control or influence over the project apart from in an advisory capacity, whereas the former have had a more major input, specifically because of the project relying to some extent on EA data. Flows of knowledge and learning have occurred principally during the main body of the research process as a two-way exchange. In the final phase it is expected to be more uni-directional – the project informing coastal management stakeholders. The cyclical pattern of the typology is very important in this case where the project has actively invited reflection at the end of a first phase of research (2005-6) before continuing into a new phase involving some further initiation, shaping, informing and so on.

A key feature of the stakeholder involvement has been through an ongoing interaction with the Environment Agency – seen as a 'central' stakeholder. The research programme within which the project sits also has a specific stakeholder contact group (including a local District Council, Natural England, the Environment Agency and DEFRA) to maintain the policy relevance of our work. Additionally there is an active research dissemination strategy including the publication of research papers and giving talks, seminars and briefings, where relevant.

The Greenhouse gas Regional Inventory Project (GRIP)

The GRIP initiative was initially part of PhD research conducted at the Tyndall Centre with funding shared between Tyndall and the Environment Agency. The initiative has subsequently been rolled out in a number of other regions and is subject to a current EU bid for funding. The first application of GRIP comprised two parts: part one involved the formation of a GHG inventory for all the English regions and the second part involved forming energy orientated CO_2 scenarios for North West England using a computer interface. The assessment below refers to the second part of the project, where stakeholders formed the scenarios (Table 6).

The nature of the ShE was intense; in total 40 interviews were conducted and in addition there was a workshop that included four break-out groups. The Environment Agency (EA) and a steering group provided overall guidance on the initiatives progress (Partners); however in order to establish the policy relevance of the scenarios conducted, key climate change policy makers and advisory groups in North West England were contacted to establish what the key focus of the scenarios should be (shapers). These same stakeholders helped to define a list of 55 potential participants. Of these 55 participants, 40 were interviewed (informants). The results from these interviews were analysed using clustering and simple statistical methods to form a set of four

'energy futures'. The participants were then invited to a workshop (22 participants) to 'backcast' these energy futures – and add or change the storylines associated with them (reviewers). All the participants were asked for their feedback on the process (reflectors) and this feedback has informed the three subsequent GRIP projects conducted over the past two years. The participants and many others were all provided with a brochure outlining the results and encouraged to provide further feedback (recipients)

Table 6: A typology of stakeholder engagement: GRIP	
Initiators	Tyndall Centre / Environment Agency
Shapers	North West Development Agency, Sustainability North West, Environment Agency, North West Climate Change Group.
Informants	Large list, Energy Providers, Energy Producers, NGO's, Academics, consultants.
Central	Environment Agency, Advisory group.
Reviewers	All informants.
Recipients	All informants + a large range of other actors.
Reflectors	All informants, funders, and Examiners.
Indirects	Unknown.

MATISSE project

The European Framework Six project, MATISSE, which ran from 2005 to 2008 and involved a consortium of 21 institutions including the Tyndall Centre, aimed to develop sustainability assessment methods and tools, including participatory methods and agent-based simulation models. Table 7 presents a summary of the stakeholder engagement in this project in relation to the typology presented in this paper.

Stakeholder involvement has occurred at every stage of the project. DG Research of the European Commission funded and evaluated the project. Other (less powerful) reviewers have included academics, government agencies, and industry representatives engaged via conference presentations and informal discussions. Several stakeholder groups acted as data providers. In the transport case study, this included national government (DEFRA), European Commission, NGOs, automotive and energy industries, general public, and researchers participating in 'visioning' workshops to identify context-specific sustainability criteria and explore possible solutions to problems of unsustainability (Weaver and Rotmans, 2006; Whitmarsh, 2007; Whitmarsh and Wietschel, 2008; Whitmarsh et al, 2007).

Table 7. A typology of stakeholder engagement: MATISSE@Tyndall	
Initiators	DG Research
Shapers	Core PI's at multiple universities.
Informants	national government (DEFRA), European Commission, NGOs, automotive and energy industries, general public, and researchers participating in 'visioning' workshops
Central	A high-level advisory group comprising senior academics, politicians and industry representatives
Reviewers	DG Research, academic community
Recipients	national government (DEFRA), European Commission, NGOs, automotive and energy industries, general public, and researchers
Reflectors	DG Research, academic community, Tyndall supervisory board
Indirects	

A high-level advisory group, comprised of senior academics, politicians and industry representatives, gave regular feedback on the project as a whole and acted as channels through which findings could be applied to real-world sustainability challenges. Stakeholders who acted as data providers were often also recipients of the research; thus, the workshops mentioned above provided a means of disseminating preliminary results and eliciting feedback to use in the ongoing research. Dissemination of findings has occurred during (and will continue after) the project via conference presentations, journal articles, downloadable working papers, website updates, and policy briefings. Reflectors include researchers and funders. Overall, the greatest efforts by project researchers were spent on engaging with stakeholders as Informants and Recipients.

6 Conclusions

At the beginning of this paper we identified the current ambiguity in respect of who or what a stakeholder is, and for the purposes of this paper we settled on a very broad definition of 'a person or group who influences or is influenced by the research'. We then presented four reasons for stakeholder engagement: when stakeholders are the subject of study; when they are the focus of co-production of knowledge; when they are increasing the legitimacy of the research; and when they are the recipients of the research. We explored the challenges that engagement can present, and identified a variety of issues – including the need to communicate with audiences of differing knowledge levels, balancing the interests, knowledge and articulation of the various stakeholders, and also the importance of not unduly influencing stakeholder inputs. We identified the various ways in which stakeholders have been categorised in the literature, and recognised that this has often been based on uncritical and subjective judgements

than on any rigorous, comparative assessment of the functional role that stakeholders can play.

The Tyndall Centre in its virtual capacity affords an excellent opportunity to explore the role of stakeholders within a diversity of climate change research. The typology of stakeholder engagement presented in this paper draws on a wide range of experiences of stakeholder engagement in Tyndall Centre research. It has been developed on the basis of the data drawn from a mixed-method process involving exploratory interviews, workshops, and questionnaires with representatives from across the Tyndall Centre. The cyclical character of the typology and the 'stages' of a research process that it represents are designed to embrace three broad features of stakeholder engagement in research, namely:

1) Timescales: The nature of stakeholder engagement in a research project may differ during the course of the study. This will depend on many things including degrees of stakeholder interest, the specific nature of the project in question and the purpose of engagement.

2) Involvement: stakeholder engagement means that there is a balance of control, input and influence that a stakeholder may exert upon a research project. This may also change as a project matures and new insights are uncovered.

3) Knowledge exchange: knowledge exchange during stakeholder engagement may vary between and during research projects. This may result in the co-production of knowledge, or may simply be in the form of dissemination of research findings.

Whilst the Typology presented here has been developed with climate change research in mind it is hoped that it could be applied in other research areas. The Typology has the potential to foster greater understanding of the role and value of stakeholder engagement in different projects. We hope that it will provide specific support for researchers in clarifying the nature of stakeholder engagement with their research projects.

Further thoughts on future work

The outputs from stakeholder engagement in research are well represented within the literature. However, the methods used and the experiences of what works and what does not are less so. This is partly because of the complexities and the different forms stakeholder engagement may take. However, it is also because currently there is more focus on publishing the results of the research than on how they are generated (Baldwin, 2000, Chilvers 2008). This study represents a retrospective attempt to look at stakeholder engagement in the Tyndall Centre (in fact carried out on a voluntary basis by researchers without specific funding). In order to develop this area further, an active research study of 'stakeholder engagement in research' is needed. Tyndall would be well placed to undertake this, as there is an established structure and wealth of experience to draw upon.

It is recognised that stakeholder engagement is time-consuming and that these efforts are not recognised by the existing RAE structure (Shove and Rip, 2000). This type of engagement results in less researcher time being spent upon producing peer reviewed papers. This may be due to the demands of stakeholders for knowledge and understanding regarding climate change, due to its near term and future relevance.

A research strand examining stakeholder engagement in research itself would not only increase the level of publications of Tyndall themes particularly those largely engaged in policy formation, delivering on both the RAE system as well as maximising near term policy relevant research, but could also identify Tyndall as innovators in this field. Furthermore, this will bring opportunities for promoting the policy impact of Tyndall work, e.g., the GRIP work conducted with policy makers under INTEREG IIIC has been nominated for a planning award this year.

This paper deliberately does not challenge the definition of 'stakeholder'; instead, it relies on a broad definition, as does the literature. However, this does result in a series of questions, namely: What is new about stakeholder engagement? How do stakeholders from the research communities differ from the peer community of researchers with whom we routinely engage to as part of research, Just as conventional research methods such as interviews are now sometimes recast as ShE, is stakeholder engagement a misleading term in research? Is there is a desire to frame research as that which has engaged stakeholders? Perhaps this desire, often pushed by research councils, devalues the concept of stakeholder engagement – not only within the academic community but also in the eyes of the stakeholders themselves.

'Researchers are part of the problem. They pursue their own interests, not those of the people they purport to help. They are essentially parasitic: stealing respondents' time, and benefiting professionally from their disadvantage'

(Baldwin, 2000)

Indeed we can go further than Baldwin (above): stakeholders, particularly commercial or state actors involved in issues where investment is at stake, may deliberately avoid engagement and any indirect legitimisation of critical academic research. Even where the research is not likely to be critical, if there is any risk of loss of competitive advantage, this may be sufficient for commercial actors to decline to participate.[10]

Research that looks at all of these issues would draw the attention of the wider research community to the knowledge, experience and innovation that lies behind the work carried out by Tyndall. Furthermore, perhaps attention needs to be given to how we as researchers contribute to the debate and the mechanisms that we use to affect policy. Fine (1994) calls for 'researchers, activists and other audiences to be engaged as critical participants in a *power sensitive conversation'* (emphasis added) (cited in Orme, 2000). This may affect how we communicate with those outside of the academic domain.

> *"Well, now that we have seen each other,' said the Unicorn, 'if you believe in me, I'll believe in you. Is that a bargain?' 'Yes, if you like,' said Alice' (Carroll, 1984)(cited in Shove and Rip, 2000)*

Perhaps the true purpose of engaging stakeholders in research should be more fully considered – so that their engagement within a project is shown 'to add value', rather than this being assumed. So that, as researchers, we don't become like Alice and the unicorn: accepting stakeholders' engagement in research, and thereby uncritically *believing* in its function.

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[10] This reflects a comment made by an internal reviewer.

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References

Anderson, K. 2001 Reconciling the electricity industry with sustainable development: backcasting – a strategic alternative *Futures* 33: 607-623

Argrawala, S. Broad, K, and Guston, D 2001 Integrating Climate Forecasts and Societal Decision Makin: Challenges to an emergent Boundary Organisation *Science, Technology and Human Values* 26: 454-477

Arnstein, S. 1969 A ladder of Citizen Participation *American Institute of Planners* 35(4): 216-244

Baldwin, S. 2000 Interactive Social Science in Practice: new approaches to the production of knowledge and their implications *Science and Public Policy* 27(3): 183-194

Barnes, M. 1999 Researching Public Participation *Local government Studies* 25(4): 60-75

Blackmore, C. 2007 What kinds of knowledge, knowing and learning are required for addressing resource dilemmas?: a theoretical overview *Environmental Science and Policy* 10: 512-525

Callon, M. 1995 *Four Models For The Dynamics of Science*, pp. 29-63 in Jasanoff, S; Markle, GE; Petersen, JC. & Pinch, T. (eds) *Handbook of Science and Technology Studies*. London: The Society for Social Studies of Science and Sage.

Caswill, C., and Shove, E. (2000) Introducing interactive social science *Science and Public Policy* 27(3): 183-194

Chilvers, J. 2005 Towards analytic-deliberative forms of risk governance in the UK? Reflections on learning in radioactive waste *Journal of Risk Research* 10(2): 197-222

Chilvers, J. 2008 Deliberative competence: theoretical and practitioner perspectives on effective participatory appraisal practice Science, Technology & Human Values, Vol. 33, No. 2, 155-185

Daley, D. 2007 Citizen Groups and Scientific Decision making: Does Public Particpation Influence Environmental Outcomes? Journal of Policy Analysis and Management Vol 26, No 2 349-368

Davies, G., and Burgess, J. 2004 Challenging the 'view from nowhere': citizens reflections on specialist expertise in a deliberative process *Health and Place* 10: 349–361

Dawson, R., Dickson, M., Hall, J.W., Jordan, A., Milligan, J., Mokrech, M., Nicholls, R., Pearson, S., Richards, J., Stansby, P., Walkden, M., and Zhou,J. 2007 Integrated analysis of risks of coastal flooding and cliff erosion under scenarios of long term change. Tyndall Centre Working Paper TWP110. Norwich: Tyndall Centre for Climate Change Research. www.tyndall.ac.uk.

Farrell, A, van Deveer, and S.D, Jager, J 2001 Environmental assessments: four under-appreciated elements of design *Global Environmental Change* 11: 311-333

Fine, M. 1994 *Dis-stance and other stances: negotiations of power inside feminist research*, in A Gitlin (editor), *Power and Method: Political Activism and Educational Research* London, Routledge.

Fiorino, D. 1990 Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms *Science Technology and Human Values* 15(2): 226-243

Gass, G, Biggs, S, and Kelly, A 1997 Stakeholders, Science and Decision Making for poverty Focused Rural Mechanisation Research and Development *World Development* 25(1): 115-126

Gibbons, M. Limoges, C. Nowotny, H. Schwartzman, S. Scott, P., and Trow, M. 1994 *The New Production of Knowledge - The Dynamics of Science and Research in Contemporary Societies* London: Sage, and New Delhi: Thousand Oaks.

Glicken, J. 2000 Getting Stakeholder participation right: A Discussion of participatory processes and possible pitfalls *Environmental Science and policy* 3: 305-310

Gough, C., Castells N., and Funtowicz, S. 1998 Integrated Assessment: An emerging methodology for complex issues *Environmental Modelling and Assessment* 3: 19-29

Grimble, R., and Wellard K. 1997 Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences and opportunities Agricultural Systems 55(2): 173-193

Hillman, A.J., and Keim, G.D. 2001 Shareholder value, stakeholder management, and social issues: what's the bottom line? *Strategic Management Journal* .22: 125–139

Intergovernmental Panel on Climate Change 2007 Climate Change 2007: Working Group II Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Parry, M, Canziani, O, Palutikof J, Cambridge: Cambridge University Press.

Jaeger, J., and Wenger, G.C. 1987 *If it's bad news, shoot the messenger*, in Simmons and Walker, 2000.

Jasanoff, S. 1990 *The Fifth Branch: science advisors as policymakers* Cambridge, MA: Harvard University Press.

Kerkhof, M., and Wieczorek, A 005 Learning and Stakeholder Participation in transition processes towards sustainability: Methodological Considerations *Technological Forecasting and Social Change* 72: 733-747

Van Kerkhoff, L., and Lebel, L. 2006 Linking knowledge and action for sustainable development, *Annu. Rev. Environ. Resour.* 31: 445–477

Kerkhof, M 2006 Making a Difference: On the Constraints of Consensus building and the relevance of deliberation in stakeholder dialogues *Policy Science* 39: 279-299

Klein, J.T., Grossenbacher-Mansuy, W., Häberli, R., Bill, A., Scholz R.W., and Welti, M. 2001 (Eds.) *Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society*, Basel: Birkhäuser Verlag.

Latour, B. 2005 *Reassembling the Social Science: An Introduction to Actor-Network-Theory.* Oxford: Oxford University Press.

Meijer, I. Hekkert MP, and Koppenjan, JFM, 2007 How perceived uncertainties influence transitions; the case of micro-CHP in the Netherlands , Technological Forecasting and Social Change 74(4) 519-537

Mendelow, A. 1991 Proceedings of the 2nd International Conference on Information Systems. Cambridge MA

Miles, M.B., Huberman, A.M. 1984 *Qualitative Data Analysis: A Sourcebook of New Methods* Newbury Park, CA: Sage.

Milligan, J, Hills J, Smith, T, and Le Tissier, M, 2004 A typology of coastal researchers' modes of interactions with stakeholders *Journal of Science Communication* 2(3): 1-11

Nicholls, R. J., Mokrech, M., Hanson, S. E., Stansby, P., Chini, N., et al. 2008. The Tyndall Centre Coastal Simulator and Interface (CoastS). Paper presented at FLOODrisk 2008 conference, Oxford, UK.

Nilsson, M., Jordan, A., Turnpenny, J., Hertin, J., Nykvist, B., and Russel, D. (submitted). The use, abuse and non-use of policy appraisal tools in public policy making: an analysis of three European countries and the European Union. *European Journal of Political Research*.

Norgaard, R., and Baer P., 2005 Collectively Seeing the Complex Systems: the Nature of the Problem *BioScience* 55(11): 953-960

ODA 1995 Guidance Notes on How to do Stakeholder Analysis of Aid Projects and Programmes, Overseas Development Administration. Social Development Department

Orme, J. 2000 Interactive Social Sciences: Patronage or Partnership? *Science and Public Policy* 27(3): 211-219

Papadopoulos, Y. 2007 Are innovative, participatory and deliberative procedures in policy making democratic and effective? *European Journal of Political Research* 46: 445-472

Pohl, C. 2007 From science to policy through trans-disciplinary research *Environmental Science and Policy* 1(1) 46-53

Pohl, C. 2005 Trans-disciplinary collaboration in environmental research *Futures* 37(10): 1159–1178

Quinlan, T., Scognings, P. 2004 Why bio-physical and social scientists cans peak the same language when addressing Sustainable Development *Environmental Science and Policy* 7: 537-546

Rayner, S. 2003 Democracy in the age of assessment: reflections on the roles of expertise and democracy in public sector decision making *Science and Public Policy* 30(3): 163-170

Renn, O, Webler, H, Rakel, P, Daniel, B, and Johnson, B 1993 Public Participation in decision making: a three step procedure *Policy sciences* 26: 189-214

Sarewitz, D., and Pielke Jr., R. A. 2007 The neglected heart of science policy: reconciling supply of and demand for science *Environmental Science & Policy* 10: 5-16

Shove, E and Rip, A, 2000 Users and Unicorns: Adiscussion of mythical beasts in interactive science. Science and Pub- lic Policy, 27, 175-182.

Sidaway, R 1998 Good Practice in Rural Development NO. 5 Consensus building Scottish National Rurral Partnership, The Scottish Office, Edinburgh

Simmons, P. and Walker, G. 2000 Contract research as interactive social science *Science and Public Policy* 27(3): 193-201

Steyaert, P, Barzman, M, Billaud, JP, Brives, H, Hubert, B, Ollivier, G, and Roche, B 2007 The role of knowledge and research in facilitating social learning among stakeholders in natural resources management in the French Atlantic coastal wetlands *Environmental Science & Policy* 10: 537-550

Studd, K. 2002 An introduction to deliberative methods of stakeholder and public participation English Nature, Report 474 UCL.

Sundqvist, G., Letell, M., Lidskog, R. 2001 Science and policy in air pollution abatement strategies *Global Environmental change* 11: 311-333

Turnpenny, J., Haxeltine, A.. and O'Riordan, T. 2004 A scoping study of user needs for integrated assessment of climate change in the UK context: Part 1 of the development of an interactive integrated assessment process. *Integrated Assessment,* 4(4): 283-300

Upham, P. and Shackley, S. 2006 Stakeholder opinion of a proposed 21.5MW E Biomass Gasifier in Winkleigh Devon: Implications for Bio-energy *Planning and Policy* 8(1): 45-66

Weaver, P. M., and Rotmans, J. 2006 Integrated sustainability assessment: what is it, why do it and how? *International Journal of Innovation and Sustainable Development* 1(4): 284 - 303

Webler, T. 1998 Beyond Science: Deliberation and Analysis in Public Decision Making *Human Ecology Review* 5(1): 61-62

Wiek, A, Binder, C, and Scholz, RW 2006 Functions of Scenarios in Transition Processes *Futures* 38: 740-766

Whitmarsh, L. 2007 *Citizens' Workshops on Sustainable Futures: Report of findings*. MATISSE Working Paper 14: SERI: http://www.matisse-project.net/projectcomm/uploads/tx_article/Working_Paper_14_cover_blau.pdf.

Whitmarsh, L., Bohunovsky, L., Jäger, J., and Nykvist, B. 2007 MATISSE WP7.1 - Hydrogen Transport Stakeholder Workshop No.2 (June 2007): Findings from Break-Out Group Discussions and Questionnaires. *MATISSE Internal Report.*

Whitmarsh, L. 2007 Participation of Experts and Non-experts in a Sustainability Assessment of Transport – Conference Paper Royal Geographical Society Annual international Conference.

Whitmarsh, L., & Wietschel, M. (2008). Sustainable transport visions: what role for hydrogen and

www.worldbank.org, 2008. http://www1.worldbank.org/publicsector/anticorrupt/PoliticalEconomy/stakeholderanalysis.htm Accessed September 2008.

Wynne, B 1996 *May the Sheep Safely Graze? A reflexive view of the expert-lay knowledge divide*. In: Lash, S., Szerszynski, B., and Wynne. B. *Risk Environment and Modernity Towards a New Ecology*. Sage, London

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