Stakeholder and Public Perceptions of 2030 Bioenergy Scenarios for Yorkshire and Humber

SUMMARY VERSION

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NB This report is a summary version of a full report of the same title, in two volumes, available as a research output at www. supergen-bioenergy.net. An accompanying report *Indicative 2030 Bioenergy Scenarios for Yorkshire and Humber* is available at http://www.supergen-bioenergy.net/?_id=339

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Executive Summary

This report describes stakeholder and public perceptions of 2030 bioenergy scenarios for the Yorkshire and Humber (Y&H) region. The objective was to identify how non-commercial, policy stakeholders and the interested public view different ways of using the same potential biomass resource. Although this resource is in practice varied, for simplicity the scenarios relate primarily to wood, including short rotation willow coppice, with some straw. The stakeholder interviews used a multicriteria assessment method and representatives of most of the main regional policy agencies were included. Nine stakeholders were interviewed between September and December of 2005 and two focus groups with a total of 20 members of the public (including four North York Moors National Park Authority staff) were held in March 2006, one in Castleton and one in Helmsley. The participants were members of Energy Groups that meet regularly. The focus group responses thus represent 'interested' members of the rural public, as potential domestic users of bioenergy.

Estimates of 2030 bioenergy potential were presented to participants in the form of four scenarios. Each envisages a different application of the same level of (largely) wood resource. The scenarios are intended as mutually exclusive extremes, in order to elicit clear preferences from interviewees and the focus groups; they are:

- Small and medium combined heat and power
- Large electric power
- Small and medium heat
- Small and medium electric power.

A full description of the scenarios, their rationale and the method for their development is available in the accompanying report *Indicative 2030 Bioenergy Scenarios for Yorkshire and Humber*, available as a research output at http://www.supergen-bioenergy.net/. The scenarios each envisage an annual haulage of 1.39 million tonnes of wood and straw, fuelling 133MW of power and heat capacity, and constituting (for comparison) 1.2% of 2002 intra-regional road freight tonnes. This level of wood supply is based on the 2020 level judged to be plausible by AEAT/Gillespies (2004a,b). The full scenarios report provides estimates of bioenergy capacity, land take and truck movements also for higher and lower levels of wood supply. Stakeholders were presented with only two levels of supply: baseline as above, and twice baseline. As the combination of both levels of wood supply was found to take too long for stakeholders to consider properly, close analysis of their responses is restricted to baseline-related results only.

The study found that using the region's wood resource for small and medium sized CHP and heat plant is more attractive to the policy stakeholders interviewed, and to potential public users, than using the same resource for large and small electric options. Although this preference by the stakeholders was not statistically significant, it was nevertheless clear: seven of the nine stakeholders interviewed ranked small and medium CHP or small and medium heat as first or second preferences. The study also found substantial variance and a statistically significant difference in the priority that different stakeholders gave to different ways of assessing bioenergy (i.e. to different assessment criteria).

In terms of explanations for the preference for small and medium sized CHP and heat plant, it should be noted that the focus groups consisted of people looking for off-grid energy solutions, mainly due to local energy infrastructure failures in winter and the rising price of heating oil. These were not people briefed to give priority to regional or national energy supply solutions, bioenergy or otherwise. Nevertheless, the focus group responses had much in common with the views of most (7/9) of the stakeholders, namely that small and medium scale bioenergy CHP

and heat are considered likely to have a higher potential regional economic and social benefit than bioenergy-derived electricity of any scale. Key reasons mentioned by stakeholders and the public are the higher energetic efficiency of CHP and heat relative to electricity, and perceptions of better performance in terms of local employment, local environmental impact and associated social benefits. There was also a common feeling that small scale electric power plants were, to date, less technologically proven.

1.0 Introduction

1.1 Project aims and context

This report presents stakeholder and public perceptions of indicative and simplified 2030 bioenergy scenarios for the Yorkshire and Humber region. The scenarios relate primarily to short rotation willow and other wood as defined in the regional resource assessment by AEAT/Gillespies (2004). There is also some reference to straw.

The scenarios have been developed to meet the objectives of eliciting clear reactions from the public and stakeholders and revealing the consequences of different directions for bioenergy. A description of the full scenarios, their rationale and the method for their development is available in the accompanying report *Indicative 2030 Bioenergy Scenarios for Yorkshire and Humber* (Upham and Shackley (2005), available at http://www.supergen-bioenergy.net/ (Research Outputs). In summary, the scenarios each envisage an annual haulage of 1.39 million tonnes of wood and straw, fuelling 133MW of power and heat capacity. This would represent 1.2% of 2002 intra-regional road freight tonnes (120,000,000t). This level of wood supply was used as a baseline due to its estimation as a 2020 level by AEAT/Gillespies (2004a,b). The full range of scenarios envisages this level of supply being scaled several increments higher and lower. For reasons of time (i.e. to keep interviews acceptably short), a simplified version of the scenarios was presented to stakeholders and the public, relating only to baseline and twice baseline supply.

The report is an output of a four-year research project (2003-7) being undertaken at the Tyndall Centre for Climate Change Research (North) at The University of Manchester. Tyndall researchers are working as part of the Biomass and Bioenergy Consortium of the UK's EPSRC SuperGen (Sustainable Power Generation) research programme (see http://www.supergen-bioenergy.net/). The Tyndall Manchester group are carrying out a life cycle socio-economic and environmental evaluation of bioenergy scenarios for example UK regions, which will use techno-economic evaluations led by the Northern Ireland Centre for Energy Research and Technology, at the University of Ulster. The objective is to determine the life cycle costs, benefits and wider implications arising from implementation of regional bioenergy systems, including upstream activities related to crop growth, their environmental impact and any indirect impacts (positive and negative) on rural economies.

Using a multi-criteria scenario evaluation technique, previously developed and applied by the Tyndall Centre in the context of wind energy, this research documents the perceptions and priorities of various stakeholder groups in relation to bioenergy. Other outputs from the project include UK-oriented data relating to:

- The overall environmental impact (local emissions, carbon balance, impact on biodiversity etc) of willow and straw as energy crops;
- Alternative technological options for electricity and heat production from biomass;
- The relative importance placed on different planning issues by various stakeholder groups;
- Quantification of the external benefits of electricity and heat production from biomass;
- Examination of the most appropriate policy mechanisms to support bioenergy implementation.

The wider context and rationale of the study relates to land use planning problems with rural renewable energy infrastructure. This was initially experienced with onshore wind power proposals, leading to a significant proportion of proposals experiencing planning difficulties (Toke, 2004). This is despite national and regional public opinion surveys finding general support for renewable energy in Great Britain and Northern Ireland (Barker and Riddington, 2003a,b; TNS Plc, 2003; MORI Social Research Institute, 2003). In terms of bioenergy, both the government-commissioned and the academic literature relating to bioenergy developments in England and Wales suggest that large bioenergy development proposals need very careful siting to avoid significant local objections (Upham and Shackley, 2004a,b,c and 2005; Sinclair and Löfstedt, 2001; Upretti, 2004; Upreti and van der Horst, 2004).

While anecdote suggests that small bioenergy schemes are popular with the public, formal evidence on public perceptions of bioenergy options and policy has to date been scarce. This study goes some way to remedying this. It provides regionally-specific information on the bioenergy preferences of a range of stakeholders and the interested public. While this is not, of course, intended as a sole basis for policy, it is intended to inform policy: those forms of bioenergy that have stronger public support are more likely to experience fewer land use planning problems and, by definition, more likely to have a social mandate that can be used as a justification for market intervention and support by government and its agencies.

Moreover, the study provides information on *why* stakeholders and the interested public hold particular opinions about bioenergy. This level of detail can be useful when designing an information campaign to encourage the use of bioenergy, or even just communication about its potential, by providing an indication of which issues to address, the prevailing level of knowledge and the nature of prevailing opinion. Pro-renewable energy information campaigns will likely become increasingly important as the effects of climate change become more evident and the need for a more significant societal response becomes more obvious. Information on the level of knowledge, values and opinions of the potential recipients of communications will be important for communications success, though this does not imply that provision of targeted information will necessarily in and of itself change minds. Siting controversies typically involve a difference of values, with, on the one hand, the existing landscape being prioritised; and on the other hand, the development or its outcomes being prioritised. Sometimes this difference in values cannot be resolved through discussion or negotiation. Nevertheless, public and stakeholder opinions remain a factor to consider in policymaking, and this study is intended to provide associated information relevant to the Yorkshire and Humber region.

2. Focus group responses

This section summarises the responses of participants in the focus groups.

2.1 Overview of Castleton comments

The Castleton group indicated a strong preference for bioenergy applications that enhanced the local natural, social and economic environment and which are energy efficient. Their comments and questions included the following:

- Approval of the relatively high efficiency of local heat and CHP compared to centralised electricity generation, particularly due to transmission losses.
- Preference for local use of any electric power generated via bioenergy.
- Biomass transportation requirements are reduced if bioenergy plant are smaller and supply local needs.
- Enhanced employment would result if biomass supplied numerous, smaller plant, relative to centralised electricity generation.
- Bioenergy plant that supply local needs could enhance local energy security by mitigating against power cuts.
- Expanding woodland for bioenergy supply could potentially improve the landscape and biodiversity, but being in a National Park means that this will require special attention.
- Hill farms: bioenergy could help them to become or remain economically viable.
- It would be easier for villagers to implement bioenergy as a co-operative group than alone.
- Would the land be too wet at times for willow harvesting?
- Would heavy snowfall damage bioenergy crops (particularly grasses)?
- Which has the better carbon balance: miscanthus, wood pellets / chips or wood logs?

2.2 Overview of Appleton-le-moors comments

The Appleton-le-moors group also indicated a strong preference for bioenergy applications that enhanced the local natural, social and economic environment and which are energy efficient. Their comments and questions included the following:

- Querying of the analytic boundaries of bioenergy life cycle analyses: should capture second-order impacts, such as transportation of additional food imports, if bioenergy crops displace UK food production
- Electricity transmission losses emphasised
- CHP favoured but practical difficulties envisaged
- National Park may need to be more welcoming of renewables
- Heavy domestic dependence on oil and seeking alternatives
- Doubts over the carbon balance of sugarbeet for ethanol and imported biomass for electricity generation
- Concerns over nutrient losses (e.g. use of forest brash)
- Carbon emissions not a material planning consideration (rightly or wrongly)
- Tall bioenergy crops would reduce views of the moors and hedge lines
- What are the biodiversity implications of energy crops?
- Would rather see willow than conifers

- Ethics of using good quality land for energy crops rather than food production
- Use of marginal land more acceptable providing it doesn't lead to food imports
- Feels good to act together on renewables as a community, but price (fuel costs) remain key.

2.3 Commentary on focus group responses

Based on the above summaries and the appended comments, several issues are notable among the focus group comments.

Firstly, the participants are primarily concerned with supplying the energy requirements of their localities, and less so the nation as a whole (multiple localities in aggregate). As such, they have a preference for forms of bioenergy that enhance their locality: they are concerned about biodiversity, landscape and visual impact, the local (rural) economy and energy security particularly in relation to their locality. There is a widely held dislike of electrical transmission losses and a distrust of lengthy biomass transportation. Both groups were strongly in favour of biomass CHP in principle, but anticipated significant problems in practice.

Secondly, this focus on the local nevertheless includes a high degree of respect for national and global environmental integrity. Climate change and other adverse environmental change is important to participants (though probably more so to some than to others). Generally, participants felt unable to commit themselves on the merits of displacing food crops for energy crops, but the carbon balance of bioenergy systems was both a familiar and important issue for many of the participants, and sometimes an issue of contention.

Thirdly, the groups and their individual members are struggling to find their way through the renewables maze, towards the best energy technologies for their individual and community situations. Despite DTI's Clear Skies grants programme and its replacement, the Low Carbon Buildings programme[1], the capital investment required by individuals installing microgeneration technologies remains substantial and in general requires particular circumstances (e.g. boiler renewal or roof replacement) to appear financially justifiable. Similarly, individuals need to undertake considerable research to estimate payback periods for different technologies. The uncertainties are also high: for bioenergy, fuel security is key, but more generally, some participants were also concerned that a change in Government energy policy (e.g. heavily towards nuclear or stronger subsidies of renewables) could render their investment obsolete or unwarranted.

These concerns are, for the most part, not readily ameliorated with information in a publicly accessible form. Under current UK energy policy, the carbon balance of biomass imported for co-firing is assumed to be positive (very probably correctly) and the environmental impacts of its production are assumed acceptable (a more contentious assumption). Similarly, the substantial inefficiencies of co-fired electricity generation and transmission are assumed to be acceptable, firstly because these are present regardless of the fuel used for centralised electrical generation, and secondly because co-fired or dedicated biomass plant provide carbon emissions reductions relative to fossil fuelled

[1] Website: http://www.est.org.uk/housingbuildings/funding/lowcarbonbuildings/

electricity. However, the life cycle analyses evidencing this are not readily available to the general public and UK-specific evidence has largely yet to be published. It is worth noting that Tyndall-Manchester's current bioenergy life cycle research will not capture the environmental and energetic consequences of food crop displacement, because the UK is a net exporter of the grade of wheat that is assumed displaced. The studies will not examine overseas production of biomass and it is not clear whether this is an objective of TSEC-Biosys research programme[2]. Moreover, all life cycle analyses rely on specific assumptions about the system under study, and unless a user-friendly model is available, people cannot readily test for themselves the consequences of changing assumptions such as transport mode and distance. They can thus remain legitimately circumspect about the conclusions of any study.

Moreover, it should not be assumed that public doubts about use of biomass for large scale electrical generation are simply the result of a knowledge deficit and hence can be mitigated through additional information availability and/or a targeted information campaign. Even if net carbon emissions gains are observed in large scale bioenergy electrical generation systems, and even if imported biomass is produced in an environmentally acceptable manner, one may still have legitimate doubts as to whether co-firing and/or dedicated electrical generation, particularly involving international transportation, are the best uses to which limited biomass resources should be put. The view repeatedly expressed in the focus groups was that biomass resources should, for reasons of environmental impact in the widest conception, be used so as to minimise transportation requirements and conversion inefficiencies, while maximising local 'ownership' in the widest sense. This perspective would be compatible with an energy policy that envisaged a reduction in the use of biomass imports, whereas the likelihood is that climate change policy will strongly stimulate international trade in these materials.[3] The present study suggests that bioenergy will need to confront many public relations issues through the course of this process.

[2] Website: http://www.serc-wales.org.uk/tsec.html

[3] From April 1 2009, the energy crop fraction of co-fired biomass must consist of a minimum of 25% energy crops, rising to 75% by 1 April 2011; co-firing ceases to be eligible for Renewable Obligation Certificates (ROCs) after 31 March 2016 (Draft Statutory Instrument, 2005).

3 Stakeholder responses - summary

This analysis of the stakeholder responses consists of a short, 'surface level', and statistically informed commentary. A more extended discussion, informed also by sociology and psychology theory, is presented in section 6.

3.1 Scenario scores and criteria weightings: results

In relation to the multi-criteria analysis of stakeholder views of bioenergy, Table 3.1 and Figure 3.1 show the criteria weightings and final scenario scores, per respondent, numerically and graphically. Table 3.2 provides an analysis of the variance between the scenarios, with means, and Table 3.3 provides an analysis of variance between the criteria, with means. Table 3.4 provides information on the ranking of the scenarios, per stakeholder and averaged across all stakeholders. Together, the analysis provides an insight into the extent to which stakeholder perceptions vary within and between individuals, with respect to both the criteria and the scenarios.

Table 3.1 Standard Deviation tables of criteria weightings and final scenario scores per respondent

	Standard Deviation of Criteria Weightings	Standard Deviation of Final Scenario Scores
Sustainable Development Manager – Energy and Construction, Yorkshire Forward	3.3	1.2
Director of South Yorkshire Forest Partnership	3.3	2.1
Chair of Yorkshire and Humber Energy Forum	4.5	0.9
Yorkshire and Humber Regional Biodiversity Co-ordinator, Yorkshire and Humber Regional Assembly, Wakefield	4.8	3.2
Senior agricultural technologies specialist, English Nature	5.4	5.6
Consultant to the large power sector	6.1	1.5
Senior Policy Advisor, DEFRA	7.9	2.4
Energy Policy Officer, Yorkshire and Humber Regional Assembly	8.3	2.1
Head of Environment at Drax	12	10.2

Figure 3.1 Standard deviation scores of final scenario scores and weighted criterion scores per respondent

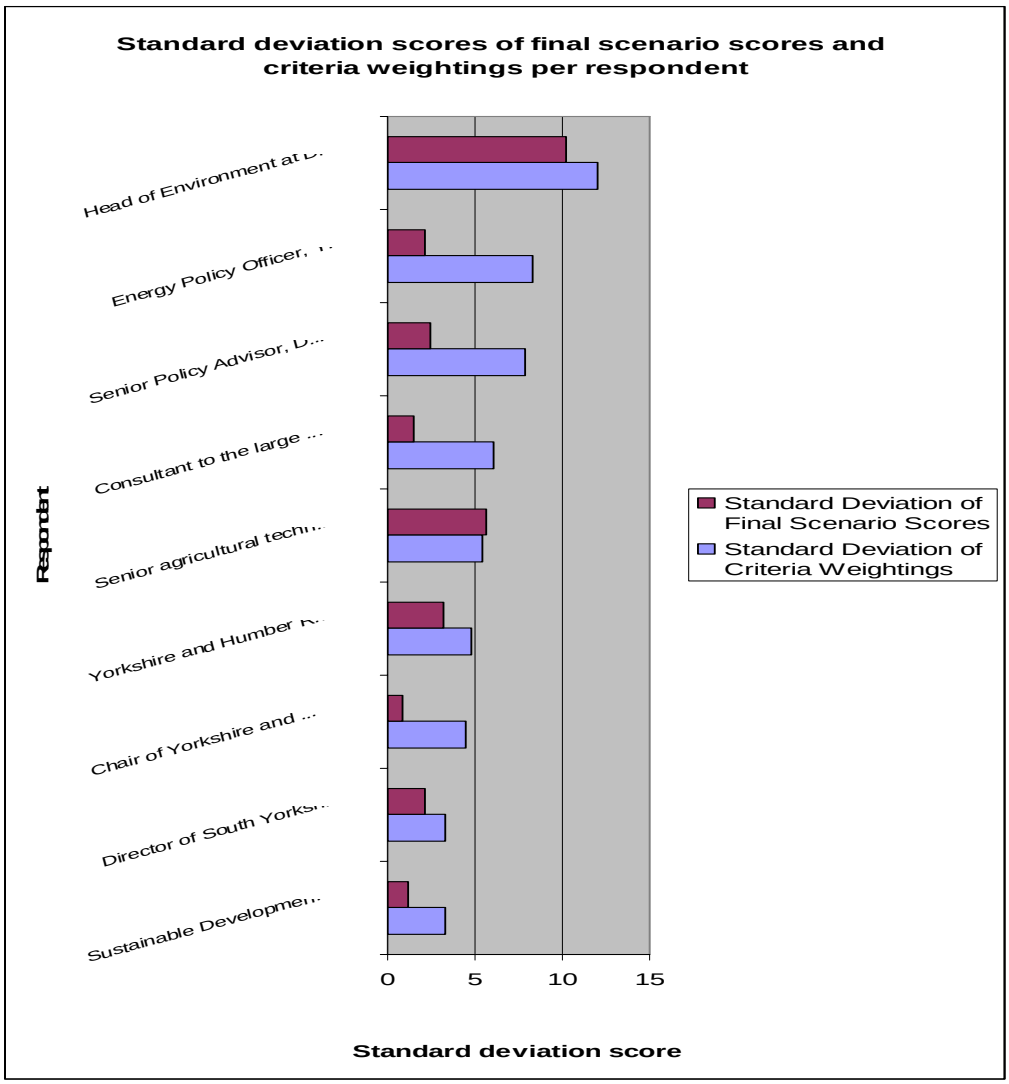

Table 3.2 Analysis of variance among the scenarios

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Mean	Variance		
S1	9	119.8	13.31111	6.428611		
S2	9	116.2	12.91111	37.59861		
S3	9	115.2	12.8	9.99		
S4	9	98	10.88889	3.733611		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	31.59556	3	10.53185	0.729468	0.542006	2.90112
Within Groups	462.0067	32	14.43771			
Total	493.6022	35				

Note: Here, each scenario is treated as a 'group' in order to test for any significant difference in the score given to it by the stakeholders as a whole, relative to the other scenarios. The p value being substantially above 0.05, there is *no* significant difference between the scores for the four scenarios, across the stakeholders as a whole.

Table 3.3 Analysis of variance among the criteria

Criteria	**Count**	**Sum**	**Mean**	**Variance**
Cost and economic viability	9	178.7	19.85556	97.73778
Regional economic & social benefit	9	95.1	10.56667	13.84
Environmental impacts	9	127.8	14.2	52.9225
Deliverability	9	122.4	13.6	30.4025
Public perceptions	9	89.4	9.933333	12.6775
Energy security	9	90.1	10.01111	20.45111
Transport and logistics	9	111.4	12.37778	12.69694
Land take and visual impact	9	85.1	9.455556	20.38028

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	756.0711	7	108.0102	3.309279	0.004559	2.156424
Within Groups	2088.869	64	32.63858			
Total	2844.94	71				

Note: Here, each criterion is treated as a 'group' in order to test for any significant difference in the weight given to it by the stakeholders as a whole, relative to the other weights. The p value being substantially below 0.05, there *is* a significant difference between the criterion weights.

Table 3.4 Scenario ranks

Stakeholder	Small/Medium CHP (S1)	Large Electric (S2)	Small/Medium Heat (S3)	Small/Medium Electric (S4)
Chair of Yorkshire and Humber Energy Forum	1	2	3	4
Energy Policy Officer, Yorkshire and Humber Regional Assembly	3	1	3	2
Senior agricultural technologies specialist, English Nature	1	4	2	3
Consultant to the Large Power Sector	1	3	4	2
Sustainable Development Manager – Energy and Construction, Yorkshire Forward	2	3	1	4
Yorkshire and Humber Regional Biodiversity Co-ordinator, Yorkshire and Humber Regional Assembly	1	4	2	3
Head of Environment at Drax	2	1	4	3
Senior Policy Advisor, DEFRA	4	3	1	2
Director of South Yorkshire Forest Partnership	2	3	1	4
Summed rank	16	24	21	27
Mean rank	1.8	2.7	2.3	3
Rank order	**1**	**3**	**2**	**4**
	Small/Medium CHP (S1)	**Large Electric (S2)**	**Small/Medium Heat (S3)**	**Small/Medium Electric (S4)**

NB: the lower the values, the higher the rank. These ranks are for 100% supply only – i.e. not for the scenarios of twice the level of wood supply assumed to be plausible by AEAT / Gillespies (2004a,b).

3.2 Scenario scores and criteria weightings: discussion

In terms of the statistical tests, perhaps the most important finding is that while there is no statistically significant difference between the weighted scenario scores, there *is* a statistically significant difference between the criteria that the weights relate to. In other words, although the stakeholders show no statistically significant difference in preference for any one of the scenarios (probably because they are drawn from a range of backgrounds), they do show a statistically significant difference in the weights that they give to the criteria. That is, there is a real divergence of opinion among the stakeholders regarding what is important when assessing bioenergy scenarios.

This is what one would expect: that stakeholders from different organisational backgrounds would have different views on what is important in a given context. That there is no statistically significant greater or lesser preference for any particular scenario may result from the small number of scenarios, in that a smaller number of groups requires a stronger test of significance. It is also possible or even likely that the criteria display significant difference, while the scenarios do not, because the design of the multicriteria assessment allows individuals to assign substantially differing numerical values to the criteria, while the final scenario scores are the product of a higher level of 'smoothing' via the aggregation of the weighted scores. It is for this reason and others that we do not focus on the final scenario scores alone, but use multicriteria assessment as a means of obtaining qualitative as well as quantitative information on stakeholder views.

Other notable points include the relatively high weighting and level of variance of the 'cost and economic viability' criterion (Table 3.3); the high variance of the scores of the second scenario in which large power plant dominate (Table 3.2); and the relatively high standard deviation of the Drax stakeholder's scenario scores. It is likely to be no coincidence that these results relate to the more contentious aspects of bioenergy, namely the role of economic factors (particularly economies of scale) and the role of large power plants within the future of UK bioenergy.

In terms of the ranking of the scenarios in Table 3.4, the headline finding is the rank order averaged across all stakeholders, as follows. The mean rank is in brackets and can be compared with the mean rank of 2.5 that would pertain if the scenario scores had been distributed equally:

1. Small and medium CHP (1.8)
2. Small and medium heat (2.3)
3. Large electric (2.7)
4. Small and medium electric (3)

Although no statistical difference was observed between the scores that gave rise to this ranking, the ranking is nevertheless noteworthy. Small and Medium CHP is ranked 0.5 points ahead of the second ranked scenario, 0.9 points ahead of Large Electric and 1.2 points ahead of Small and Medium Electric. Referenced as a percentage to the median rank of 2.5 points[4], Small and Medium CHP is ranked 28% above the median, 20% above Small and Medium Heat, 36% above Large Electric and 48% above Small and Medium Electric. Referenced to the mean rank of Small and Medium CHP, the latter is ranked 27% above small and medium heat, 50%

[4] I.e. the difference between the small and medium CHP rank and each other rank (in turn) x 2.5/100 %.

above Large Electric and 67% above Small and Medium Electric. **Seven of the nine stakeholders gave the first rank to either Small and Medium CHP or Small and Medium Heat.**

The next section considers why this may be so, taking into account sociological and psychological studies of public perceptions of renewable energy.

4. Interpretation and conclusions

A review of the UK-related bioenergy-related opinion survey literature to date is appended to the full report (volume 2). The purpose of the present section is to interpret the results and discuss them in relation to some of the relevant sociological and psychological literature. Related doctoral research at Tyndall-Manchester (2005-9) is examining public and stakeholder perceptions of bio-, wave and tidal energy from a more overtly sociological perspective. As this report is for a general audience we will not take a strongly theoretical approach here, but will briefly summarise some of the relevant sociological and psychological literature.

4.1 Looking beyond the NIMBY label: related literature

For social scientists observing renewable energy policy, it is becoming a truism to say that if we are to minimize public opposition to renewable energy developments, we need to move beyond the NIMBY label and better understand public opposition and support. For example, Devine-Wright (forthcoming 2007) recommends that we pay closer attention to, and investigate empirically, the symbolic, affective, discursive[5] and socially constructed nature of beliefs about renewable energy technologies and facility siting disputes. As an example of what he considers to be required, Devine-Wright (ibid) refers to a study by Lee, Wren and Hickman (1989) in which 62% of a sample of 1286 respondents associated wind turbines as a 'sign of progress', 15% with 'harking back to the past' and 16% with a combination of both. Devine-Wright (ibid) also refers to recent studies employing a discursive approach to understanding public opposition to wind farms (e.g. Haggettt and Smith, 2004; Ellis, Barry and Robinson, 2006), observing that such studies are helpful in drawing out how rhetorical and communicative aspects of the social context influence the beliefs and actions of individuals and organisations involved in siting disputes.

Devine-Wright (2005) has written on the significance of high levels of place attachment in relation to public opinion of developments. By place attachment is meant "positive emotional bonds between people and valued environments" (ibid). Several authors have also written on the aesthetics and perceptions of place in relation to renewable energy and similar projects, some of which have parallels for bioenergy. For example, Franco et al (2003) discuss the planned re-introduction of agroforestry networks in the lagoon of Venice drainage basin (in Italy), for control of lagoon pollution and for landscape improvement. Using GIS linked to photographic simulation, Franco et al (ibid) found a strong explanatory relationship between citizens' estimates of scenic beauty estimation and the attributes of high 'connectivity and circuitry' in the pattern of the simulated landscape. This held constant across socio-economic groups.

Möller (2006) has used GIS to build a regional landscape model for Northern Jutland County, Denmark, to assess the visibility of wind turbines in the period of 1990 to 2010, including developments that are currently planned but not yet built. This shows that a decrease in the number of turbines by about 40% and an increase in installed capacity of 20% will not add to the visual impact of wind-power at a general level. However, the pattern of the visibility will change and will become concentrated, and the present homogenous distribution of visible turbines will fade. In Möller's view, this, together with changing ownership and receding local involvement, could

[5] This relates to discourse analysis, the study of the language and concepts that people use to describe or argue etc.

ultimately lead to a decline in the popular acceptance of wind power in Denmark. In this example, there is an expected interaction between the landscape and the pattern of economic ownership in relation to public perception.

4.2 Conclusions

What does this study tell us of the views of the public and stakeholders in Yorkshire and Humber region, as of mid-2006, and how may the above literature contribute to an understanding of those views?

To reiterate, the study involved interviews of 9 policy stakeholders from differing, but non-commercial backgrounds, plus 2 focus groups of 20 interested members of the public (including four staff of the North York Moors National Park Authority) in remote villages in the region. The stakeholders were asked to assess, through the structured method of multicriteria analysis, four contrasting scenarios developed in conjunction with comments from other stakeholders who know the UK bioenergy sector well. The scenarios portrayed, qualitatively and quantitatively, strongly contrasting options for the sector in 2030, taking into account likely resource constraints, but focussing on wood only (including SRC willow). The focus groups, which consisted of potential users of bioenergy, discussed the topic more generally, partly in relation to our presentations of the potential of bioenergy (see appendix to the full report, volume 2), but also in relation to their own objective of a search for off-grid heat and power solutions.

The first main finding from the exercise is that using the region's wood resource for small and medium sized CHP and heat plant is more attractive to the policy stakeholders interviewed, and to potential public users, than using the same resource for large and small electric options. Clearly this requires some explanation (discussed below), though it should be noted that the difference between the scenario scores was not statistically significant. The second main finding is that there is substantial variance and a statistically significant difference in the priority that different stakeholders give to different ways of assessing bioenergy (i.e. to different criteria). This finding is perhaps more obvious in its possible causes, though as the anova test used does not allow fine discrimination, we can only speculate as to which criteria are associated with the largest differences, in part by inspecting their internal variance. Further analysis in relation to stakeholder background would require a larger number of stakeholder interviewees, though it is possible to comment on individual criteria by inspecting their means and variance.

To return to the first main finding: the preference for small and medium sized CHP and heat plant. For explanations, given the limited number of interviewees, we must rely on the qualitative information gathered, coupled with the limited psychological and social literature available. First, it should be noted that the focus groups consisted of people looking for off-grid energy solutions, mainly due to local energy infrastructure failures in winter and the rising price of heating oil. These were not people briefed to give priority to regional or national energy supply solutions, bioenergy or otherwise. Nevertheless, the focus group responses had much in common with the views of most (7/9) of the stakeholders, namely that CHP and heat are considered likely to have a higher potential regional economic and social benefit than electricity. Key reasons mentioned are the higher energetic efficiency of CHP and heat relative to electricity and **perceptions of better performance in terms of local employment, local environmental impact and associated social benefits.** There was also a common feeling that small scale electric power plants were, to date, less technologically proven.

The literature in section 6.1 above provides possible reasons for perceptions of the better all-round performance of small and medium CHP and heat relative to large electric in particular. **While this must remain speculative without additional study, it would certainly appear that small and medium CHP and heat applications (both infrastructure and crops) are seen as less visually intrusive, more in keeping with people's sense of place than large electric power.** Comments made about small electric power suggest that people see this in a different light – as mentioned, as technologically uncertain and of uncertain value. This in turn suggests that there is a stronger potential for achieving positive symbolism for these small power plants – i.e. that their image with the public and stakeholders has yet to be strongly formed. By contrast, large electric will need to 'undo' its less positive symbolism and perception - i.e. the public relations challenge may be greater for the larger plant. It should be noted this may be a place-specific issue: it *may* be that people used to larger plant and fields would be less likely to find fault with large scale crop cultivation and power plant. In turn this suggests that these power plant would find least opposition in such areas. While this may sound obvious, the psychological and sociological literatures offer potential explanations in support of what would be a 'common sense' assumption.

To conclude, this small but detailed study of the views of policy stakeholders and potential users of bioenergy among the public evidences the diversity of opinion on regional bioenergy options, in this case for Yorkshire and Humber. It finds that small and medium CHP and small and medium heat applications are highly favoured relative to electric supply options due to the perception of better performance in terms of local employment, local environmental impact and associated social benefits. A further and final social study, now underway in the final months of the first phase of the Supergen Biomass and Bioenergy Consortium, is using the results of UK-specific life cycle analyses to investigate the views of policy stakeholders in NW England on bioenergy options for this region.

It is recommended that further research focuses on providing a more detailed understanding of the role of contingency in influencing public and stakeholder perceptions this context. While energy supply companies need to make early investment decisions on the variety of renewable and low carbon energy options, it is clear from our research to date that the public and policy stakeholders want to know much more about the potential roles of these technologies relative to each other, as well as the potential role of energy efficiency, before accepting or supporting new infrastructure of any one type. It is important that a better-informed and much more inclusive debate on energy supply and consumption options takes place.

References and Bibliography

AEAT / Gillespies (2004a) *Planning for Renewable Energy Targets in Yorkshire and Humber. Vol. 1 Main Report*, Oxfordshire, http://www.yhassembly.gov.uk/p_contentdocs/453_6.pdf

AEAT / Gillespies (2004b) *Planning for Renewable Energy Targets in Yorkshire and Humber. Vol. 2 Renewable Energy Resources*, Oxfordshire, http://www.yhassembly.gov.uk/p_contentdocs/453_7.pdf

Ellis, G., Barry, J. and Robinson, C. (2006) *Renewable Energy and Discourses of Objection*, Summary of main Research Findings, Queen's University Belfast, http://www.qub.ac.uk/research-centres/REDOWelcome/filestore/Filetoupload,31634,en.pdf

Brown, K., Adger, N., Tompkins E., Bacon P., Shin, D. and Young, K. (2001) "Trade-off Analysis for Marine Protected Area Management", *Ecological Economics* **37**, 417-434.

Countryside Commission (1998) *The National Park Authority, A Guide for Members*, ref CCP 230, Cheltenham, England.

Council for National Parks (2006) "Facts and Figures", *Council for National Parks Website*, http://www.cnp.org.uk/facts_&_figures.htm

Devine-Wright, P. (2005) "Local aspects of renewable energy development in the UK: public beliefs and policy implications", *Local Environment* 10(1), 57-69.

Devine-Wright, P. (2006) "Energy citizenship: psychological aspects of evolution in sustainable energy technologies". In J. Murphy (Ed.) *Framing The Present, Shaping The Future: Contemporary Governance Of Sustainable Technologies*. London: Earthscan.

Devine-Wright, P. (2007) "Reconsidering public acceptance of renewable energy technologies: a critical review. In: Grubb, Jamasb and Pollitt (Eds.) *Taking Climate Change Seriously: A low carbon future for the electricity sector*. To be published by Cambridge University Press in 2007.

Draft Statutory Instrument 2005 *The Renewables Obligation Order 2005*, HMSO / TSO, Norwich, http://www.opsi.gov.uk/si/si2005/draft/20052230.htm

Ek, K. (2005) "Public and private attitudes towards 'green' electricity: the case of Swedish wind power", *Energy Policy*, Volume 33, Issue 13, September 2005, pp.1677-1689. (http://www.sciencedirect.com/science/article/B6V2W-4BYNPD7-2/2/e858be21c82f73fb84776ac6055c091f)

Franco, D., Franco, D., Mannino, I. and Zanetto, G. (2003) "The impact of agroforestry networks on scenic beauty estimation: The role of a landscape ecological network on a socio-cultural process", *Landscape and Urban Planning*, Volume 62, Issue 3, 1 February 2003, Pages 119-138, (http://www.sciencedirect.com/science/article/B6V91-46RKP4K-3/2/059adea0b9eac1b90c3a1ae95b7b0d50)

Gough, C. and Shackley, S. (2006) "Towards a multi-criteria methodology for assessment of geological carbon storage options", *Climatic Change* (in press 2006). Also: http://www.tyndall.ac.uk/research/theme2/final_reports/it1_22.pdf

Haggett, C. and Smith, J.L (2004) "Tilting at windmills? Using discourse analysis to understand the attitude-behaviour gap in renewable energy conflicts", British Sociological Association Conference, York, March 28th.

Jessel, B. (2006) "Elements, characteristics and character - Information functions of landscapes in terms of indicators", *Ecological Indicators*, Volume 6, Issue 1, Theoretical fundamentals of consistent applications in environmental management, pp. 153-167. (http://www.sciencedirect.com/science/article/B6W87-4H74M66-3/2/300e184cb881abf2f48bd29b80cf7f64)

Keeney, R. and Raiffa, H. (1993) *Decisions with Multiple Objectives: Preferences and Value Trade-offs*, Cambridge University Press, Cambridge.

Lee, T.R., Wren, B.A. and Hickman, M.E. (1989) "Public Responses to the Siting and Operation of Wind Turbines", *EWEC'89 - European Wind Energy Conference and Exhibition*, UK Dept of Energy, Scottish Development Agency, City of Glasgow and European Economic Community, Glasgow, Scotland, July.

Marvin, S., Chappells, H. & Guy, S. (1999) "Pathways of smart metering development: shaping environmental innovation", *Computers, Environment and Urban Systems*, 23, 109-126.

Möller, B. (2006) "Changing wind-power landscapes: regional assessment of visual impact on land use and population in Northern Jutland, Denmark", *Applied Energy*, Volume 83, Issue 5, pp.477-494. (http://www.sciencedirect.com/science/article/B6V1T-4GFNGBY-1/2/09aac7b09622cadf6a1739d3e1e23c3f)

ODPM (2000) *DTLR Multi-criteria Analysis Manual*, Office of the Deputy Prime Minister, London, http://www.odpm.gov.uk/index.asp?id=1142254

ONS (2006a) "Glossary of terms", Office for National Statistics, London, http://www.statistics.gov.uk/census2001/glossary.asp#nat_parks

ONS (2006b) *Census 2001. Key Statistics for Local Authorities in England and Wales*. Part 1, Table KS01, Office for National Statistics, The Stationery Office, London.

Renn, O. (2006) "Participatory processes for designing environmental policies", *Land Use Policy*, Volume 23, Issue 1, Resolving Environmental Conflicts: Combining Participation and Muli-Criteria Analysis, p. 34-43. (http://www.sciencedirect.com/science/article/B6VB0-4F53N5N-1/2/e02b2ba4c4c7dd45b4cc69fdc21038d1)

Skärbäck, E. and Becht, P. (2005) "Landscape perspective on energy forests", *Biomass and Bioenergy*, Volume 28, Issue 2, pp.151-159. (http://www.sciencedirect.com/science/article/B6V22-4DN4JTP-1/2/be21034a28f279d38405242345bb842d)

Stern, P. C. & Aronsen, E. (1984) *Energy Use: The Human Dimension*, Washington, DC: National Academy Press.

Stirling, A. and Mayer, S. (2001) "A Novel Approach to the Appraisal of Technological Risk: A Multi-Criteria Mapping of a Genetically Modified Crop", *Environment and Planning C: Government and Policy* **19,** 29-555.

Upham, P. and Shackley, S. (2005) *Indicative 2030 Bioenergy Scenarios for Yorkshire and Humber*, Tyndall Centre / Manchester Business School, The University of Manchester, www.supergen-bioenergy.net