

Public Engagement Activity

1. A 3 hour public engagement (PE) event was organised on 5th November 2011 at the Informatics Forum, University of Edinburgh in the city centre. The aim was to explore public perceptions of carbon reduction technologies through providing information in a structured way followed by facilitating discussions in two smaller groups.
2. 20 participants recruited from members of public in Edinburgh & Lothians plus several from MSc classes at UoE. The non-students were recruited following their involvement in a one-day event on CCS that was held at the University of Edinburgh on 24th September 2011.

<http://www.globalccsinstitute.com/publications/public-perceptions-low-carbon-energy-technologies-results-scottish-large-group-process>

3. All the participants had reasonable back-ground knowledge on climate change, the need for carbon reduction and the key options for achieving such as a consequence of having attended that one day meeting or (in the case of the students) because of the courses that they were taking for their MSc.

Session	Start	Time
Welcome	11:00	10 mins
Questionnaire #1 – Pre-workshop	11:10	10 mins
Presentation – Dr Simon Shackley	11:20	30 mins
Questions and Answers	11:50	5 mins
Write-up of questions	11:55	5 mins
TEA	12:00	15 mins
Interactive Discussion 1 (public + mediators)	12:15	40 mins
LUNCH	12:55	20 mins
Interactive Discussion 2 (public + mediators + panel members)	13:15	30 mins
Questionnaire #2 – Post-workshop	13:45	10 mins
Voicing concerns	13:55	15 mins
FINISH	14:10	

Table 1: Schedule for Carbon Reduction Removal Technologies: Group Process, Saturday November 5th 2011, 11 am. Informatics Forum, University of Edinburgh

4. The schedule for the event is shown in Table 1. The event manager was Rodrigo Ibarrola. The first activity was for participants to complete a pre-event questionnaire. There was a short introduction followed by the main presentation – by Dr Simon Shackley – on carbon reduction technologies. This presentation is provided as Appendix 1. The presentation started with a discussion of carbon, carbon dioxide and the carbon cycle. It distinguished between the short carbon cycle – whereby CO₂ is cycled from the atmosphere to hydrocarbons in biological matter via photosynthesis, and then back into the atmosphere as CO₂ through respiration and/or microbial decomposition; and the long carbon cycle – whereby carbon is extracted from fossil fuel combustion and released into the atmosphere as CO₂. Some of the carbon captured during photosynthesis can reside in soils for long time-periods, e.g. as charcoal, while on very long-term timescales, biomass can convert into fossil fuels.
5. The ‘bath-tub’ model was then presented (see slide 5). This is the idea that CO₂ is entering the atmosphere due to fossil fuel use, steel and concrete manufacture and deforestation / land-use change. But there is insufficient removal of CO₂ from the atmosphere from natural sinks such as the ocean, soils, forests, etc. The bath-tub metaphor sets up the problem as not only how to reduce the CO₂ emissions going in, but also how to accelerate removal of carbon.
6. Four main methods for removing CO₂ from the atmosphere were considered: a) afforestation, b) CO₂ capture and storage (CCS); c) bioenergy with CO₂ capture and storage (BECCS); d) biochar; and, e) direct air capture of CO₂. We decided to include CCS since it fits within the Royal Society’s (2009) definition of CCS, namely: the “deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change”. Furthermore, it is difficult to understand BECCS unless CCS itself is first explained. Within (e) two different approaches were presented: the larger-scale devices proposed by Caldeira, Keith, et al., and the smaller-scale domestic devices explored by the project team. The two options are included separately in the questionnaire and separate discussion of both was encouraged. Each option was compared using the following assessment criteria: effectiveness, affordability, timeliness and safety (as used by the Royal Society (2009)). Following the presentation, any immediate questions were asked and addressed.
7. Two break-out groups consisting of 10 persons each were then convened, with individuals self-selecting into a group. The groups were facilitated by Dr Leslie Mabon and Rhys Howell, both experienced facilitators within the School of GeoSciences, and continued for 40 minutes. The participants were asked to discuss the following questions:
 - What are your general thoughts and feelings about CO₂ removal?

- Of the technologies and options presented, which do you think are the most desirable?

Then go through each option in turn:

- Why?
 - What ones do you think are not a good idea? Why not?
 - What do you think in particular about the domestic CO₂ capture unit?
 - Do you think it would be useful?
 - Do you think it could be popular?
 - What would have to be done to make it more popular?
 - Do you think there might be any risks or issues from using a domestic CO₂ capture unit?
 - What are the key research requirements for taking (some of) these ideas forward?
8. It may be asked why we chose to present the topic as CO₂ reduction technologies, rather than focusing solely on the domestic direct CO₂ air capture unit. The main reason is that we wanted to avoid presenting one answer. When undertaking PE it is generally not recommended to present a single 'answer', since this will seem biased and also presupposes that everyone agrees with the definition of 'the problem'. Presenting a range of options is more legitimate in public engagement and allows comparisons to be made. A second reason is that we did not have sufficient detail on the domestic CO₂ capture unit to focus just on this.
9. After lunch, the groups re-convened and a further discussion was held, involving participants and experts for 30 minutes. These discussions took the form of a 'question and answer' session with the experts. Experts present in Dr Mabon's group were: Dr Mark Winskel, Dr Simon Shackley and Dr Maria-Chiara Ferrari. The experts in Howell's group were: Dr Andrei Gromov, Professor Eleanor Campbell and Ben Evar.
10. The event finished with a repeat questionnaire. Before we closed, however, participants were invited to give any final thoughts or comments or questions to the group.

Key Findings: Survey

11. Since the sample size is only 20 it is not possible to make any statistically-robust analysis. All we can do is to provide descriptive statistics and point to some interesting patterns and trends. In order to do so, we entered the data into SPSS Version 19. In the table and figures below, CCS = CO₂ capture and storage; BECS = bioenergy with CCS; Afforest = afforestation; DAC = direct CO₂ air capture using larger-scale devices; nano = direct CO₂ air capture using domestic small-scale devices (as proposed in the project and called nano due to the use of nano-scale carbon tube manufacture).

12. The Sample. Figure One shows the sample's self-stated level of environmental consciousness, which is generally quite high (mean = 5.35 in range 1 to 7, hence mid-point of 4). However, there is some what less self-stated involvement in environmentally-friendly behaviours (Figure Two) (mean = 5.2). 15% of the sample stated that they are a member of an environmental group. Compared to the population on average, it appears likely that the sample is skewed some what towards environmental-consciousness and environmentally-related behaviours.
13. There were 11 males and 9 females in the group. 30% of the sample were in their 20's, another 30% in their 30's, 20% in their 40's and 10% each in their 50's and 60's. This is reasonably consistent with the age distribution of the population of Edinburgh and the Lothians (Howell et al., 2011).

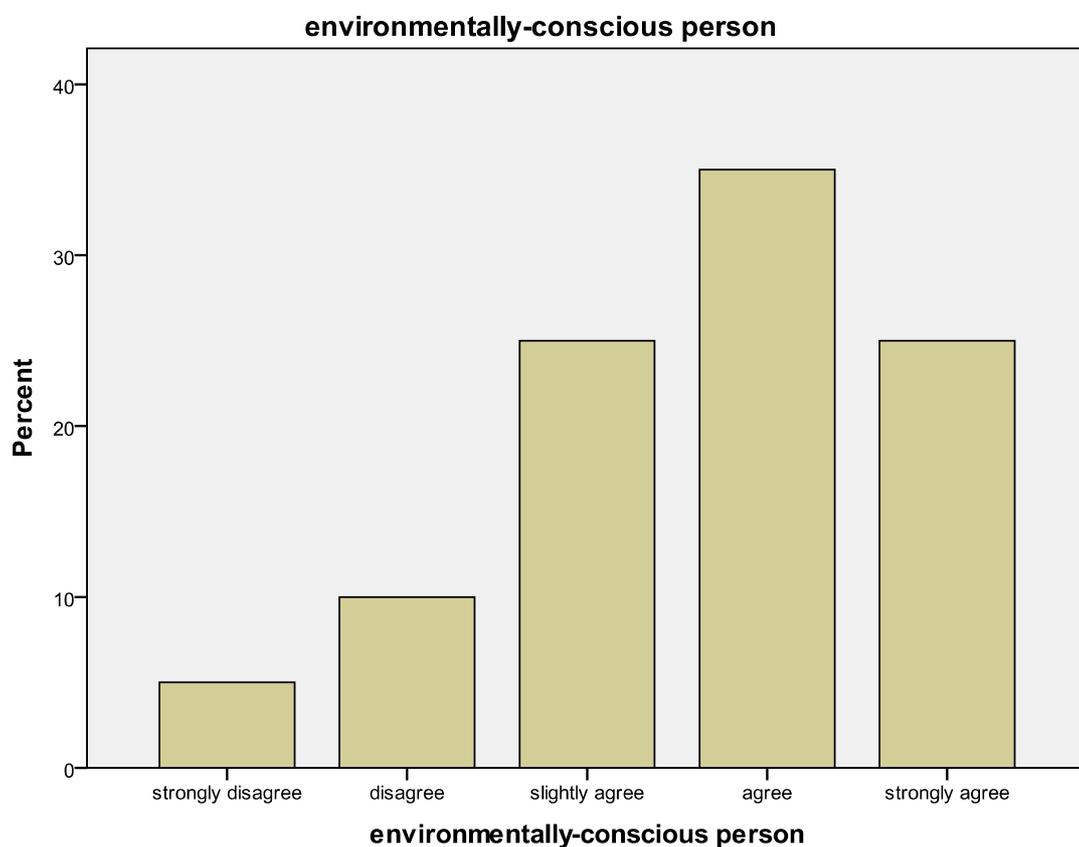


Figure One: Responses to the question: 'I think of myself as an environmentally-conscious person'

12. Mean response on acceptability of the different options before and after workshop (Figure Three). Mean acceptability, where 0 means 'strongly disagree' in the option, 4 means 'unsure' and 7 means 'strongly agree'. Perceptions of most options at the start were characterised by 'unsure' (mean c. 4), with more acceptance of afforestation (mean = 5.29) and slightly

less for nano-scale DAC (mean = 3.50). Acceptability of all options increase after the information provided and the associated discussions and questions and answers. The increase tended to be similar for all options, though slightly greater for biochar. The workshop served to move participants from a position of being 'unsure' about the acceptability of many options to a more positive view on the acceptability of all options.

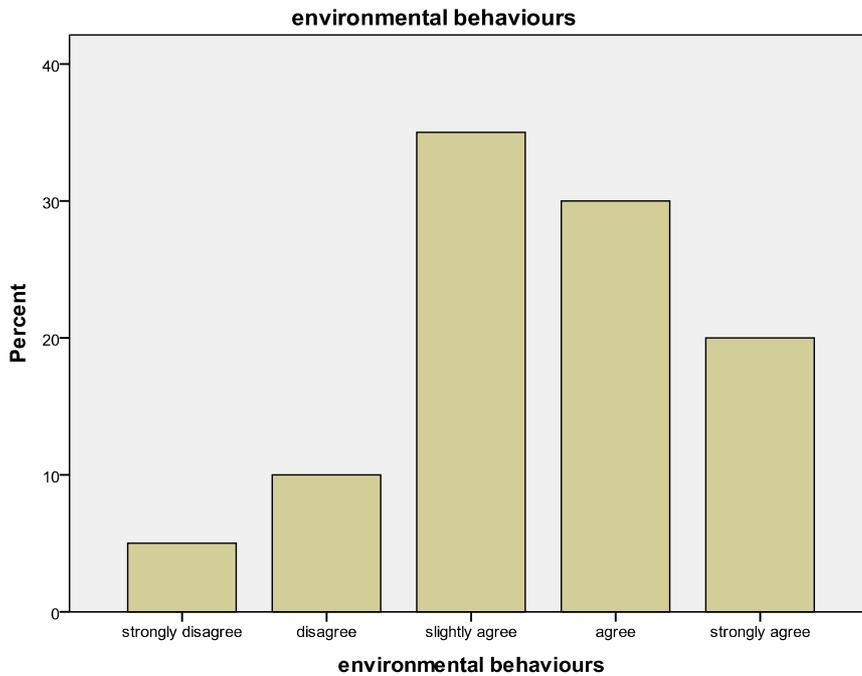


Figure Two: Responses to the question: 'I am the type of person who engages in environmentally-friendly behaviours'

13. Another way to look at the data is to show the distribution of opinion in a box plot (see Figure Four). The minimum to maximum values are shown, while the boxed part represents the values of the 25 to 75% distribution of the sample. The line within the box plot represents the median value. Hence the longer the boxed area, the greater variation in opinion within the sample. Where no boxes appear, there are insufficient respondents to the particular question to allow a distribution to be shown. What can be seen is that not only do opinions become more favourable, but also that there is a firming-up of opinions following the information provided and discussions. This suggests that the information provision was successful in reducing uncertainty in expressed attitudes.

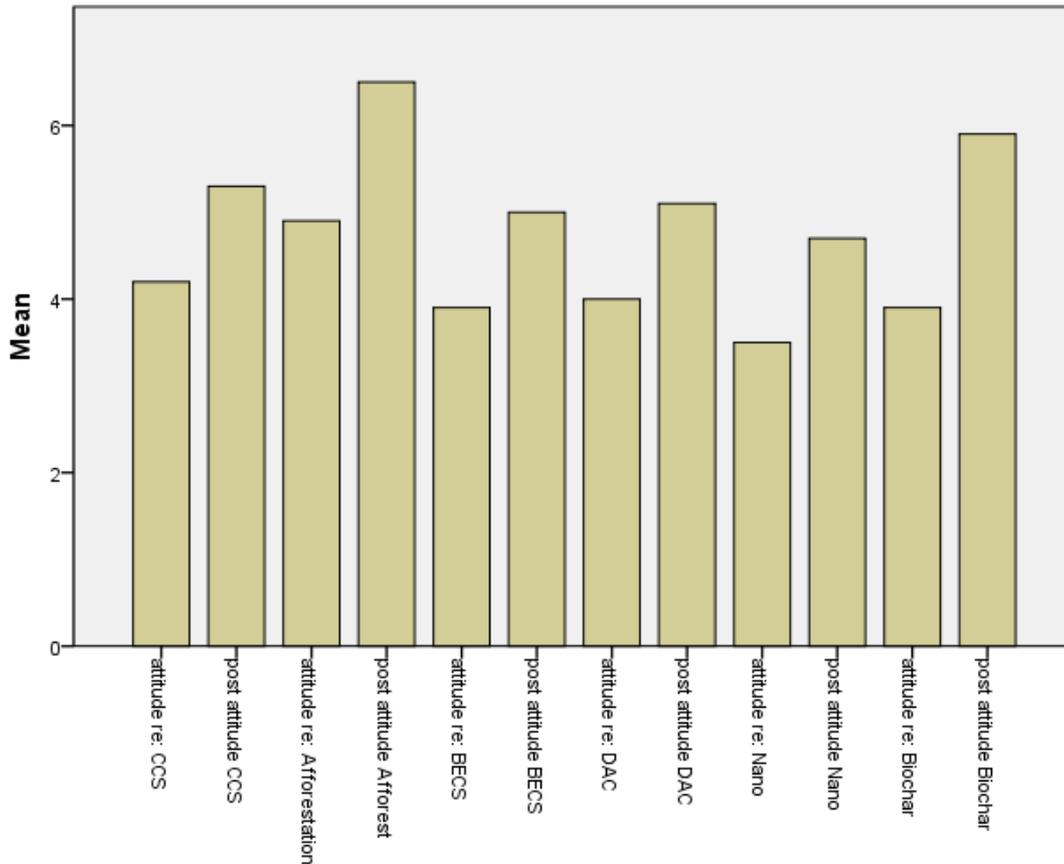


Figure Three: Mean Response before and after workshop (1 = strongly disagree; 4 = unsure; and 7 = strongly agree)

14. Level of knowledge in the topic at the **start** of the event. In this case 1 = 'no knowledge', 4 = 'moderate knowledge' and 7 = 'high knowledge'. For climate change, greenhouse gases and CCS, respondents stated that they possessed more than moderate knowledge. This has to be seen in the light of point (2). The lowest level of knowledge was expressed in relation to nano (domestic CO₂ direct air capture unit), followed by (in order of increasing knowledge): biochar, direct air capture (larger units), BECS, afforestation, climate engineering and carbon dioxide removal.

15. Level of knowledge in the topic at the **end** of the event. Self-declared knowledge in all the topics had increased by the end of the workshop. Increase in knowledge of topics that were already reasonably well known was moderate (especially for climate change and greenhouse gas emissions, with some greater increase in knowledge for climate engineering, CCS and CO₂ removal). Knowledge increased more strongly for the specific technologies and options that were the main focus of the workshop, namely BECS, afforestation, DAC, nano-scale CO₂ removal and biochar. In these latter cases, knowledge typically increased by 2 to nearly 3 points, so knowledge went from 'very little' knowledge to 'moderate' knowledge. [show box plots when can work it out]

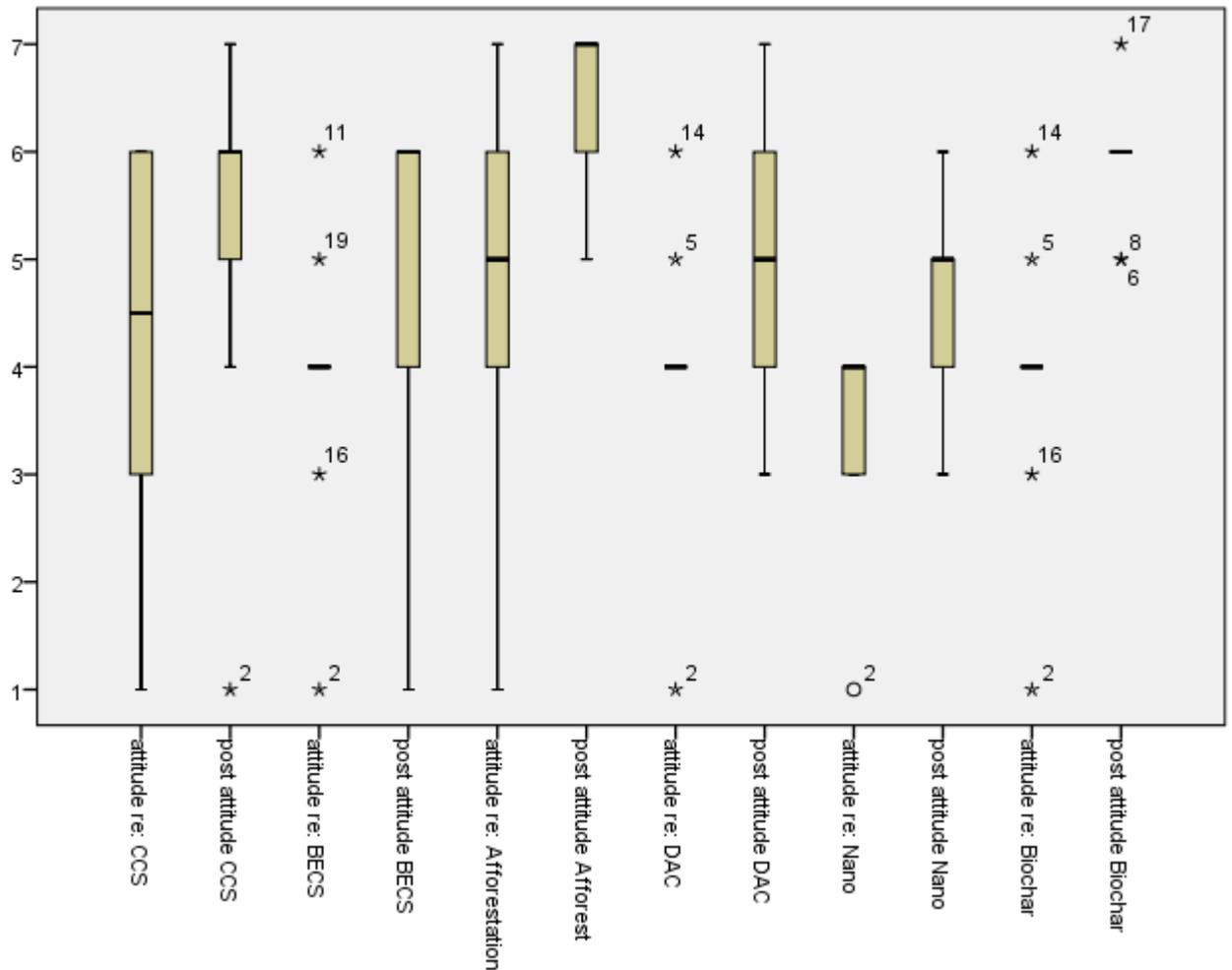


Figure Four: Box plot showing attitudes towards the CDR options presented before and after the workshop.

16. When asked about the purpose of the workshop, the most common responses were all of the following: to Engage, Consult, Inform and Access opinions. The activities during the workshop were generally viewed positively, with favourable reception of the presentation. Participants viewed the opportunity to ask questions favourably: 45% strongly agreeing, 40% agreeing and 10% slightly agreeing. The discussion sessions were also viewed favourably: 25% strongly agreeing, 45% agreeing and 20% slightly agreeing. 40% strongly agreed that the workshop was informative, 45% agreed and 10% slightly agreed. Meanwhile, 20% strongly agreed the workshop was enjoyable, 55% agreed and 20% slightly agreed.

17. In the post-event questionnaire, participants were asked whether they would seek further information on the topics discussed during the workshop and whether they would talk about the workshop with friends, family and work colleagues. There was most support for seeking further information from the internet: 25% strongly agreeing, 35% agreeing, 35% slightly agreeing and 5% unsure. There was slightly less support for seeking the information from books

(e.g. 50% slightly agreeing and 15% disagreeing). There was agreement that participants would talk to friends, family and work colleagues about the workshop (20% strongly agreeing, 40 – 45% agreeing, 25 - 35% slightly agreeing).

Key Findings: Discussion Groups

17. Of the options presented, 'afforestation' appealed to most of the participants. This was because trees were seen as natural compared to all the other options, which were perceived as being industrial and requiring built infrastructure. As one participant put it: 'Who doesn't like trees?' Several participants stressed that any trees cut down for fuel should be replanted. While afforestation might take some time to make a difference, because it can be started immediately and does not cost much, it was felt by most that the sooner it started the better. One participant commented about afforestation: 'At least it's something'.
18. While most participants supported afforestation, most also expressed the view that - by itself - afforestation would not be sufficient and not rapid enough to tackle the problem of climate change and carbon reduction. Many participants leaned towards CCS as an option that was more scaleable and more likely to be effective in cutting carbon emissions. CCS was also seen as being somewhat further developed than the other CDR options presented, which were regarded as being in their infancy and not proven. CCS was regarded by some as a (relatively) short-term policy option, however and it was stressed that in the long-term low carbon energy technologies that did not require CCS would be necessary.
19. Some participants expressed concerns over the potential risks of CO₂ storage. Could earthquakes result in sudden release of CO₂, e.g. from pipelines? This was perceived as being highly unlikely but 'not impossible'. It was noted that too high a concentration of CO₂ can result in death. The effect of leaks in the fracking / shale gas industry in the USA was noted – just a few leaks brought operations to a standstill in some instances. "If something that is trying to reduce emissions rather than just produce more gas and oil has a small leak, what will that do to the public perception of a [CCS] project like this?" Another participant noted that: "The risk of doing nothing would be greater because that would mean that everyone would die, not just those standing on top of it [a CO₂ leak]".
20. Others questioned the cost-effectiveness of CCS and whether the public would support paying more for their energy to subsidise CCS. Another person questioned whether the first priority should not be to find ways of reducing unnecessary energy use in the home first. CCS was felt by others to be important because it could tackle large emission sources that were the responsibility of large companies. In this way, the big emitters would be 'doing their bit' while individuals and households could 'do their bit' using some of the other smaller-scale technologies presented in the workshop.

21. Some participants expressed the view that renewable energies would be preferable to CCS in the Scottish context. The argument was that Scotland had great potential and already proven expertise in renewable energies and that it could create successful industry and jobs from such. The money that could be spent on CCS was, it was thought, better spent on developing renewable energy technologies. Others countered that a successful CCS industry could export technologies to other countries and hence contribute to wealth creation. It was also suggested that Scotland could sell its pore space for CO₂ storage to other countries without suitable rock formations or where onshore storage would not be acceptable.
22. Options such as biochar, direct air capture (DAC), BECS, etc. were regarded as interesting, perhaps with potential, as 'not a bad idea', something which 'can be part of the solution', etc. They were not rejected *per se*, but were viewed as being at a very early-stage and requiring a lot more testing and development to be seen as really credible.
23. 'Artificial trees' for DAC were regarded as being potentially expensive. One participant thought that a large infrastructure of such artificial trees would be required to make a real difference and that this would probably be 'really expensive'. There was some discussion over whether artificial trees would be better or worse than wind turbines. The point was also raised that while CDR techniques are important, the priority might be to reduce CO₂ emissions into the atmosphere first, e.g. through CCS.
24. One appeal of 'artificial trees' was that they could be placed on the edge of cities which give rise to most of the demand for energy, hence indirectly responsible for CO₂ emissions. This was felt to be fairer than populating rural areas with wind turbines to supply electricity to urban areas. Others noted, however, that the CO₂ captured by DAC is globally-sourced and not directly related to a particular city's emissions.
25. The domestic-DAC domestic device was perceived as being quite unrealistic by some participants. 'The public won't go for it'; 'It seems an awful lot of money for perhaps not very much benefit'. If the public have to pay to buy such a unit, participants were not convinced any one would pay for it. What would be the benefit? The domestic-DAC unit was compared to a boiler. A boiler is perceived as useful because it provides hot water. But the domestic-DAC unit has no clear utility of direct benefit to the householder. If there was something akin to a feed-in-tariff for installing the domestic-DAC unit then it could be made a more attractive proposition.
26. One participant bucked the trend some what by expressing a liking for the domestic-DAC device because it would be a way of 'doing my little bit for the environment', making a comparison with recycling. Another participant noted that while the costs of the first designs might be quite high, the costs

of technologies always comes down over time and that more R&D will bring the costs downwards.

27. Others pointed out some of the limitations of the domestic-DAC. Would installation require obtaining planning permission? How would they be installed in densely populated cities? Given that is difficult to get permission to install a satellite dish in an Edinburgh tenement, how easy would it be to get permission to install such a unit? Will there be sufficient space? Could the CO₂ captured pose a risk if it were to leak out? What are the risks? Could it set fire? What if it was vandalised? How reliable would the domestic-DAC be? What would happen if it were to break? Given that rubbish collection is not always adequate, could people be assured that their full CO₂ canisters would be collected and returned? What if collection was delayed? There was some comparison of a domestic boiler breaking down and a domestic-DAC unit breaking. Would the risks in both cases be substantially different? It was proposed that a manufacturer might provide a guarantee and a free-service if a break-down occurred.
28. If a household is already aiming to be low-carbon, then why would they wish to install the domestic-DAC unit? I.e. households might wish to meet the challenge of carbon reduction in different ways.
29. Another proposal was that a domestic-DAC unit might work best at a neighbourhood level, e.g. one per street (a bit like an electricity sub-station serves a neighbourhood). This suggestion was generally supported as it was felt that it would make sense for a larger unit to be housed and maintained outside individual households. It was felt that it would be safer if it were 'out the way'.
30. In terms of research and development needs, one suggestion was that the technology needs to be both practical, widely accessible and universally applicable. Another need is for more effective communication to the public and the University was perceived as having a role here. One participant noted that people are not interested in things like CO₂ capture and storage (CCS) and attributed this in part to a lack of awareness of the dangers of high CO₂ levels in the atmosphere.
31. In terms of a process for engaging and consulting with the public, 'more events like this one' were generally supported. 'We have to show [the politicians] we care'. Referring to the other CCS event we organised in September 2011 (the Large Group Process (LGP)), one participant remarked that she had spoken to 'half a dozen people about it' and that other people she knew had enquired how they could get involved in similar processes. The need for the process to be perceived as neutral and independent was also stressed. The previous LGP event in Edinburgh was sponsored by the Global CCS Institute, an organisation paid for by the Australian Government.

This sponsorship was viewed with some suspicion by several participants as it was felt that the Australian government has a vested interest in coal export.

32. The main questions raised during the second discussion group were related to: the risks of the CDR methods; costs and financing; politics and policy; effectiveness; how to allocate money sensibly; what China and other countries are doing and why; more explanation of what biochar is and how it is produced; how direct air capture works using carbon nano-tubes and status of such technologies; explanation of what CCS projects are happening internationally and the key drivers.

Conclusions

33. The Public Engagement event was a successful way of providing information to members of the public about the key ways in which CO₂ reduction from the atmosphere can be achieved. The public sample was not quite a 'lay' one, however, since participants had already been involved in a CCS PE event 6 weeks prior to this PE event, or were MSc students with a professional interest in the topic. Nonetheless, the survey results showed clearly that the information and discussions had a strong impact on levels of knowledge and attitudes (which became more positive with respect to all the technologies).
34. The discussions provided a more nuanced understanding of attitudes and perceptions. There was a clear preference for afforestation but also a realisation that this would probably be hard to scale-up quickly enough to have a big enough impact on CO₂ emissions. Participants tended to lean towards CCS as a more scaleable, realistic option. As for the domestic-DAC unit, there was interest but many questions raised about practicality, reliability, costs and safety. The concept of a neighbourhood DAC unit, as opposed to a domestic unit, was received favourably.

References

Howell, R., Shackley, S. and Mabon, L. (2011), *Public perceptions of low carbon energy technologies: Results from a Scottish Large Group Process*, University of Edinburgh, GCCSI and CSIRO

Royal Society (2009), *Geoengineering the climate: Science, governance and uncertainty*, The Royal Society, London.