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Public Attitudes towards Hydrogen energy:
Preliminary analysis of findings from focus groups
in London, Teesside and Wales

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The authors are solely responsible for the views expressed in this report

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1. Introduction

This report provides a detailed overview of the findings of the work carried out by Prof. Bellaby, Prof. Flynn and Dr Ricci on public perceptions of and attitudes towards hydrogen energy. This research is part of a wider programme of research activities within the UK Sustainable Hydrogen Energy Consortium (UK SHEC, <http://www.uk-shec.org>).

UK SHEC is a four year multi-disciplinary initiative funded under the Research Council's SUPERGEN Programme, whose aim is to support research into sustainable power generation and supply. UK SHEC brings together eight leading universities/research centres and the Greater London Authority to investigate scientific, technological and socio-economic dimensions of sustainable hydrogen-based economies.

We conducted our research in three different localities of the UK - Teesside, Wales and Greater London - where hydrogen energy developments are either being planned or already in operation. We sought to elicit public perceptions of and attitudes towards hydrogen as a future energy carrier and fuel, in the context of broader issues around energy and the environment.

To do so, we carried out focus groups – i.e. facilitated discussions covering a set of specific issues – with a cross-section of the public, recruited through existing local authority consultation panels. Groups varied in size from eight to thirteen participants. The groups were mixed in terms of age, gender, socio-economic group and ethnicity. Each discussion addressed issues such as security of energy supply and climate change, and the benefits and costs of hydrogen energy, not only its risks or hazards. Information on hydrogen systems, not just applications, was provided gradually during each meeting with the aid of visual material, and people were able to ask technical questions and receive explanations.

To date, nine focus groups have been carried out (2 in South Wales, 3 in Greater London, and 4 in Teesside) in the period June 2005 to March 2006. The meetings took between one and two hours and were facilitated by members of the research team.

The report is structured as follows. Section 2 presents a summary of the key findings, which are fully illustrated in Section 3. Section 4 outlines the main conclusions and, finally, Section 5 attempts to draw lessons from the fieldwork with members of the public in the three areas and identifies key issues that require further investigation.

2. Summary of Key Findings

1. Generally, participants in our groups did not have established 'a priori' opinions and views about hydrogen as an energy carrier. Levels of awareness of new hydrogen applications and knowledge about potential configurations of a future hydrogen economy were rather low. However, in areas such as Teesside and South Wales we found greater awareness and almost specialist knowledge (at least in a few male participants) of hydrogen as an industrial gas, which reflected the local awareness and knowledge of the chemical industry's practices, facilities and infrastructure.
2. Participants in our groups were self-selected and this might have introduced a bias in the samples we have studied. By agreeing to participate, they implicitly expressed an interest in the topics the group discussion would cover and a certain amount of curiosity and willingness to know more about them, regardless of their education and socio-economic background.
3. Spontaneous associations with the word 'hydrogen' were mainly neutral, but on several occasions people (especially older members of the public and those with work experience in the chemical industry) mentioned 'negative' attributes. Very few associations that might be classified as 'positive' were made. Nevertheless, such associations did not seem to predominate or pre-empt the content of the subsequent discussion.
4. Most participants were aware of the problems associated with energy and in particular those caused by fossil fuels (foreign dependence, finite resources, climate change, pollution, etc.). A few were familiar with the technical terminology, but the majority preferred to refer directly to the specific type of fuel or energy and felt more confident when talking about direct or indirect experiences.
5. Most people in the groups agreed they were concerned and thought these problems are serious. Most of them claimed that they regularly engage in energy- and environmental-conscious practices, such as recycling, avoiding the use of private transport, insulating their homes, buying energy-efficient appliances, etc.
6. Discussions about broader energy and environmental issues allowed participants to express their views and expectations concerning the way such issues are currently dealt with. We found a high level of public distrust of both governments and industry in their willingness to tackle energy and environmental problems with a long-term, well-planned strategy, capable of bringing public, rather private, benefits.
7. Most participants also felt that people in general might not be so aware or worried about these problems and might not be prepared to change their behaviour. However, awareness alone might not be enough, in fact people stressed that individual behaviour is shaped by contextual, local factors such as cost, personal convenience and lifestyle. To be able to change their behaviour, people need to see tangible benefits rather than just global ones.
8. Participants believed that renewable energy (which they tended to call 'green' or 'clean') should be improved and become more widespread, although most people recognised its

technical and economic limitations. Some people stressed the need to improve energy saving technologies, which they thought are currently undervalued.

9. Whatever their commitment to improving the environment and saving energy, most people felt powerless and ineffective. Personal agency is problematic, especially in a context of distrust of the institutional actors (such as governments) that should 'lead by example'.
10. The discussion about hydrogen took place against a background of beliefs and values concerning wider energy and environmental issues, and was constantly intertwined with issues around trust in information and institutions.
11. During and after a presentation of visual material, describing how an energy economy based on hydrogen would look like and outlining the hydrogen supply chain, its possible applications and demonstration systems around the world, people asked a number of cogent questions about not only the technical specifications of hydrogen (its properties as a fuel), but also in relation to the broader implications of using it as an energy carrier:
 - a. How hydrogen would be produced, from which primary sources, at what costs and efficiency, and with what implications for the environment (more or less CO₂ emissions?);
 - b. How much hydrogen technologies would cost and how they would compare with conventional and other alternative technologies, in terms of benefits, costs and risks;
 - c. If hydrogen would really be effective in tackling energy and environmental problems, and if it would bring private benefits to people as well;
 - d. What kind of new or improved storage technologies and distribution infrastructure would need to be developed, and how prototypes would evolve;
 - e. How hydrogen technologies (such as cars, domestic CHP and refuelling stations) would work in practice and if they would be easy to use and understand.
12. When asked if they would support any hydrogen applications and technologies, most people tended to avoid direct answers. Support was conditional to knowing about the 'bigger picture' and the context in which these developments would take place.
13. Concerns about safety of hydrogen systems were expressed, especially by those who had a specialist knowledge of the chemical industry or had an interest in technology in general. However, such concerns did not lead the groups to develop negative opinions about hydrogen, in fact there was a recurring expectation that hydrogen technologies would be engineered to be safe if rolled onto the market. In contrast, safety issues were not raised at all in the Young People focus group in London.
14. The group discussion allowed people with different views about safety to confront their arguments and learn from each other, thereby developing a 'communal' understanding of such complex - and largely unknown and unfamiliar - issues. Possible risks to public safety were discussed not in abstract terms, but with reference to realistic, practical situations and in comparison with more familiar fuels and technologies. In Teesside, for example, the presence of the local chemical industry was significantly reflected in the 'pragmatic' way people perceived hydrogen risks.

15. People's attitudes and behaviour towards future hydrogen systems and applications, such as cars and domestic CHP, and facilities (i.e. refuelling stations where hydrogen could be produced/stored and delivered) would be the outcome of a trade-off involving costs, safety, and perceived personal and global benefits:
16. There also emerged sceptical opinions about hydrogen, with some people questioning the real environmental benefits of hydrogen and the efficiency of the supply chain. There were also concerns that other energy-saving technologies that are currently available would lose ground in favour of an uncertain technology such as hydrogen.
17. Most participants agreed that people need to receive sound, reliable and impartial information about hydrogen and see real applications in use to be able to develop a better understanding of it. Some believed that hydrogen technologies should be endorsed by a 'celebrity' to gain relevance among certain sections of the public.
18. However, requests for more information must be put against a backdrop of widespread lack of confidence in information sources, institutions and industry, and public unease in dealing with, and making sense of, disagreement among experts.
19. Our groups discussed energy and environmental policy, even if not all participants actually used these terms explicitly. They expressed the need to see a clear commitment by governments and industry to develop new and better energy technologies without compromising the environment, so that citizens would feel their own efforts were effective.
20. They welcomed more public participation in such matters, albeit highlighting the difficulties that it might entail, such as the cost and appropriate scale of public consultation activities, the complexity of such decisions, the need for more 'education' on the part of the public and in particular for the next generations, and the need for a clear strategy set by the government in partnership with all the relevant actors (industry, international organisations, etc.)

3. Preliminary analysis of focus groups in London, Teesside and Wales

We conducted our investigation by using a qualitative methodology, based on focus groups with a cross-section of the public in three different localities of the UK - Teesside, Wales and Greater London - where hydrogen energy developments are either being planned or already in operation.

Teesside, an area in the North-East of England characterised by a long-standing tradition in the chemical and petrochemical industries, has an established infrastructure for hydrogen production, storage and distribution. In an attempt to improve the local economy by capitalising on existing skills and facilities, regional authorities and organisations are currently developing several projects around renewable energy, recycling and hydrogen (such as the Tees Valley Hydrogen Project and the Fuel Cell Application Centre at Wilton).

Similarly, a number of projects are being actively planned in **Wales** to create a sustainable economy through the use of hydrogen energy, such as the Hydrogen Valley Initiative and the H2 Wales project carried out by the University of Glamorgan.

London is witnessing several developments directed at exploring the potential of hydrogen, especially as a means for tackling air pollution, and is part of the hydrogen bus CUTE project. The Mayor of London and the London Hydrogen Partnership are actively promoting a series of initiatives to develop hydrogen energy projects.

It was decided that it was inappropriate and impractical to carry out a large-scale questionnaire survey in these areas, and that to gauge public awareness of, and attitudes towards, possible development of hydrogen technologies, intensive qualitative methods using focus groups were more likely to yield useful insights.

To date, nine focus groups have been carried out (2 in South Wales, 3 in Greater London, and 4 in Teesside) in the period June 2005 to March 2006. The meetings took between one and two hours and were facilitated by members of the research team. Groups varied in size from eight to thirteen participants. The groups were mixed in terms of age, gender, socio-economic group and ethnicity. The focus group members were recruited through existing local authority consultation panels (themselves a representative cross-section of the local population).

During the focus groups, people were able to discuss several broad issues around energy and the environment, and were encouraged to actively frame the debate in the terms they felt most relevant to them. Each discussion addressed issues such as security of energy supply and climate change, and the benefits and costs of hydrogen energy, not only its risks or hazards. Information on hydrogen systems, not just applications, was provided gradually during each meeting with the aid of visual material, and people were able to ask technical questions and receive explanations.

The objective of the focus groups was to address the following **research questions**:

1. Are people aware of hydrogen energy in general and of hydrogen technology developments in their regional area?

2. Are people aware of the broader issues about energy and the environment, which also have a bearing on the increasing interest in hydrogen? What are their attitudes and behaviour in this respect?
3. What do people think of hydrogen-based systems and technologies when given more information about them? Do they suggest any alternative?
4. What would be the main drivers (and barriers) to supporting and/or adopting hydrogen-based systems and technologies?
5. Is there a difference between their roles as consumers and citizens?
6. What concerns (including risk issues) are raised, in which contexts are they discussed, and what role do they play? How do people frame the risks of hydrogen and their relevance to their everyday life?
7. What are the values and beliefs that shape those concerns? How do public attitudes and concerns compare with those of interested parties, such as industrial and public sector stakeholders?
8. Who should decide and act about developing hydrogen as a fuel of the future? Do people want to be involved in the broader debate about energy?

The following sections bring together the comments and observations made by participants in all of the focus groups; illustrative quotations are used to indicate the range of opinions and concerns.

3.1 Awareness/Knowledge of Hydrogen

Across and within groups people showed a varied level of awareness and knowledge. In some groups, especially in areas where there is a tradition of chemical industries (Teesside and Wales) we found that some people, mainly men, had a specialised knowledge of chemicals and hydrogen.

When asked what hydrogen meant to them, most people expressed 'neutral' concepts, such as chemical substance, gas and part of water. Some - a few - associated hydrogen with the 'H-bomb' and the accidents involving the space Shuttle and the Hindenburg airship. Those who had specialist knowledge of the chemical industry (because of their work experience or through anecdotal evidence) mentioned some of the principal properties of hydrogen that have implications for safety: flammability and explosive potential, invisible flame, high volatility, etc. Other people knew about hydrogen through the popular media, such as TV and radio programmes, the press and scientific magazines.

Very few people expressed associations relating to the new uses of hydrogen for transport applications, like fuel cells. In some cases, hydrogen was related to alternative forms of energy, such as wind. Broadly, initial awareness of hydrogen as an energy carrier and fuel was very low in all groups, especially in the young persons group in London, and with very few exceptions, people did not express already formed opinions about it.

3.2 Concern with broader environmental and energy issues

Participants were asked to discuss broader energy and environmental issues they knew about in relation to the use of conventional types of fuels, which were referred to as 'fossil fuels'. Very seldom did people spontaneously use the term 'fossil fuels', preferring to refer directly to the specific fuel in question: oil, gas, LPG, petrol, diesel, etc. The same can be said of other widely used concepts or terms used in the environmental policy discourse, such as 'sustainable' and 'renewable', which participants in our groups tended not to use, favouring more 'pictorial' terminology, such as 'clean' and 'green'.

All groups were aware of **energy and environmental problems**, such as depletion of resources, increased gas and oil prices, energy dependence on foreign sources, climate change, global warming and pollution.

"When you burn them you produce carbon dioxide" (Man, Middlesbrough, TS)

"They won't last forever these fossil fuels" (Man, Middlesbrough, TS)

"In the long term I think it's really serious because of, erm, we envisage that it will affect the growth of crops." (Man, Middlesbrough, TS)

"Everything's changing and it's because of this, I'm convinced of it. It's because of this global warming" (Man, Middlesbrough, TS)

"There is an argument which suggests that, erm, this is a natural cycle of warming and cooling as happened in centuries gone by. And I'd go along with that to some extent, but believe that we've got two factors coming into play. There is a natural cycle of warming, but I also believe there is global warming caused by CO₂" (Man, Middlesbrough, TS)

"I can see that, it is a point of the natural progression, the natural cycle, but we are enhancing that, we are speeding it up" (Man, Middlesbrough, TS)

"Energy crisis, since we might be without heat and electricity in the winter" (Man, Guisborough, TS)

"Not just cost, you are also in the hands of unstable parts of the world, where political or religious factors can influence supplies" (Man, Guisborough, TS)

"We are relying on outside gas" (Man, Llanelli, SW)

"The oil comes from places we can't control", (Woman, Llanelli, SW)

"They are too dirty, causing too much pollution" (Woman, Carmarthen, SW)

"But they are all finite as a resource at the end of the day. One day we are going to run out of them. There is nothing else as a substitute other than the renewable energies" (Man, Carmarthen, SW)

Public **awareness** of these problems might have been enhanced by the rising prices of fuels:

"It already seems to have come down to price" (Man, Redcar, TS)

"If they (=people) get their gas bills, they do" (Man, LSX 1, London)

Most people thought that these issues have led to **increased interest in hydrogen** as a new, cleaner fuel and energy carrier.

"I think another thing is people always want something that is cheaper. If you can offer this a cheap alternative to gas, which is rising and rising and rising, you know people are going to be more interested" (Woman, Eston, TS)

"I think more people are environmentally aware at the moment so that is why we are still looking for a safer purer fuel" (Woman, Llanelli, SW)

"It's said to be clean" (Man, LSX 2, London)

A few people were sceptical about hydrogen from the start and started to bring in issues of **trust in information**:

"One thing I don't quite understand, erm, in the generation of hydrogen that has to be done by burning some other fuel sources. It seems to me that the hydrogen economy is not sustainable in fact it requires more energy than it produces" (Man, LSX 2, London)

"It is clean at the point of use, like electricity is, but it is not an answer to sustainability and the public is being sold part [of the answer], in my opinion" (Man, LSX 2, London)

"I heard that too that they could be pulling the wool over our eyes" (LSX 2, London)

While discussing these issues, people expressed their **beliefs, values** and **concerns** with energy and the environment. Most people were convinced that environmental problems caused by the use of fossil fuels are serious and should be tackled, however some participants felt that other people might not be as aware of these broader issues around energy and the environment.

"Concerned definitely. That's why we are here" (Man, Redcar, TS)

"I think people who are read and do read newspapers and use the internet and, erm, seek self knowledge are concerned, but when it comes to the rest of the population, I don't think it's quite hit them" (Man, Redcar, TS)

"They are too busy trying to organise their pay packet. You'll always have gas every week, they don't really think beyond next year [...] People don't always notice things until it starts hitting their pockets. [...] They are too wrapped up in getting by from day to day" (Man, Llanelli, SW)

"I mean here in England I was really shocked when I arrived, for example when speaking of awareness, how little, you know, how behind London was compared to you know Sao Paulo" (Woman, LSX 1, London)

"Isn't it the case that most people are concerned, frightened even, but for everyday purposes they discount these issues and the reason is that it seems intractable given the conditions under which we live" (Man, LSX 2, London)

"I think that's the sort of problem with people and energy: people want the energy but they don't want the consequences of it" (Man, LSX 1, London)

Some participants felt that the perception of the **timescales** involved is also important, as people might see these problems too distant in the future.

"In our lifetime maybe the changes are going to be relatively small. But when we read about what could be happening in 40 years time, 30 40 years time, it's horrifying to think about our grandchildren" (Man, Middlesbrough, TS)

"It's sort of well my kids will see the effects" (Woman, Llanelli, SW)

Although most people believed that environmental deterioration and climate change are caused by human activities related to energy use, and that conventional fuels will run out eventually, there was some recurring **scepticism** about the reliability of **information sources** (mainly TV, radio and the press) and a sense of unease and confusion in understanding issues about which experts have **conflicting** views.

“And is this global warming just a natural thing that’s happening and are the politicians just getting on it so they can cut down emissions. So you know, what do you believe?” (Man, Redcar, TS)

“Perhaps other things that are in the newspapers, things that are in the press are not quite true. Some of them are actually promulgated for perhaps political ends” (Man, Redcar, TS)

“We don’t honestly know what is causing global warming. There are conflicting stories all the time” (Man, Carmarthen, SW)

“Most journalists aren’t scientists and that shows” (Man, Carmarthen, SW)

“If you turn to the experts you have to go on the expert opinion and if the experts can’t agree...” (Woman, Carmarthen, SW)

“It’s not very convincing really, is it?” (Man, Carmarthen, SW)

“We are all aware I think that there are newspapers from one part of the political spectrum which will actively discount these problems and I think many of their readers want the, you want to have your concerns allayed by being told that perhaps this is a politically motivated panic” (Man, LSX 2, London)

People tended to express more **confidence** in their beliefs when talking about these problems through concrete examples taken from their daily lives (such as experience of air pollution and extreme weather patterns) or based upon widely known circumstances, such as the war in Iraq (which some participants regarded as a tangible sign of the Western world’s dependence on foreign oil) and the increased costs and uncertainty associated with supply of imported gas and oil from politically unstable areas.

“Bad weather, do you know what I mean? I mean, last Sunday they had once in a lifetime flooding on the moors” (Man, Middlesbrough, TS)

“I think recently, you know, with natural disasters that have been happening, a lot of people have now got this hunch – maybe it could be something to do with global warming [...] I think people are definitely concerned about climate change” (Woman, LSX 1, London)

“Well, there is a big war about it, isn’t there? I think that’s pretty much an indication of how serious it is” (Woman, LSX 2, London)

Most people thought something should be done to avert an energy crisis and improve the environment, through the exploitation of alternative sources of energy, such as renewables, energy saving and recycling.

“I think if something is sustainable then it has to be sustainable across the board and not just from one aspect” (Woman, Eston, TS)

They realised **local and national governments** have an important role to play, by leading by example, but there might be **constraints** at international level that may hinder the process (such as the US failing to sign the Kyoto protocol and developing economies not protecting the environment).

"I think the local councils, I used to work in local government and they are very much environmentally trying to push these sorts of things, perhaps to start the initiative rolling and set an example if you like to follow in some way" (Man, Redcar, TS)

"You can look over the Atlantic and look at America and say what's the point in us doing this. Until the bigger CO2 gets under control" (Man, Middlesbrough, TS)

"Yes. But they're only the biggest CO2 producers at the minute, aren't they, because we've got China who is coming into play and I think that will really push us" (Woman, Middlesbrough, TS)

"This is difficult because the Kyoto agreement is there to be signed and ratified and the USA will not sign it, because I think there's a general feeling that this will affect the petrochemical businesses particularly hard. And also the governments. But maybe the oil producers should then be encouraged and given financial incentives to move us all towards a hydrogen economy, if they convince a cynic such as myself that the hydrogen economy will move us away from the generation of carbon dioxide" (Man, Middlesbrough, TS)

"Surely the one central body to pull all this together, irrespective of business, should be government" (Man, Guisborough, TS)

Moreover, people felt that governments may not have the political will to enact the necessary change in environmental and energy policy, whereas **industry and business** alone may find it too costly and unprofitable to invest in 'cleaner' technologies and energy.

"I don't think your politicians, your big politicians, I don't think they've really got the will, because it's going to cost that much money and jobs, they'll say just forget it" (Man, Middlesbrough, TS)

"I think there is a basic flaw that affects all of us and that is lost confidence in good information coming out [...] so if we have lost confidence in councils, governments, environmentalist groups, people who want to sell you things [...] you can't make wise informed decisions on how to move forward" (Woman, Redcar, TS)

"It (= the Government) hasn't got the strength" (Man, Llanelli, SW)

"Business will dictate in the end" (Man, Llanelli, SW)

People discussed individual technologies and **alternative forms of energy** that might help tackle current problems. Solar power attracted the most favourable views, whereas **wind** received mixed opinions.

"I think they are the prettiest things on the landscape" (Man, Redcar, TS)

"I think they are pretty awful" (Woman, Redcar, TS)

"There is nothing more appalling than the sight of a wind farm" (Man, Guisborough, TS)

"They look quite picturesque" (Woman, Guisborough, TS)

Some people mentioned the problems associated with renewable forms of energy, such as cost, intermittency, low efficiency and limited availability.

"It's ok being an ecologist and all this, sometimes you have to look at things [...] alternative energy is not going to solve our problems" (Man, Llanelli, SW)

On balance, **nuclear energy** was not particularly popular with most people, though it was perceived in some cases as an inevitable option.

"I think nuclear is the worst option entirely, we know so little about hydrogen, but nuclear is not high on my list" (Man, Redcar, TS)

"You must not put all your eggs in one basket, so [...] one of those (energy source) must be nuclear as well" (Man, Redcar, TS)

"We've still got a lot to think about nuclear" (Man, Redcar, TS)

"In the present state of technology there is only one way forward to generate electricity and that's nuclear. There is no alternative" (Man, Redcar, TS)

"If the alternative was that (=nuclear) or the lights going out then they'd have to put a nuclear power station in." (Man, Eston, TS)

"It's the only viable alternative" (Man, Eston, TS)

"It's sustainable" (Man, Eston, TS)

"Well, it's just as bad as we've got the ICI. If that went up, it would be exactly the same" (Man, Eston, TS)

Other alternative and possibly clean forms of energy that people mentioned were wave, tidal, geothermal, hydro-electric and biomass. Bio-fuels were mentioned as well. In sum, most people favoured a '**mixed energy portfolio**' approach.

"I think there is a role as well for the small scale technologies that would benefit individuals" (Woman, Llanelli, SW)

"I do think we need renewable [...] if we have everything in the nuclear basket that's not good" (Woman, Llanelli, SW)

When asked about **individual behaviour** towards energy and the environment, most people discussed such practices as recycling, cycling and using more public transport, buying energy-efficient appliances, improving home insulation and installing renewable energy in their homes.

"I'm quite happy that recycling came to Redcar and Cleveland. We haven't really had it long. I mean Germany were doing this 10 years ago, so I think we were slow [...] And I readily do that, it's part of my everyday life now" (Man, Redcar, TS)

Some participants felt too little is being done to develop cleaner energy technologies and to support energy saving.

"I get the impression that governments are funding the various sorts of power and not funding some of the more obvious, as you suggest, sustainable forms of energy" (Man, LSX 2, London)

"I think the emphasis in general and indeed so far within this focus group has been on the generation of energy rather than saving and I think that is something which is ... perhaps you might want to explore that issue but it is something which seems profoundly undervalued" (Man, LSX 2, London)

However, while most participants felt they were doing 'their bit', they were unsure whether other people were as motivated as them and discussed the **effectiveness of individual behaviour** and the constraints (lack of awareness, lack of information about available technologies and grants, affected personal convenience, the absence of tangible private benefits, and, importantly, costs) that might dissuade people from taking up energy- and environmentally-conscious practices.

"I think people are aware, but they are not, at the end of the day, being aware and actually doing something about it [...] I think most people say – I know about global warming, but I'm not going to stop driving my car" (Man, LSX 1, London)

“But if there was an alternative they would say – Great!” (Woman, LSX 1, London)

“Yeah, as long as it didn’t cost them anything” (Man, LSX 1, London)

“I think the poor use less energy, or consume less, so they shouldn’t be penalised” (Woman, LSX 1, London)

“I was thinking that there is you know that class issue as well, it’s a kind of concerned white middle classes who have got time maybe to shop around and read about this, the newspapers” (Woman, LSX 1, London)

“And it is not affordable for people to start living sustainably [...] if you look at the costing and putting in solar heating and all that expense, it’s astronomical, and they tell you the long term, they say, but it’s that initial cost and there doesn’t seem to be a drive to, you know, support the cost of all the sustainable” (Woman, LSX 2, London)

Personal agency – whether people individually feel willing to take action - was problematic and we found a widespread feeling of powerlessness in this respect.

“Well, when I think about the environment I look at it from a personal and local perspective, rather than globally. Because no matter what we do here, somebody else somewhere in the world might do something totally different, which negates what we’re doing here. So I look to the fact that my living environment is clean. If it’s good for me then it’s up to everybody else to clean theirs” (Man, Redcar, TS)

“They say something should be done, but it’s always by somebody else. They don’t think they can make any difference themselves” (Woman, Llanelli, SW)

“The bottom line is I think we are doing too little too late and if you want to make a difference then you have to do it by yourself. You have got to change yourself” (Man, Carmarthen, SW)

“But the trouble is the individual person, they don’t know, say they want to save the environment, but how much is it going to cost. And as you say if it is not going to be cost effective, then...” (Woman, Carmarthen, SW)

“No matter what recycling I do and no matter what I do, every time a plane goes past, you know what I have done for the whole year has been undermined by that” (Woman, LSX 1, London)

“In terms of individuals I am not sure that changing everybody’s how they use the energy in the country is going to be much different if the way businesses and industries uses and disposes of energy and waste isn’t changed first, because that’s much greater. Industry is throwing out a lot more waste than ordinary people are” (Man, LSX 2, London)

“There is one tower block I can see from my window in the city, which is 26 storey high, really wide and every day, 24/7, Christmas Day, morning at 3 o’clock, Sunday morning, every floor is lit up, all the way across from ground to top it is lit up 24/7, and it seems ridiculous to start hassling them, hassling people to change the way they do things, to do this and to switch off lights when you can see industry behaving in that way” (Man, LSX 2, London)

Most people thought that only collective, well structured efforts would achieve results and some believed change can occur from the bottom up, through **education** of the new generations in schools and at home.

“Education is starting with the children” (Woman, Llanelli, SW). Recycling “it’s simply seeing what the neighbours are doing” (Woman, Llanelli, SW)

“Education, from the bottom up, from nursery school on” (Woman, Carmarthen, SW)

“If you change your behaviour then you can initiate behavioural change. It’s an energy, it’s a snowball isn’t it” (Woman, LSX 2, London)

Participants showed a general **distrust** of industry, business and the main actor – the Government – that should lead this process through better regulation, taxes, incentives and investment in cleaner and energy-saving technologies.

“Well, you know what the politicians are like cos we’ve seen so many lies” (Man, Redcar, TS)

“We want honesty” (Woman, Redcar, TS)

“Could I put a possible perspective that many people are prepared to make marginal changes, I myself have low energy bulbs throughout my house, I have a condensing boiler, etc. etc., but fundamental changes don’t seem to be made” (Man, LSX 2, London)

“It certainly occurs to me that all the tower blocks in this immediate area, that a lot of them, couldn’t some of them have some sort of wind generation on the top that would supply most of the power that they need” (Man, LSX 2, London)

People in Teesside were especially concerned with comparing possible developments in hydrogen with how they perceived their local environment, both now and in the past:

“We’ve cleaned up smog, such as that. We’ve cleaned up the sulphur dioxide, the pollution was horrendous. And we’ve cleaned it up pretty quickly through the Clean Air Act” (Man, Middlesbrough, TS)

“It’s like a natural progression, I know, but we are supposed to be in a technological age now where we can prevent diseases and illness, and we are getting more of it, specific illnesses. And now you see all related to what you’re breathing in” (Man, Middlesbrough, TS)

“I think we are a lot cleaner than we used to be, a lot cleaner” (Man, Redcar, TS)

“It’s probably as serious but you can’t see it” (Man, Redcar, TS)

3.3 Reactions to presentation of possible applications of Hydrogen energy technologies

People were presented with images showing a **detailed visual overview** of hydrogen energy systems, from production to applications. It was explained that the hydrogen is a carrier rather than a primary energy source. They were also shown images of hydrogen-powered prototypes and demonstration projects in portable, stationary and mobile applications.

Some participants were completely unaware of these developments and needed to understand the technical vocabulary:

“I don’t understand this volatility” (Woman, LSX 1, London)

“Put a match to it - bang” (Man, LSX, London)

In the London groups only a few people had already heard about the hydrogen bus project. In Teesside there was some local knowledge of the hydrogen pipelines and industrial facilities serving the local industry, but only a few participants knew about other developments (such as the hydrogen-powered sign on the Transporter Bridge in Middlesbrough and the CHP in Middlehaven).

After the presentation, people asked relevant **questions** about the whole hydrogen supply chain rather than focusing only on the applications. They wanted to know:

- How hydrogen would be produced, from which primary sources, at what costs and efficiency, and with what implications for the environment (more or less CO₂ emissions?);
 - “Is it easy to make the H?” (Man, Redcar, TS)*
 - “How efficient is electrolysis [...] how much carbon do you actually need to produce H from water?” (Man, Redcar, TS)*
 - “So where do they get the H₂ from?” (Woman, Guisborough, TS)*
 - “There are lots of uses for the hydrogen once you have got it, but where do you get it from, how do you produce it and how much does it cost to produce?” (Man, Guisborough, TS)*
 - “How much fossil fuel to produce it?” (Man, Guisborough, TS)*
 - “How much electricity?” (Woman, Guisborough, TS)*
- How much hydrogen technologies would cost and how they would compare with conventional and other alternative technologies, in terms of benefits, costs and risks;
 - “Is it going to affect my pocket. That’s what 99% of the people would say” (Man, Middlesbrough, TS)*
 - “How does it compare with other fuels?” (Woman, Llanelli, SW)*
 - What sort of pressure is on all of that” (Man, Llanelli, SW)*
 - “Is there a safety aspect?” (Man, Llanelli, SW)*
 - “Would a hydrogen power station supply the needs on the scale of a nuclear power station?” (Man, Carmarthen, SW)*
 - “You have got the different health hazard with this one, you’ve got lots of water vapour coming out [...] if you suffer from asthma, is that going to create a problem?” (Man, p.29 LSX 1, London)*
 - “What are the risks with hydrogen plants and leakage?” (Woman, LSX 1, London)*
 - “You said about nuclear being sort of risky [...] but are there any kind of risks like that with hydrogen?” (Man, Redcar, TS)*
- If hydrogen would really be effective in tackling energy and environmental problems, and if it would bring private benefits to people as well;
 - “For me the basic knowledge I’ve got of the hydrogen concept, I would say well, is it cost effective in that as I said earlier about producing it, and will it relieve the pressure of global warming” (Man, Middlesbrough, TS)*
 - “Is that (transportation) the most effective use of hydrogen in terms of fuel?” (Woman, Llanelli, SW).*
- What kind of new or improved storage technologies and distribution infrastructure would need to be developed, and how prototypes would evolve;
 - “Are there any of those projects developing into commercial applications? What do you need to bring the costs down? How do you get governments to take things on board” (Man, Redcar, TS)*

"The servicing capability and the cost of servicing" (Woman, Llanelli, SW)

- How hydrogen technologies (such as cars or domestic CHP) would work in practice and if they would be easy to use and understand.

"Can I be sure that I can top up wherever I go in the United Kingdom?" (Man, Middlesbrough, TS)

"Is it safe? And is it easy to understand [...] without having a lot of jargon surrounding it?" (Woman, Eston, TS)

"These are the questions that really need to be addressed [...] how quickly can you turn it on, how quickly can you decommission it if you don't need it" (Man, LSX 1, London)

When asked if they would approve and **support** any of hydrogen applications and technologies, most people tended to avoid direct answers. Support was conditional to knowing about the 'bigger picture' and the context in which these developments would take place.

In Teesside, for example, there emerged a sense of pride about the long-standing industrial heritage of the area and some people thought there would be no better place to develop hydrogen technologies in the UK.

"I think the standards are quite good for health and safety [...] I'm a fireman so we do visits to places and you see this area, I would probably say the best area for industry and the way it is run. If anybody could handle it (=hydrogen), I would say this area could [...] we started off talking about things like nuclear fuel and things that are associated with hydrogen and if anybody could deal with it, here I think we could here in Teesside" (Man, Eston, TS).

"There's the local knowledge, there's the local expertise and you say the fire department are well trained on the chemical side of things" (Man, Eston, TS).

However, this was combined with a sort of resignation to live in immediate contact with **environmental threat**.

"We've lived with the threat for so long." (Man, Eston, TS)

"We are surrounded by it." (Man, Eston, TS).

"ICI and all the other companies round here, we've lived with it." (Woman, Eston, TS).

They also felt that if such developments would bring jobs for the local community, then acceptance would increase.

"Because that would be another way to get this over to the public, this is going to bring x amount of jobs and people would welcome it" (Woman, Eston, TS).

Across the groups, the recurrent idea was that hydrogen must prove to be cost-effective to consumers and the environment for people to get interested and supportive. **Benefits** such as no CO₂ emissions and no pollution at the point of use were recognised, especially in the London groups (air quality seems an important concern for Londoners).

There were some concerns about the **safety** of hydrogen, coming in particular from men who had direct experience in the chemical industry, who discussed about possible hazardous situations and which new technological requirements might be needed. There was some concern with transferring hydrogen out of a controlled industrial environment into more everyday consumer uses:

"It still concerns me though that new technology, although it's an old technology, it's not established worldwide technology and what concerns me is, what a wonderful thing ordinary gas was, but look at the accidents, explosions there was in the early days of that. So it's got to be road tested, so to speak" (Man, Middlesbrough, TS)

"It is like everything, if it is an a safe environment, if it is working properly and it is designed like nuclear power stations, like gas power stations, whatever, as soon as it goes out of that controlled environment... To put that in the public forum in a busy rush area, it's like a mini bomb" (Man, Guisborough, TS)

"Looking at that and from my energy background I'd be worried about safety", "my primary concern" (Man, Llanelli, SW)

"What crossed my mind when I saw some of the pictures here, that chap putting the pipe into his car, I was thinking there has got to be some very sophisticated valves involved there, because if there is a leak of gas, you know, then that's pretty volatile stuff isn't it?" (Man, Carmarthen, SW)

Within each group (with the exception of the young group in London, in which safety issues were not raised at all by participants), possible **risks to public safety** were discussed in the context of more familiar fuels (such as gas, petrol, LPG, etc.) and there was a recurring expectation that hydrogen systems, if introduced to the market, would be **engineered to be safe**. In this case, group discussion allowed people with different views about safety to confront their arguments and learn from each other, thereby developing a 'communal' understanding of such complex issues.

"I think a lot of people would actually be a little bit frightened of it" (Woman, Middlesbrough, TS)

"If you think about it, I mean, it would have to be safe before it was put onto the public market for consumption, wouldn't it" (Man, Middlesbrough, TS)

"I agree that I'm very confident that the industry would be able to cope with the new safety requirements" (Man, Middlesbrough, TS)

"Methane's a natural gas, so hydrogen won't be any different" (Man, Redcar, TS)

"[...] people don't realise quite a bit of it is actually transported by road around Teesside and the nation already [...] they've been doing this for years and there's not one blown up yet" (Man, Redcar, TS)

"I suspect if you are sitting on a front row of a bus, over a tank of hydrogen, you are going to get off and walk [...] that's my feeling" (Man, Redcar, TS)

"Surely you sit over a tank of petrol" (Man, Redcar, TS)

"There is a petrol station right in the middle of the street, an empty target of a bomb, you don't even think about it because we've never been asked to think about it. We are so used to things that we live with that we are not even aware of" (Man, Guisborough, TS).

"How would you know if there is a leak" (Man, Eston, TS)

"Natural gas is the same and we have all of that" (Woman, Eston, TS)

"I would presume that if something got to a stage of being on the road then it would have been tested sufficiently so that it was safe" (Woman, Llanelli, SW).

"Because I've worked in it and I've seen a lot of nasty accidents" (Man, Llanelli, SW)

"That could happen with anything though" (Woman, Llanelli, SW)

(If people knew about the high pressure) "I don't think they would be very comfortable about it" (Man, Llanelli, SW). "But petrol is explosive" (Woman, Llanelli, SW).

"It is one of the more hazardous gases isn't it?" (Man, Carmarthen, SW)

"From an explosion point of view, but then so is petrol vapour" (Man, Carmarthen, SW)

"Well gas and petrol are all dangerous, it's just usage isn't it, you become familiar with them. It's the unfamiliar we are a bit..." (Woman, Carmarthen, SW)

"But they (= gas cylinders) are hazardous, they are forever blowing up" (Man, Carmarthen, SW)

"I don't see that hydrogen will be any more dangerous than any of those" (Woman, Carmarthen, SW)

"It is more flammable" (Man, Carmarthen, SW)

"It goes through small holes and if you had a small leak in something, more hydrogen would go through that larger gas" (Man, Carmarthen, SW)

"When you are at a petrol station they advise you not to smoke as there are fumes coming out of the petrol tank" (Man, LSX 1, London)

"I think the technologies and the health and safety, which goes into these, and you are plugging them to a state where they are safe to use" (Man, LSX 1, London)

"Well, what if someone crashed into it or something" (Woman, LSX 1, London)

"I think they car crash them first to see if they are strong enough to withstand that" (Man, LSX 1, London)

"What is the worst case scenario, what is the worst thing that could happen?" (Woman, LSX 1, London)

"It's fair to say, but never asked the question what happens if your petrol station goes up? You know, I don't think people are that worried about it" (Woman, LSX 1, London)

"The difference between the hydrogen supply to a factory and to a hydrogen supply to a private car, and the fact that private cars tend to get abused and it is not going to be regularly checked in the same way. It just seems inherently more dangerous when it is private vehicles as opposed to industry supply" (Man, LSX 2, London)

"If the car is in an accident what happens" (Man, LSX 2, London)

"Attitudes about car use and freedom that people associate with that and that freedom which I think many people read across as discounting safety requirements" (Man, LSX 2, London)

"I was unaware of the danger until I came here, I think it is possible that that is the situation with most people, but again I would imagine if it does, if it is used, you, know, the same issues would be covered" (Woman, LSX 2, London)

People's **attitudes and behaviour** towards future hydrogen applications, such as cars and domestic CHP, and facilities (such as refuelling stations where hydrogen could be produced/stored and delivered) would be the outcome of a trade-off involving costs, safety, and perceived personal and global benefits. In all of the groups, a majority of participants placed their remarks about hydrogen futures within a broader context than technologies as such, and posed questions about their place in the wider energy and environmental systems:

"If it was a little bit more expensive I wouldn't mind that, as long as we were going to get a cleaner fuel" (Man, Middlesbrough, TS)

"If it (=domestic CHP) were going to be really safe for us, marginally more expensive, but it was going to be clean, you would say – yes, I would go with that. But if you are domestic, you might not be able to afford a little hike in your expenses" (Man, Middlesbrough, TS)

"It's like organic food, they're more expensive than these chemically grown ones, aren't they, so every time they have something good you can't afford it" (Man, Middlesbrough, TS)

"They (=other innovations) have enhanced the person, haven't they, the mobile phone, as well as, all enhances the person individually, how would hydrogen?" (Man, Redcar, TS)

"You can't talk to people on the street, they are not interested in electricity or gas and the impacts it's having, they are interested in what the bill is at the end of the month or quarter or whatever it is" (Man, Guisborough, TS)

"Plus the cost of running the vehicle [...] the first one should be safety environment, but I think the cost would come before that for most people" (Woman, Llanelli, SW)

"It would depend where they have got the hydrogen from, would it not? I mean, I wouldn't want to see, where did you say it could come from, nuclear power stations" (Woman, Carmarthen, SW)

"If you could make it so that the whole process was renewable and clean then it would be good, but otherwise then you are just half and half" (Woman, Carmarthen, SW)

"I don't think people would want to know the detail but if they could be reassured and believe it was economical" (Man, Carmarthen, SW)

"I mean, I would be quite keen to drive one of those, but I'm not getting too excited about changing to hydrogen from petrol" (Man, Carmarthen, SW)

"There is a difference there, if you came along with a new invention, a mobile phone which has got no previous equivalent which exists, someone comes along with a hydrogen powered car and this is supposed to replace our petrol cars, which we know and love, and then people turn around and say - well, is it safe? - It is different from a mobile phone where everyone says – oh they are wonderful - you know" (Man, Carmarthen, SW)

"I think we need to investigate as many different possibilities and ways of producing energy, but nobody is going to go for it unless it has been shown to be effective, either money or environmentally. You know, and then once it is, it is through information and education. But it can't come from individual people on a mass scale, it's got to come from Government" (Man, Carmarthen, SW)

"Your average bod is just concerned about having a warm home and it being economical" (Woman, LSX 1, London)

"It's no good saying you're going to save the planet, they don't give a toss about saving the planet, they care about their lungs, they care about what is happening to their kids and it's better to be selling things that matter to people" (Man, LSX 1, London)

"What will sell it is if we can find ways and means for it to be available to all" (Man, LSX 1, London)

"But people can embrace, I find from my experience they can embrace things which are good for the planet, good for your health, and good on every level, beneficial, but if it is not going to disrupt their lifestyle too much, if it is not going to be too costly for them. Because it sounds like in the end, you know, the general public would say how much is that going to cost me, you know" (Woman, LSX 1, London)

"Well it depends how the information is delivered doesn't it. It depends how you educate people and how clear you make it to them, this is safe" (Woman, LSX 1, London)

“People vote with their wallets, you know, if hydrogen is going to be a lot cheaper than petrol they are going to use hydrogen” (Man, LSX 1, London)

“If you want to reduce your eco footprint it would be easier to produce it locally and sell it locally” (Man, LSX 1, London)

“I don’t mind having a refuelling station in a residential area” (Woman, LSX 1, London)

“I would say – great, it’s nice and clean on the street, but where’s the hydrogen coming from and how is the hydrogen produced” (Man, LSX 2, London)

Sceptical opinions about hydrogen also emerged, with some people questioning the real environmental benefits of hydrogen and the efficiency of the supply chain. There were also concerns that other energy-saving technologies that are currently available would lose ground in favour of an uncertain technology such as hydrogen.

“If you use a finite source to produce hydrogen that’s not going to be a solution, you have got to have some renewable source” (Man, Redcar, TS)

“To me it’s just another way, it’s just another process in the chain that is going to cost money. It hasn’t solved the problem yet” (Man, Guisborough, TS)

“I think that by using it at present would be contributing to using more energy than less. And that to me seems a bit of a paradox” (Man, LSX 2, London)

“I personally don’t feel that hydrogen is necessarily the Holy Grail that we need tomorrow, there are actually lots of things, much more low cost immediately” (Woman, LSX 2, London)

“Whilst I appreciate everything is kind of glowing at the moment, I do know you need a balance to see what potential pitfalls are too” (Woman, Eston, TS).

Most participants agreed that people need to receive more **information** about hydrogen and see **real applications** in use to be able to develop a better understanding of it:

“They have to prove that is viable end economical” (Man, Carmarthen, SW)

“You can see that they have got systems now actually working, so I myself know they work, I think if they had a prototype in this town and I think it’s advertising as well, so people can see these things” (Man, Carmarthen, SW)

“It’s ok I like the idea, but I just think it might cause confusion if people didn’t respect and understand the use of it” (Woman, LSX 1, London)

“First thing to do is to get a bus running out and people would see it” (Man, Carmarthen, SW)

“Demonstrations so people can see it” (Man, Carmarthen, SW)

“Getting a bus to go round and demonstrating the thing, taking it to school fairs and all that kind of stuff” (Man, LSX 1, London)

“General media, television, radio” (Man, LSX 1, London)

“You know there is the bus going in central London, it is clean, no pollution, people would welcome the idea, they just need to be brought near to the reality” (Woman, LSX 1, London)

Responsibility for the development of hydrogen applications was placed mainly on governments in a context of collaborative efforts with industry.

“The transport industry are the biggest users of fuel anyway. So some responsibility does lie on them to encourage this” (Woman, LSX 1, London)

Some people across groups believed that certain types of hydrogen applications (such as high-tech, small portable applications) could create an **initial market** for hydrogen and thought that a strong **marketing campaign**, using ‘celebrities’ or popular TV and radio presenters, would raise hydrogen’s profile in the public eye.

“I think we are a lot more pro green and to be honest if I could buy a car I think hydrogen enhances me as an individual, sends a message to my children and other people, and I would do it if it was cost effective, if it was affordable. And the only way it’s going to be affordable is if you do a campaign and you do brand it and everyone buys into it” (Man, Redcar, TS)

“Well if something like that (=portable application) could be introduced slowly, you know if people had hydrogen powered radios” (Man, Eston, TS).

“Mobile phones” (Woman, Eston, TS).

“You must become familiar with, comfortable with before it goes on an enormous scale” (Man, Eston, TS) “At the moment I don’t think there is a spokesperson, you know, a celebrity that you can identify with hydrogen use, it’s a vague concept to me, but that’s probably because I don’t know anything about science” (Woman, LSX 1, London)

“The young people it’s going to be perhaps toys, toys that are using this kind of energy and promoting it’s good to use, so make it catchy and punchy” (Woman, LSX 1, London)

“Well you could have one connected, put a face to it. You need a celebrity to be the face of hydrogen” (Woman, LSX 1, London)

“I think if you put prices up, petrol 93p a litre, hydrogen 25p a litre” (Man, LSX 1, London)

“I think what will set hydrogen off in the economy will be business. Large fleets that courier equipment down the road, the haulage companies” (Man, LSX 1, London)

“It needs to be fashionable, desirable as you said, but actually you know, marketable, fashionable, it needs to be ‘the thing’, you know” (Woman, LSX 2, London)

3.4 Questions of Trust, Information and Public Consultation/Engagement

While discussing energy and environmental issues, and new developments in hydrogen energy and associated technologies, people expressed the need for sound, reliable and impartial **information**.

“It’s got to be factual not just promises. I said this a long time ago in this discussion, I said it’s got to be assessed and the proof has got to be there. The facts have got to be there to tell us it’s a viable concept and all that comes into viable – safety, economy, cost-effectiveness” (Man, Middlesbrough, TS)

“(People) need to be informed about the safety, the health and safety aspects on it really” (Woman, Redcar, TS)

“It has to be objective information, it can’t be biased, it depends who provides the information” (Young woman, London)

However, when asked who they would **trust** in giving them such information, responses varied widely.

“I think we would have to trust a lot of the government” (Man, Middlesbrough, TS)

“I think they’d have to be scientists” (Man, Middlesbrough, TS)

Concerning in particular the responsibility in ensuring the safety of hydrogen systems, most people pinpointed the **HSE** (Health and Safety Executive) as an independent and trustworthy body.

Distrust of Government and ‘**big industry**’ clearly emerged in all of the focus groups, combined with a feeling of powerlessness in relation to people control over the information they receive. However, in areas such as Teesside, where many people’s lives are directly or indirectly connected with the chemical industry, we found that some people expressed confidence in the local industry.

“But generally speaking I would trust the scientists in the petrochemical industry telling me it’s safe, and I trust any scientists in the hydrogen economy telling us that it’s safe. It’s the after effects that I worry about, because I do think too many scientists are in political pockets” (Man, Middlesbrough, TS)

“The industry ultimately is out to make a profit, the government, well we all know about governments” (Man, Redcar, TS)

“No politician is going to stick his neck out for no benefit to himself” (Man, Redcar, TS)

“You’ve got to trust somebody” (Man, Guisborough, TS).

“I think during the foot-and-mouth and Chernobyl [...] you don’t get the whole truth until afterwards unfortunately” (Woman, Guisborough, TS).

“They (=industry) are not looking to be altruistic in terms of finding the perfect fuel for the world” (Man, Guisborough, TS).

“If there is a profit margin they (=industry) are going to break the laws then, aren’t they?” (Woman, Eston, TS)

“Hasn’t there really been a discounting of the trust that people are prepared to give to government, to business, to science, we think of BSE, we think of many other political crisis” (Man, LSX 2, London)

The provision of information by popular **media** and **scientists** receive also mixed views.

“Do we trust scientists?” (Man, Middlesbrough, TS)

“No” (Man, Middlesbrough, TS)

“I don’t always trust scientists, always. It’s partly because, particularly in Courts of Law, I feel that some scientists have exaggerated a point of view and they should stick to facts” (Man, Middlesbrough, TS)

“It’s the media, there’s too much bickering in the media. One day you will hear that it is a really serious problem and the next day you will hear someone say that is a load of rubbish, there is actually no problem at all. There is no hole in the ozone layer” (Woman, Carmarthen, SW)

“When you say who do you trust – I think for me it would be what comes out in the papers, the press, media, the scientific journalists, because they are trouble shooting [...] they are meant to be informing the public. That’s how to get the message out, I reckon, and people can make up their own minds” (Woman, LSX 1, London)

In some groups, several people discussed **environmental and energy policy** in its political context.

"I don't see it (=hydrogen) as a party thing, I see it as a country issue, we should sort it out independent of politics and it should be laid down for the next 10 years and if all they do instead"

"I think things need to happen from above in terms of generally energy policy from the UK government. But I think also people have to work from the grass roots, they have to come from individuals" (Woman, Llanelli, SW)

"And I think, yes, government should be involved, but it should be driven by communities and people involved [...] So it's really looking at professional bodies, whether it's institutions or councils or residents committees, they should all be in a forum that drives the particular bit" (Man, Guisborough, TS)

"I think we have to think bigger than just UK" (Woman, Redcar, TS)

"So run a scheme where there is a solar panel block of flats and then you've got hydrogen power, which was the most cost-effective to the public not to the fuel companies" (Man, Eston, TS).

"There needs to be a firm commitment from major political parties [...] it needs to be seen as part of the mainstream and not a side issue" (Woman, p.31)

On the one hand, they welcomed more **public participation** in such matters, but on the other they highlighted the difficulties that it might entail, such as the cost of public consultation activities, the complexity of such decisions, the need for more 'education' on the part of the public and in particular for the next generations, and the need for a clear strategy set by the government in partnership with all the relevant actors (industry, international organisations, etc.)

"The public are ignorant because we have not been told the facts or we haven't got the education. I'm not talking about basic education, I'm talking about chemistry and physics and the rest of it. I mean the general public is ignorant about things like that." (Woman, Guisborough, TS)

"You can't do it in the abstract, you can't do it by lecturing and sending things out, people have got to see something happen." (Man, Guisborough, TS).

"You've got to see the government has got a strategy for dealing with whatever the subject is. That's fundamental, if you haven't got that people aren't going to be interested at all. [...] but the government has got to say – look, these are the choices – rather than counselling about hydrogen or nuclear fuel. We have got to see it in a broader picture to see how it fits in." (Man, Guisborough, TS).

"This (=group discussion) is quite new to me and it is provoking thought to me" (Woman, Eston, TS).

"It's fine and dandy coming up with new technology but you have got to say, well look this is the cost as well, this is what you've got to do. It's alright having rights but you've got to have responsibilities too" (Woman, Eston, TS).

"I think people need to be involved, but I think at the end of the day it may not be the most popular decision is the best decision" (Woman, Llanelli, SW)

"People changed depending on what they learned. What they've been told and what we've learned about it" (Woman, Llanelli, SW)

"Everyone has got to be involved in such an education programme, haven't they? It's not just down to one person" (Man, Carmarthen, SW)

“I think you should have a choice, but I think people who are in positions of power and positions to persuade people should be the leaders in new technology, I believe, by setting an example” (Woman, LSX 2, London)

“Does public involvement not depend upon the type of society we want, I think most of us are used to living in a society in which we are made inactive as citizens by the power of business, of government, we can now foresee a future in which these things are adopted irrespective of public opinion. But can we not also see a future in which they might be adopted through some form of stakeholder and a genuine stakeholder culture. Now that might be more effective as a way of encouraging their adoption, might it not. My guess is actually it wouldn't be, it might actually make things more difficult. However, there might be other benefits to us as human beings, as genuine citizens, which we are not seeing at the moment in the adoption of technological developments” (Man, LSX 2, London)

“I think it (=sustainability) should be a major focus of new education for children” (Woman, LSX 2, London)

4. Main conclusions

1. The focus groups in each of the three areas indicate that public awareness of Hydrogen (as an energy carrier and its possible role in a future hydrogen economy) is low or minimal. However, in those areas with an industrial history linked with petrochemicals, levels of knowledge of hydrogen's characteristics were high. Most participants gave 'neutral' responses when asked about hydrogen, although some raised critical or negative comments.
2. Almost all participants in the groups expressed concern about global environmental and climate change, and about a growing crisis over fossil fuels. Many advocated stronger programmes of investment in energy saving schemes, recycling and alternative/renewable energy, as well as innovative technologies such as hydrogen.
3. Discussion of these issues revealed some disquiet and distrust of government and industry for their alleged failures to tackle 'the energy problem' seriously. At the same time, while acknowledging the need for radical shifts in consumer behaviour, focus group members' views suggest that individuals will need significant persuasion (mainly through financial incentives) to adjust their energy consumption and adoption of new technologies.
4. There was some latent interest in the potential advantages which might be obtained from the development of hydrogen energy systems, but all participants expected more detailed information and familiarity with demonstration projects and prototypes – before they are willing to give positive endorsement. Linked with this, a frequent issue raised by many people was their ambivalence about what, and whom, to trust in the provision of information.
5. Most people in the focus groups expect much greater public involvement with, and consultation about, the development of hydrogen energy technologies, but many acknowledged that crucial strategic decisions are likely to be taken by institutional and governmental stakeholders.

5. Lessons learnt & issues that require further research

1. In communicating complex and uncertain issues to 'lay' people, expert jargon should be avoided or at least clarified from the start, to prevent people from misunderstanding. People tend to use concrete terminology borrowed from their daily lives and experiences, rather than abstract terms. Visual material best captures the attention and provides reference points for discussions.
2. Quantitative surveys of public opinions about hydrogen as a future fuel indicate a low level of awareness but a high level of support, and the desire for more information. We have found that support cannot be measured in absolute terms, but is always the outcome of a trade-off between contextual factors. People can use different criteria to express their views, and this clearly emerges when hydrogen is presented not simplistically as a new

fuel or in conjunction with innovative transport applications, but as the pivotal node of a new energy system.

3. In our groups, support for hydrogen was highly conditional and contextual, and mixed with scepticism. What implications might this have in shaping and governing regional and local 'hydrogen economies'?
4. We did not find outright opposition on safety grounds, but concerns were present. Although people were somehow confident that hydrogen technologies would be safe if put on the market, they also expressed distrust of both industry and government, which should ensure that such technologies are safe. In this sense, there is an ambivalence in public views. Can such ambivalence be resolved?
5. While experts and representatives of hydrogen lobby groups tend to frame the debate around the acceptability of a future hydrogen-based economy in terms of its perceived risks to safety, findings from our groups suggest that public concerns actually cover a broader and deeper set of issues, of which safety is an important, but not exclusive, component. What would be a suitable arena for voicing such concerns?
6. Trust, and the lack of it, pervades all group discussions. Speaking about complex and uncertain issues, in which direct knowledge or experience may be little or non-existent, requires that people have confidence in the information they receive. How can public requests for reliable and impartial information be met?
7. Current debates about public participation provide a case for 'upstream' public engagement in technological development. However, the earlier public participation is conducted, the more uncertain and unknown are technological developments. In the case of hydrogen, people expressed the need for seeing and experiencing real applications in use: is this telling us that it can be too early to engage the public now? From another perspective, would it then be too late, once demonstration projects are produced, to change the course of hydrogen developments?
8. Some participants made the point that public participation would enhance the spirit of democratic citizenship, not only in the development of particular technologies, but in shaping the society of the future. What implications can this have for political and social science?