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Assessing the impact of framing on the comparative favourability of nuclear power as an electricity generating option in the UK.

Christopher R. Jones [a,*], J. Richard Eiser [a,†], Tim R. Gamble [b]

[a] Department of Psychology, University of Sheffield, Western Bank, Sheffield, S10 2TP, United Kingdom.

[b] Department of Psychology, University of Bath, Bath, BA2 7AY, United Kingdom..

*Corresponding author

Email: c.r.jones@shef.ac.uk (C. R. Jones)

Tel: +44 (0)114 222 6592

Fax: +44 (0)114 276 6515

[†] Researcher's forename is 'Richard'; shortened name reference will read: J. R. Eiser

Highlights

> Three studies investigate the acceptability of nuclear power in response to 'framing' used by government in 2007 UK consultation. > Acceptability of nuclear power was compared against four energy sources in an 'electricity calculator' task. > Study 1 showed an apparent increase in the endorsement of nuclear following climate change 'framing'. > Studies 2 and 3 contradict this finding, suggesting that 'framing' had a limited direct effect on preferences for nuclear power.

Abstract

In 2007 the UK government's public consultation on the future of nuclear power courted much criticism. Three studies were conducted to assess whether key arguments used by government within this consultation might have influenced public opinion about the technology. Participants first read a passage of text which made salient certain positive (climate change mitigation, increased energy security) or negative (nuclear waste) aspects of the nuclear debate. Participants then completed a task that required them to create an electricity mix for the UK by varying the contributions made by each of five energy sources (coal, gas, nuclear, renewables and electric import). Study 1 seemed to indicate that pitching the debate in terms of climate change mitigation was effective in increasing endorsement of nuclear power. The results of studies 2 and 3, however, contested this conclusion suggesting that these arguments were having little direct impact upon participants' preferences for nuclear power. The results of these studies hold implications for UK energy policy and attitude assessment and can contribute to the understanding of how the arguments used by government in the 2007 consultation might have influenced public opinion.

Running Head

The impact of framing on the favourability of nuclear power.

Keywords

Nuclear Power; Attitudes; Framing

1. Introduction

The recognised financial, environmental and humanitarian risks that could result from a failure to mitigate climate change (e.g. IPCC 2007; Stern, 2007) are placing the international community under ever increasing pressure to ensure rapid and substantial reductions of Greenhouse Gas (GHG) emissions. The UK is no exception and is committed to an ambitious target of reducing GHGs by 80% by 2050 (compared to 1990 levels), with a shorter term desire to meet a 34% reduction by 2020 (see Climate Change Act, 2008).

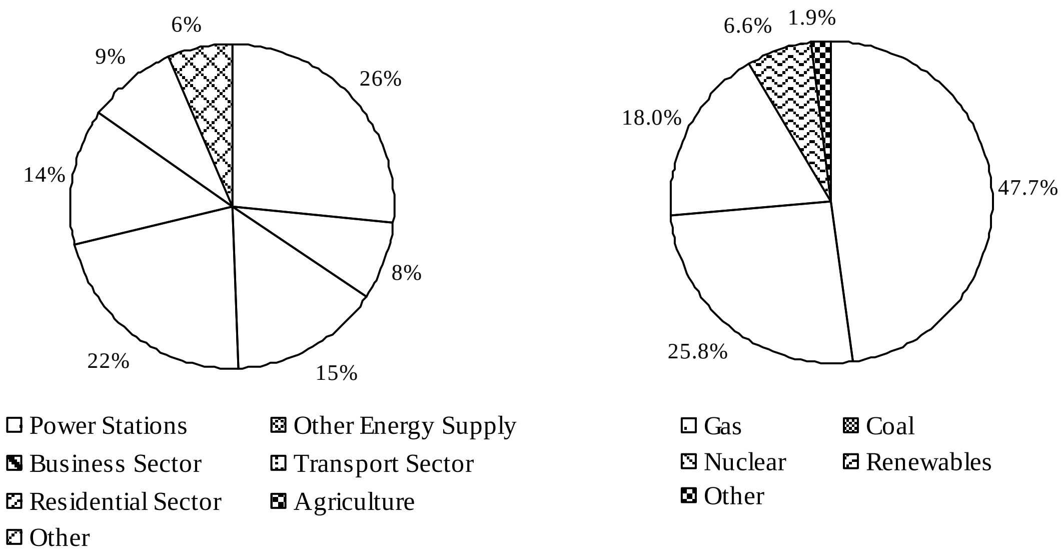

Figure 1. a. The UK Greenhouse Gas (GHG) emissions by sector in MtCO_2e (2009) and **b.** The UK electricity mix (2009-2010) by energy source. Note: GHG emissions by sector do not reflect savings arising from Land Use Change (Sources: UK emissions statistics: 2009 UK figures; Fuel mix disclosure data table [2009-2010] - available from http://www.decc.gov.uk).

While the sources of GHGs in the UK are manifold, the largest single contributing sector is electricity generation (see Figure 1; see also DECC, 2010). While recent efforts to decarbonise this sector (e.g. through investment in renewables and fuelswitching from coal to natural gas) have helped to reduce GHG emissions, some believe that such efforts might come at the price of reduced energy security (see Stern, 2004; see also Bahgat, 2006). It is the triple challenge of ensuring that electricity is not only low-carbon but that it is also secure and affordable, which has recently been used by the UK government to reopen the ‘nuclear debate’ in the UK (see DTI, 2006a).

2. Nuclear Power in the UK

Nuclear power (NP) has been a part of the UK electricity mix for over 50 years and in 2009-2010 accounted for around 18% of electricity generated (see Figure 1b). NP is considered to be a comparatively low-carbon, secure and affordable energy source (see Sustainable Development Commission, 2006a, 2006b, see also Fthenakis and Kim, 2007) and while these claims have been disputed (e.g. Friends of the Earth, 2006; Greenpeace, 2007; see also Sovacool, 2008), it was for these reasons that in January 2008, following a period of public consultation (see DTI, 2007a, 2007b; BERR, 2008), that the then UK government gave the ‘green light’ for a new generation of nuclear power stations in the UK. This pro-nuclear decision has since been upheld by the new coalition government.

This pro-nuclear decision has met with considerable objections, principally due to perceived failings in the public and stakeholder consultation process accompanying it (see Table 1 for a recent history of the nuclear debate in the UK). For example, during the second of two periods of consultation (May – October, 2007), prominent environmental NGOs (e.g. Friends of the Earth, Greenpeace) and the Nuclear

Consultation Working Group (NCWG) – a group of leading experts in the energy policy and economics, environmental risk and justice, and the social and political sciences – questioned not only the apparent brevity and exclusivity of the whole process but argued that the simplistic (and contentious) twinning of global warming and nuclear power within the consultation was designed to purposefully yield pro-nuclear responses, thereby ‘rubber-stamping’ a ostensibly pre-ordained pro-nuclear decision (see NCWG, 2008; see also Greenpeace, 2007; NIRS/WISE International, 2005).

3. Overview of Studies

In response to the assertion that the government had presented or ‘framed’ information within the 2007 consultation in order to yield pro-nuclear responses, we conducted a series of three experimental studies. Each study was designed to investigate what impact key arguments used by government might have had upon participants’ opinions about the use of NP in UK electricity generation relative to other key energy sources. The impact of two psychological principles, namely ‘framing’ and ‘anchoring’ were of interest to this study and are briefly outlined below.

3.1. Framing: It has long been recognized that the manner in which an issue is presented, that is to say the manner in which an issue is ‘framed’, can exert a marked impact upon a person’s assessment of that issue (e.g. Brewer and Gross, 2005; Iyengar and McGrady, 2005; Jacoby, 2000; Levin et al., 1998; Tversky and Kahneman, 1981). Further, research into a type of framing known as emphasis framing, demonstrates that such effects can be achieved by simply focusing people’s attention on certain features of a debate or issue (i.e. by emphasising certain aspects or arguments above others) (e.g. Druckman, 2001a, 2001b).

Table 1.

Nuclear Consultation Timeline

Date	Event	Details
Feb 2003	UK Government publishes: 'Our energy future – creating a low carbon economy' (see DTI, 2003).	UK Government commits to engaging in *"fullest public consultation"* before making decisions about a new programme of nuclear build.
Nov 2005	UK Government announces plans for energy review.	Environmental NGOs note desire for review to be more than just a 'rubber stamping' process for a new generation of NP stations.
Jan 2006	**Energy review consultation process begins.**	
Jan 2006	UK Government publishes: 'Our energy challenge: Securing clean affordable energy for the long term' (see DTI, 2006a)	Consultation document outlines progress towards goals outlined in 2003 and outlines options for future, including possible investment in NP.
Apr 2006	**Energy review consultation process closes.**	
July 2006	UK Government publishes: 'The energy challenge: Energy review report' (see DTI, 2006b)	UK Government registers belief that NP should play a role in future UK power generation and begins consultation on new-build.
Oct 2006	Greenpeace (with the support of Green Party) launch legal challenge against UK Government	Greenpeace take UK Government to High Court on grounds that they did not engage in *"fullest public consultation"*.
Feb 2007	High Court rule in favour of Greenpeace	Consultation deemed to be *"misleading"*, *"flawed"*, "*inadequate and unfair"*.
Feb 2007	UK Government reaffirm belief that nuclear should play an important role in future UK generating mix.	Prime Minister, Tony Blair, announces that the ruling would not affect their pro-nuclear policy and that the UK Government would consult again.

May 2007	**NP consultation process begins.**	
May 2007	UK Government publishes: ‘Meeting the energy challenge: A white paper on energy’ (see DTI, 2007a).	Outlines the two principal energy challenges faced by the UK as: (1) *“tackling climate change”* and; (2) *“ensuring secure, clean and affordable energy”.*
May 2007	UK Government publishes: ‘The future of nuclear power: The role of nuclear power in a low carbon UK economy’ & begins second consultation (see DTI, 2007b).	Consultation document focuses on how NP could help to tackle climate change and security of supply issues.
July 2007	UK Prime Minister undermines consultation process	Prime Minister, Gordon Brown, announces Government’s decision to *“...continue with nuclear power”* before completion of consultation.
July 2007	Series of stakeholder, site stakeholder[a] and citizen deliberative events begin.	Environmental NGOs (e.g. Greenpeace) publically exit the consultation process on the eve of the citizen deliberative events.
Oct 2007	**NP consultation process closes.**	
Jan 2008	UK Government publishes: ‘The future of nuclear power: Analysis of consultation responses’ (see BERR, 2008).	Justifies the nature and design of the consultation process and includes analysis on the responses from the public consultation, the citizen deliberative events and stakeholder meetings.
Jan 2008	UK Government announces second pro-nuclear decision (10th January 2008).	It is concluded that nuclear power will be a safe and affordable way of meeting the future energy needs of the UK, while helping to fight climate change.

[a] Site stakeholders are classed as interested parties (e.g. community groups, schools) located near to existing nuclear sites.

Note. This timeline is not exhaustive and should be used as a rough guide to the consultation process only.

There is certainly evidence that politicians will employ emphasis framing in order to "…mobilise voters behind their policies" (Chong and Druckman, 2007, p.106; see also Nelson et al., 1997) and, as such, it is perhaps unsurprising that some commentators raised concerns about the possibility of this having occurred in the 2007 consultation.

However, while a belief in 'freewheeling manipulation' is attractive to politicians, a growing literature contests the ease with which emphasis framing effects may be induced, with a number of important moderators having recently been identified, e.g. perceived source credibility (e.g. Druckman, 2001b), the presence of strong pre-existing attitudes (e.g. Brewer, 2001; Haider-Markel & Joslyn, 2001) and access to alternative viewpoints (e.g. Druckman and Nelson, 2003). Thus, it remains an empirical question as to what impact the information provided to people within the 2007 consultation might have had upon their attitudes towards NP.

3.2 Anchoring: In addition to investigating the impact of emphasis framing on participants opinions about NP, we also wished to investigate what impact the provision of figures relating to the current use of NP in the UK power generation might have had upon participants' opinions about NP within the consultation.

The anchoring and adjustment heuristic is one of many mental shortcuts (or 'rules of thumb') that people employ with making decisions or judgments (see Tverksy & Kahneman, 1974; 1981). In short, research into this heuristic shows that the provision of numeric values when asking people to make decisions (e.g. probability judgments) can fundamentally influence the nature of the conclusions reached (e.g. Epley & Gilovich, 2006; Gilovich et al., 2002). Indeed, particularly with unfamiliar tasks or in uncertain situations, people will use given values or numbers as reference-points to 'anchor' their decisions, adjusting from them in order to reach their final conclusions (see Fiske and Taylor, 1991).

Within the 2007 consultation, participants were provided with information about current UK electricity generating mix, which informed participants of the relatively large role of NP in electricity generation (18%) compared to other sources like renewables (4%). In accordance with the principles of anchoring and adjustment, we would argue that the provision of such information may have increased the acceptance of NP as a generating option, compared to if no such detail had been provided.

4. Study 1

Study 1 (21/04/2008 to 19/02/2009) provided initial insight into the impact of each argument in a context where participants also had access to information about the current electricity generating status quo.

4.1. Method

4.1.1. Procedure: Participants were recruited via email invitation or via the University of Sheffield Online Research Participation Scheme (ORPS)[1] and received either course credit or chocolate as payment for their time.

Participants were tested individually in a quiet laboratory setting. Upon arrival, each participant registered their level of support for the use of each of five key energy sources used in UK electricity generation (i.e. coal, gas, NP, renewables, and electricity import[2]). All responses were recorded using a pen-paper questionnaire on 5-point Likert-scales (5 = Strongly support to 1 = Strongly oppose; plus 'Don't know').

Each participant was then sat at the computer where they were provided with an on-screen introduction to the experimental task. This explained that the experiment was designed to assess the future role that they saw for NP in UK electricity generation (relative to other key energy sources) and provided some information about the general uses for electricity and the current role played by NP in UK electricity generation. The instructions ended by outlining the UK government's opinion that energy companies operating in the UK should be allowed the option of investing in new NP stations (see Appendix A1, for exact phrasing of introductory instructions).

The computer then assigned each participant to one of four experimental 'framing' conditions (i.e. climate change, energy security, nuclear waste or control condition).[3] While each framing condition proceeded in an identical manner, there were differences in the information provided to participants. Specifically, participants in each condition received a different passage of text (between 221-226 words), designed to emphasise the aspects of the NP debate consistent with the theme of the condition (see Table 2 for brief details). Each passage of text was based upon information contained within the handouts provided to participants at the 2007 consultation, citizen deliberative events (see Appendix A2 [1-4], for the exact phrasing of each frame).

Table 2

Brief details of the framing employed in each condition within the three studies

Condition	**Valence**	**Details**
Control	Neutral	Neutral discussion of the key stages in generating electricity from NP. Does not talk about purported positive or negative attributes of NP.
Climate change	Positive	Outlines climate change. Discusses NPs status as a low-carbon form of power generation and its utility in reducing CO2 emissions from this sector alongside other low-carbon options.
Security of supply	Positive	Outlines security of supply concerns. Discusses role for NP in reducing reliance on gas and oil imports from politically unstable regions and maintaining diversity in the UK electricity generating portfolio
Nuclear waste	Negative[a]	Highlights nuclear waste as a serious and important issue associated with NP new-build. Discusses pro- and anti-nuclear viewpoints on the issue.

[a] While ostensibly a negative (i.e. anti-nuclear) framing condition, discussion of the issue of nuclear waste was presented in a relatively ambivalent way within the consultation document. Note. The 'nuclear waste' frame was not used in the study 3 in order to focus on the impacts of pro-nuclear framing on electricity mix decisions.

Participants then received instructions detailing the specifics of the experimental task (see Appendix A3), which required them to create an electricity generating mix for the UK by manipulating the relative contributions made by five energy sources (coal, gas, NP, renewables and electricity import).

Participants were free to use as much or as little of each energy source as they liked, with two exceptions: (1) they could not be more than 50% reliant upon any one source; and (2) they had to meet 100% of electricity demand. These restrictions forced participants to make trade-off decisions between the available energy source options by preventing a 100% reliance on any one energy source or a 0% reliance on all energy-sources.[4] The instructions ended by reaffirming the content of the frame relevant to the condition (for an example of how this was done, see Appendix A3).

Within the main task, participants were presented with the 'electricity calculator' (see Figure 2) and asked to create their preferred electricity generating portfolio. When participants were first presented with the 'electricity calculator' the bars for each energy source were set to a level indicative of the approximate contribution made that particular energy source to the current UK mix, i.e. the status quo (coal = 38%; gas = 36%; NP = 18%; renewables = 4%; electricity import = 4%).[5]

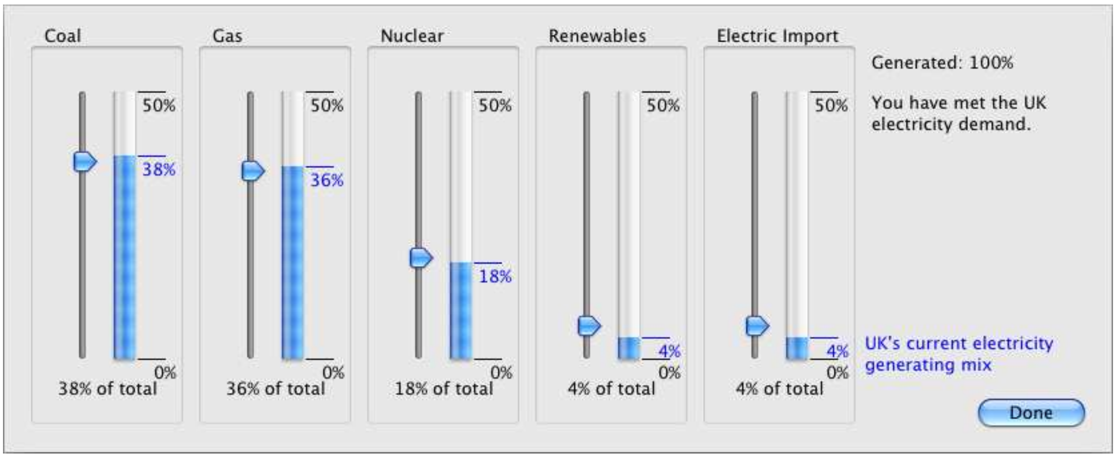

Figure 2. The 'electricity calculator'. Participants were required to reconfigure the bars associated with each energy source to create their 'preferred' mix. When first presented with the calculator the bars were positioned to reflect the status quo. Note. Participants were required to meet 100% of demand and could be only up to 50% reliant upon any one energy source.

Having settled upon their preferred mix, participants then responded to a series of post-mix questions that assessed: (1) their self-proclaimed knowledge about how electricity is generated, their opinions about the use of NP to generate electricity, their opinions about the use of NP to combat climate change and increase energy security, and concerns over the safety of NP and the creation of new nuclear waste (8 questions); and (2) their more general beliefs about climate change and favoured mitigation options (3 questions) (see Appendix B, for details of each question).

Participants finally recorded some basic demographic information (e.g. age, gender) before being debriefed, thanked and then dismissed.

4.1.2. Hypothesis: It was anticipated that if participants were directly responding to the content of the information provided to them (i.e. a direct response to the emphasis framing) that the two pro-nuclear frames should significantly increase reliance on NP compared to the 'control' condition, while the 'waste' condition should significantly reduce reliance on NP compared to the 'control' condition.

4.2. Results

4.2.1. Participants: One-hundred University of Sheffield psychology undergraduate and postgraduate students participated in this study (69 females and 31 males). Participants were aged between 18-38 years (Mean = 21.2 years) and the majority (i.e. 89%) believed in anthropogenic climate change (ACC).

4.2.2. Framing condition comparability: Univariate ANOVA and Chi-square analysis confirmed that the participants assigned to each of the 4 framing conditions (Ns = 25) were comparable with respect to mean age ($p = .161$), self-reported knowledge about electricity generation (knowledge) ($p = 1.00$), initial attitudes to the 5 energy sources ($ps \geq .210$), the proportion of male and female participants ($p = .275$) and the proportion of climate change believers and sceptics (climate) ($p = .959$) (see Table C1 in Appendix C for descriptive data).

This broad comparability between the participant groups in each framing condition meant that we could be more certain that any differences found in the electricity mixes created by participants in each condition were related to our emphasis framing manipulation.

4.2.3. Electricity Mix Analysis: Participants in all 4 conditions responded in a relatively consistent manner, opting for a high reliance on renewables, a moderate reliance on NP, a low-moderate reliance on gas and coal, and low reliance on import.

To gain a fuller appreciation of how the framing might have influenced responses, we conducted a series of univariate ANOVAs with planned simple contrasts (using the 'control' condition as a referent category).[6] These analyses were used to assess: (a) whether there were differences in the mean use of each energy-source within each framing condition; and (b) whether mean responses in the pro- or anti-nuclear framing conditions differed significantly from the 'control' condition (see Figure 3, for the mean mixes from each framing condition).

The analysis revealed that there were no differences between the conditions with respect to the mean inclusion of coal (p = .115), gas (p = .135), renewables (p = .840) or import (p = .778). There was, however, a significant difference in the mean inclusion of NP, $F(3, 96) = 3.15$, $p = .028$, $\eta_p^2 = .090$, with participants in the 'climate' condition using significantly more NP that those in the 'control' condition (p = .042). Participants in both the 'security' (p = .844) and 'waste' (p = .351) conditions incorporated comparable levels of NP to those in the 'control' condition.

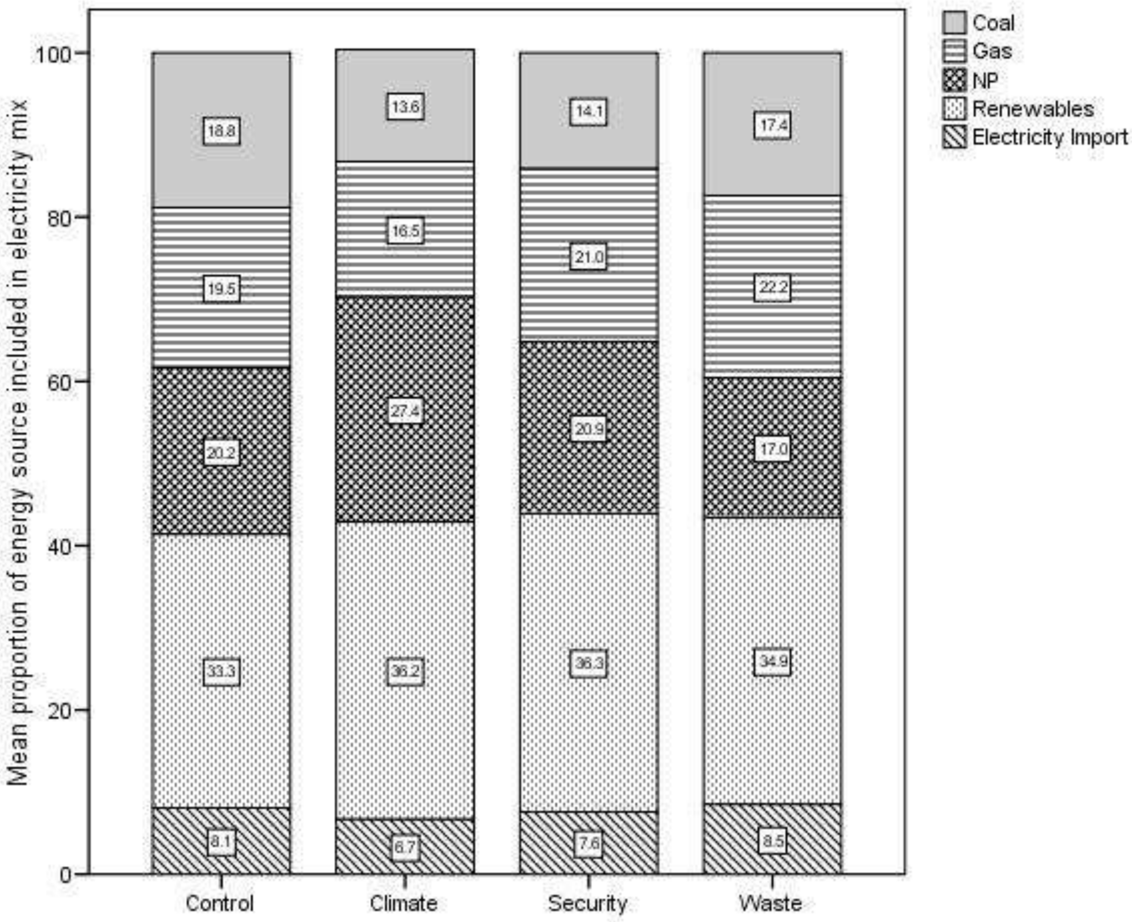

Figure 3. Mean electricity mix portfolios generated within each framing condition (study 1). Overall means for each energy source in rank order of inclusion: [1] Renewables = 35.1%; [2] NP = 21.4%; [3] Gas = 19.8%; [4] Coal = 16.0%; [5] Import = 7.7%. Note: All mixes are roughly comparable except in 'climate' condition in which a significantly greater proportion of NP is endorsed.

Table 3.

Means and standard deviations for responses to post-mix questions concerning NP (study 1).

	Framing condition				
Variable	Control	Climate	Security	Waste	p
Continued use	2.80 (1.16)	3.20 (1.01)	3.04 (1.14)	3.04 (1.24)	.700
SoS challenge	4.36 (0.64)	4.48 (0.59)	4.48 (0.59)	4.48 (0.71)	.879
NP increase SoS	3.56 (0.92)	3.62 (1.02)	3.72 (0.94)	3.60 (1.00)	.946
CC challenge	4.40 (0.56)	4.68 (0.48)	4.16 (0.90)	4.40 (0.58)	.050*
NP combat CC	3.87 (0.92)	4.15 (0.67)	3.78 (0.74)	3.79 (1.02)	.473
Safety concern	2.60 (0.91)	3.08 (0.88)	2.68 (0.75)	2.92 (0.70)	.150
Waste concern	3.08 (0.76)	3.36 (0.49)	3.16 (0.69)	3.12 (0.67)	.483

* $p < .05$

Note. Responses to first 5-items were made on 5-point Likert-type scales (1 = strongly disagree – 5 =

strongly agree). Responses to the safety concern and waste concern items were made on a 4-point scale (1 = not at all concerned – 4 = very concerned). All analyses discount respondents answering 'Don't Know'. For exact phrasing of questions and the codes for each item, see Appendix B1. Abbreviations used: CC = Climate Change; SoS = Security of Supply; NP = Nuclear power.

4.2.4. Post-Mix Question Analysis: The results of these analyses ostensibly supported the conclusion that couching the nuclear debate in terms of mitigating climate change had produced a greater direct endorsement of NP (i.e. evidence of a direct emphasis framing effect). However, while on the surface this finding might have been seen to validate the concerns of critics of the consultation, participants' responses to some of the post-mix feedback questions argued against this basic conclusion (see Appendix B1 for details of the post mix questions used in this study and see Table 3 for the mean responses to these questions).

In short, if participants were directly responding to the content of the 'climate' frame, one should have expected those in this condition to be: (a) more convinced that climate change is a critical challenge for the UK (CC challenge); and (b) hold a stronger belief that NP could help to address this challenge (NP combat CC). However, while a difference in CC challenge was observed between the conditions, $F(3, 96) = 2.71$, $p = .050$, $\eta_p^2 = .078$ (with concern shown to be highest in the 'climate' condition), there was no comparable difference in responses to the NP combat CC item between the conditions ($p = .473$). Thus, while it appeared that the 'climate' frame was effective in heightening concern over climate change, this apparently did not convince participants that NP was the obvious solution to the problem.

Indeed, taken together, participants across the conditions were shown to favour: (a) the expanded use of renewables; (b) behavioural interventions to reduce consumption; and (c) improved energy efficiency over the expanded use of NP as the preferred means for mitigating climate change (see Table 4 for preferred climate change mitigation choices). Moreover, participants in the 'climate' condition were no more likely to select NP as a favoured options than those in other conditions, χ^2 (3) = 2.42, p = .490.

Finally, if participants in the 'climate' condition were directly favouring NP as a generating option, then one might have expected them to be more convinced of the relative safety NP within this condition. However, assessment of the planned simple contrasts between the mean responses to the safety concern item in each condition (from this point on referred to simply as 'planned simple contrasts') revealed that participants in the 'climate' condition actually had a significantly elevated concern about the safety and security of NP compared to the control condition (p = .041) .

Table 4

Favoured options for mitigating climate change (study 1).

Rank	Option	Checked	Unchecked
1	Expanded use of renewables	95	5
2	Change behaviour to reduce consumption	82	18
3	Expand energy-efficient technology	74	26
4	Expand use of NP	23	77
5	Reduce consumption via regulation/taxes	13	87
6	Continued use of fossil fuels with CCS	4	96

Note. Participants were asked to select 2 or 3 options; however, the number of checked options varied thus: 4-options (N = 3); 3-options (N = 86); 2-options (N = 10); 1-option (N = 1). There were also 'none of these' and 'don't know' options but these were not selected. Abbreviations used: CCS = Carbon Capture and Storage; NP = Nuclear Power.

In sum, while there was evidence for an apparently elevated preference for NP in the 'climate' condition within this study, analysis of respondents' post-mix responses pointed towards this being the result of something other than a direct endorsement in response to climate change framing.

4.3. Discussion

Study 1 provided initial insight into the trade-off decisions that participants would make when confronted with the task of having to create an electricity mix for the UK with a limited number of options. Findings suggested that participants in all conditions were in broad agreement as to the general nature of their preferred mixes, opting for a relatively low reliance on fossil fuels and import, high reliance on renewables, and a moderate reliance on NP.

The results also provided insight into how these trade-off decisions might vary in response to arguments centred upon the issues of climate change, security of supply and nuclear waste. The findings suggested that while there was little evidence of framing effects among participants in the 'waste' and 'security' conditions, the 'climate' frame apparently did prompt participants to rely significantly more on NP.

While on the surface this could perhaps be taken to validate the concerns aired by critics of the 2007 consultation, the lack of corroborative trends within the responses to the post-mix questions cast doubt over this assumption and suggested that this increase may have formed more indirectly – and perhaps reluctantly – as a consequence of other decisions made within the task. For instance, it is possible that this trend might have resulted from an elevated desire to reduce fossil fuel use within the ‘climate’ condition and the dependence of energy source decisions within the task.

In short, participants’ reliance on both coal and gas was visibly lowest in the ‘climate’ condition. While this decision to more noticeably limit the inclusion of fossil fuels is consistent with the general thrust of the frame (i.e. reduce GHG emissions from electricity generation), the nature of the ‘electricity calculator’ meant that participants would have necessarily had to increase their reliance on the other energy sources (i.e. renewables, NP, and electricity import) relative to the other conditions in order to create a viable electricity mix (i.e. one totalling 100%).

With the use of renewables ostensibly saturated, participants in the ‘climate’ condition apparently favoured investing in NP over electricity import. While this decision could have related to relative familiarity of these energy sources, we would argue that it might have also stemmed from participants’ recognition of the existing contributions made by each of these energy sources to UK electricity generation (18% NP vs. 4% electricity import), i.e. an anchoring effect caused by the provision of the status quo figures.

In this way then, the greater reliance on NP in the ‘climate’ condition might not be the result of a direct emphasis framing effect, but something more akin to a reluctant acceptance resulting from: (a) the need to bridge a generating deficit created by the reduced reliance on fossil fuels in this condition; and (b) an awareness of the UK's existing reliance on NP as a generating option. A conclusion of reluctant acceptance is certainly consistent with existing literature on attitudes towards NP (see Bickerstaff et al., 2008; Corner et al., 2011; Pidgeon et al., 2008) and can perhaps explain why the higher preference for NP in the 'climate' condition was accompanied by heightened concern for safety and security.

5. Study 2

Study 2 (25/02/2009 to 03/12/2009) investigated the findings of study 1 in a context where status quo information was no longer available. Thus, we could assess whether the elevated reliance on NP in the 'climate' condition was indicative of a direct emphasis framing effect or a reluctant acceptance resulting from other decisions made within the 'electricity calculator' task and anchoring provided by the status quo.

5.1. Method

5.1.1. Procedure: The procedure for study 2 was the same as study 1, with two exceptions. First, all references to the status quo figures were removed and the 'electricity calculator' task was updated such that when beginning the task each energy source was making a standard 20% contribution to the generating mix. This change meant that while the initial sum of the contributions made by the energy-sources still totalled 100% (akin to study 1), participants received no information about the comparative 'real-world' contributions made by each source. Secondly, participants could be assigned to any of the four framing conditions (i.e., 'control', 'climate', 'security', and 'waste') from the outset of the experiment.

5.1.2. Hypotheses: It was reasoned that if participants' decisions in study 1 were being anchored by the status quo figures, that participants in study 2 should show comparatively higher reliance on the low-anchored energy-sources (i.e. renewables [4%] and electricity import [4%]) and comparatively lower reliance of high-anchored energy-sources (i.e. coal [38%] and gas [36%]).

It was also reasoned that if the elevated reliance on NP in the 'climate' condition of study 1 was tied to the provision of the status quo figures (as opposed to a direct framing effect), that the absence of this information in study 2 should reduce any discrepancy in the preference for NP between the conditions.

5.2. Results

5.2.1. Participants: One-hundred and twenty participants took part in this study (100 female and 20 male). All participants were either University of Sheffield undergraduate or postgraduate students, members of the University of Sheffield volunteers list, or visiting sixth-form students. The participants were all aged between 17-56 years (Mean = 19.8 years), with 81.6% shown to believe in anthropogenic climate change (ACC). Postgraduate, undergraduate and volunteers-list participants were recruited via email invitation or through the ORPS. Each received either course credit or chocolate as payment. The remaining participants (i.e. sixth-form students) were recruited on departmental open-days, where the study was run as a demonstration.[7]

5.2.2. Framing-condition comparability: Participants in each condition (N = 30) were comparable with respect to mean age ($p = .810$), self-reported knowledge about electricity generation (knowledge) ($p = .581$), initial attitudes to the 5 energy sources ($ps \geq .294$), the proportion of males and female participants ($p = .696$), and the proportion of climate change believers and sceptics (climate) ($p = .774$) (see Table C1 in the Appendix C for descriptive data).

5.2.3. Electricity Mix Analysis: Despite having no access to status quo information, participants in all 4 conditions responded in a manner akin to those in study 1, opting for a relatively low reliance on fossil fuels and import, a large reliance on renewables, and a moderate reliance on NP. However, in contrast to study 1, overall mean inclusion of electricity import out-ranked that of both the fossil fuels and there was no obviously elevated reliance on NP in the 'climate' condition (see Figure 4).

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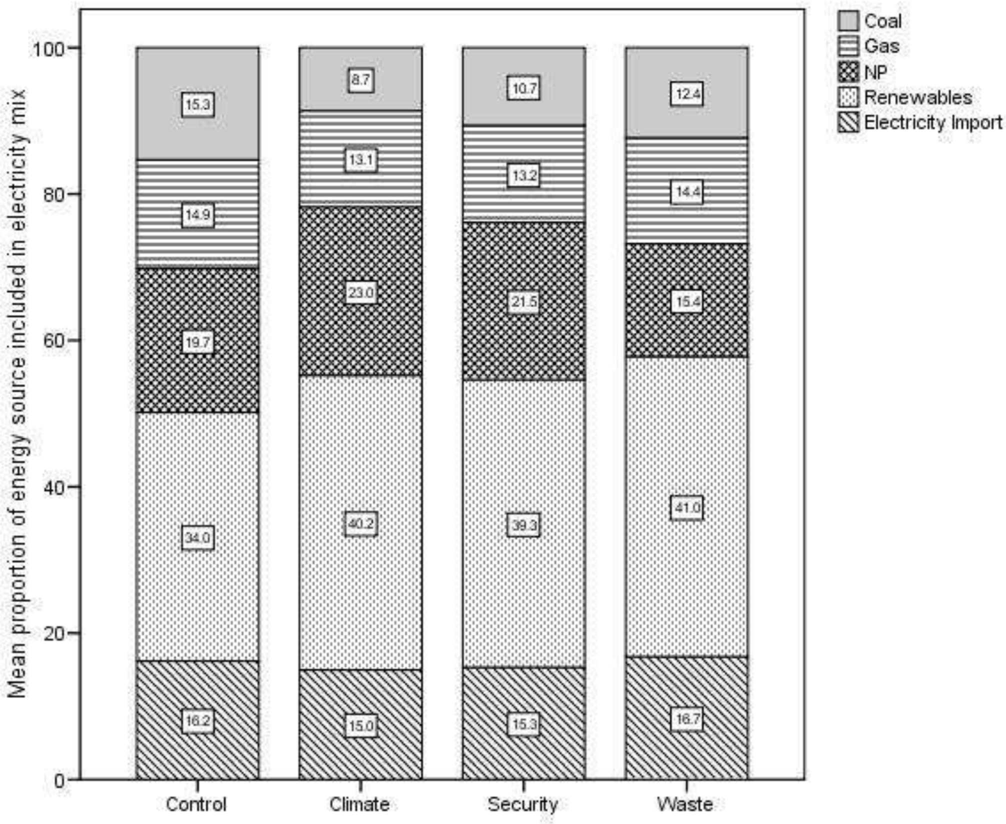

Figure 4. Mean electricity mix portfolios generated within each framing condition (study 2). Overall means for each energy source in rank order of inclusion: [1] Renewables = 38.6%; [2] NP = 19.9%; [3] Import = 15.8%; [4] Gas = 13.9%; [5] Coal = 11.7%. Note: All the mixes are roughly comparable and the elevated endorsement of NP in the 'climate' condition (vs. control) observed in study 1 is greatly attenuated.

Univariate ANOVAs (with planned simple contrasts) revealed that there were significant differences between the conditions with respect to the inclusion of coal, $F (3, 116) = 6.60$, $p < .001$, $\eta_p^2 = .146$, and renewables, $F (3, 116) = 3.47$, $p = .018$, $\eta_p^2 = .082$, but no statistically significant differences in terms of the reliance on gas ($p = .535$) or electricity import ($p = .803$). A marginal difference in the relative preference for NP was recorded, $F (3, 116) = 2.25$, $p = .063$, $\eta_p^2 = .061$; however, the planned simple contrasts revealed that inclusion of NP in the 'climate', 'security' and 'waste' conditions, did not differ significantly from the inclusion of NP in the ‘control’ condition ($ps \geq .153$)[8].

The significant differences in the reliance on coal and renewables were explored further through the planned simple contrasts. In terms of reliance on coal, participants in the ‘climate’ ($p < .001$) and ‘security’ ($p = .003$) conditions included significantly less than those in the ‘control’ condition, while use in the ‘waste’ and ‘control’ conditions was comparable ($p = .059$). In terms of renewables, participants in the ‘climate’ ($p = .011$), ‘security’ ($p = .029$) and ‘waste’ ($p = .004$) conditions included significantly more in their mixes than those in the ‘control’ condition.

5.2.4. Post-Mix Question Analysis: Analysis of the post-mix questions revealed that there was again a difference in the perceived criticality of climate change as a challenge for the UK between the conditions (CC challenge), F (3, 115) = 4.41, $p = .006$, $\eta_p^2 = .103$. Participants in both the ‘climate’ and ‘security’ conditions perceived climate change a greater challenge than those in the ‘control’ condition ($ps < .028$). As with study 1, however, this heightened concern about climate change was not accompanied by a heightened belief that NP should be used to mitigate this threat (NP combat CC), F (3, 111) = 0.17, $p = .917$. Indeed, analysis of the between-group differences in responses to the safety concern and waste concern items revealed that the ‘security’ frame had actually increased unease about NP relative to the ‘control’ condition on these items ($ps \leq .019$) (see Table 5).

Table 5.

Means and standard deviations for responses to post-mix questions concerning NP (study 2).

	Framing condition				
Variable	Control	Climate	Security	Waste	p
Continued use	3.00 (1.02)	3.14 (0.97)	3.00 (0.96)	2.86 (0.99)	.764
SoS challenge	4.14 (0.58)	4.33 (0.48)	4.45 (0.51)	4.33 (0.55)	.167
NP increase SoS	3.37 (0.97)	3.63 (0.72)	3.34 (0.86)	3.41 (1.09)	.609
CC challenge	4.07 (0.64)	4.55 (0.57)	4.47 (0.68)	4.03 (0.85)	.006**
NP combat CC	3.74 (0.86)	3.63 (0.77)	3.57 (0.88)	3.67 (1.06)	.917
Safety concern	2.46 (0.64)	2.69 (0.76)	2.93 (0.70)	2.59 (0.63)	.072
Waste concern	2.90 (0.62)	3.03 (0.68)	3.28 (0.53)	2.86 (0.58)	.043*

* p < .05

** p < .01

Note. Responses to first 5-items were made on 5-point Likert-type scales (1 = strongly disagree – 5 = strongly agree). Responses to the safety concern and waste concern items were made on a 4-point scale (1 = not at all concerned – 4 = very concerned). All analyses discount respondents answering 'Don't Know'. For exact phrasing of questions and coding for items, see Appendix B1. Abbreviations used: CC = Climate Change; SoS = Security of Supply; NP = Nuclear power.

With respect to climate change mitigation, investment in NP remained only moderately favourable option in all the framing conditions (see Table 6) and was no more likely to be favoured by participants in the 'pro-nuclear' framing conditions than those in the 'control' and 'waste' conditions, χ^2 (3) = 1.10, p = .778.

Taken with the findings of the electricity mix analyses, these results indicated that the 'pro-nuclear' framing, while perhaps effective in stimulating concern over unsustainable and insecure generating practices, apparently did not significantly affect participants' relative preference for NP as an electricity generating option.

Table 6.

Favoured options for mitigating climate change (study 2).

Rank	Option	Checked	Unchecked
1	Expanded use of renewables	112	8
2	Change behaviour to reduce consumption	108	12
3	Expand energy-efficient technology	93	27
4	Expand use of NP	21	99
5	Reduce consumption via regulation/taxes	15	105
6	Continued use of fossil fuels with CCS	5	115
7	Don't Know	1	119

Note. Whilst participants were asked to select the two or three options they most favoured; the number of checked options varied thus: 5-options (N = 2), 4-options (N = 3); 3-options (N = 103); 2-options (N = 12). Abbreviations used: CCS = Carbon Capture and Storage; NP = Nuclear power.

5.2.5 Comparing Studies 1 and 2: A series of 2 (study: one vs. two) x 4 (framing condition: control, climate, security, waste) univariate ANOVAs (with planned simple contrasts) were run to formally assess how the provision of the status quo figures in study 1 might have influenced participants' reliance on each energy source, in addition to checking for any interactions between study and framing condition.

The results showed significant anchoring effects for the relative inclusion of coal, gas, renewable and electricity import. As predicted, participants in study 1 (anchored task) on average included significantly more coal and gas ($Fs \geq 17.71$, $ps < .001$, $\eta_p^2 \geq .077$) and significantly less renewables and import ($Fs \geq 5.07$, $ps \leq .025$, $\eta_p^2 \geq .023$)

than those in study 2 (unanchored task). On average there was no significant difference in the inclusion of NP between the studies ($p = .357$).

Main effects of framing condition were only observed in the reliance on coal, $F(3, 212) = 6.87$, $p < .001$, $\eta_p^2 = .089$, and NP, $F(3, 212) = 5.40$, $p = .001$, $\eta_p^2 = .071$ (Gas: $p = .084$; Renewables: $p = .109$; Import: $p = .580$). In terms of coal, this resulted from participants in the 'climate' and 'security' conditions using less coal than those in the 'control' condition (ps < .001); while the difference in NP principally resulted from the elevated inclusion of this source in the 'climate' condition of study 1. There were no significant interactions between study and framing condition (ps ≥ .274).

5.3. Discussion

In addition to confirming the status of renewables as the clearly favoured generating option, the results of study 2 demonstrated how the provision of the status quo figures in study 1 had influenced participants' decisions in the 'electricity calculator' task, leading them to incorporate significantly less renewables and import and significantly more coal and gas. The results also confirmed the apparent ineffectiveness of the experimental framing in influencing participants' preferences for NP. Indeed, the 'climate' and 'security' frames in particular prompted the participants to reduce the reliance on coal and increase the contribution of renewables rather than to increase reliance on NP.

Importantly, the absence of the elevated endorsement of NP in the 'climate' condition argued against the trend observed in study 1 being the result of a direct framing effect.

Participants in the 'climate' condition still showed a desire to reduce reliance on coal relative to other conditions, however, in the absence of the status quo figures, they apparently felt more able to rely on investment in electricity import and renewables (i.e. the otherwise 'low-anchored' sources) to make up for any additional generating deficit, which negated the need for heavier investment in NP.

With regard to the inclusion of NP, it was interesting to find that participants in both studies opted for broadly comparable reliance on this option on average (i.e. approx. 20%). While in study 1 this finding could possibly be attributed to the anchoring provided by the status quo (i.e. 18% NP), it was less clear why a similar reliance on NP should be found in study 2 (i.e. where no such anchoring information was available). Two explanations were considered for this finding: (1) The 20% figure was indicative of a generic acceptable level of endorsement for NP within the 'electricity calculator' (a figure coincidentally resembling the levels within the status quo); or (2) The 20% figure resulted inadvertently from our decision to set the initial starting values for each energy source to a standard 20% level.

In order to determine between these explanations a third study was conducted. This study also tested the findings of the previous studies within a more diverse sample of participants (i.e. a non-student sample). This was achieved by recruiting participants alongside a nationally representative survey on attitudes towards climate change and energy futures in Britain (see Spence et al., 2010).

6. Study 3

Study 3 (07/01/2010 to 20/04/2010) tested the findings from the previous two studies in a more diverse sample of participants and allowed for the investigation of whether participants' reliance on NP in study 2 might have been inadvertently anchored by the decision to set the initial starting values of the energy-sources within the electricity calculator to 20%.

6.1. Method

6.1.1. Procedure: Participants were recruited alongside a national survey exploring public perceptions of climate change and future electricity generation options (for details, see Spence et al., 2010; see also Spence et al., 2011). After completing this survey, participants were provided with a link to an online version the 'electricity calculator' task, which they were asked complete at their own convenience.

Of the 2339 people who participated in the national survey[9], 1181 expressed interest in completing the online task and were issued with a participation code. Provision and use of this code allowed us to coordinate participants' online responses with their survey responses.

The experiment operated in the manner previously described, with four exceptions:

1) Because the focus of the research was principally on whether the government's use of pro-nuclear framing was influencing attitudes to NP, the decision was taken to drop the 'waste' condition from study 3. Thus, when accessing the online task, participants could be randomly assigned to 1 of 6 conditions (i.e. the 'control', 'climate' or

‘security’ condition, in either the anchored or unanchored version of the ‘electricity calculator’ task).

2) The operating platform was changed to enable the task to operate within an online environment. The questions recording participants’ initial attitudes to each of the 5 energy-sources (originally delivered in a pen-and-paper format) were also uploaded to become a part of the online task and ‘key press’ instructions were adapted to ensure compatibility with different computers.

2) The initial contributions made by each energy source when people began the task were set to 0%. This removed the inadvertent 20% anchor present in study 2. The same was done for both the anchored and unanchored versions of the task; however, in the anchored task, the status quo values were still visible alongside the energy-source bars.[10]

3) Each participant who completed the online task was sent a £5 gift voucher as payment for participation, rather than course credit or chocolate.

6.1.2. Hypotheses: It was anticipated that: (a) participants’ decisions within the ‘electricity calculator’ should broadly mirror the previous studies (i.e. high reliance on renewables, low-moderate reliance on fossil fuels and electricity import, and moderate reliance on NP); (b) that the pro-nuclear framing should not promote the greater reliance on NP compared to the ‘control’ condition; and (c) that anchoring would likely exert more of an effect on participants responses than framing.

It was also hypothesised that if participants' inclusion of NP in study 2 was not a product of inadvertent anchoring, that on average participants in study 3 should again include around 20% of NP within their mix.

6.2. Results

6.2.1. Participants: Of the 1181 participants issued with a participation code, 184 completed the online task. Of these, 6 failed to enter a valid code and were omitted from the dataset leaving a final population of 178. All 178 participants were aged between 15 and 83 years (Mean = 43.3 years; SD = 16.9 years), 48.9% were male and 86.5% believed in anthropogenic climate change. Consistent with the aims of the study, this sample was more demographically diverse than those tested in either of the previous studies. However, being self-selected, it should be noted that the sample was not representative of the UK and is likely to have contained a disproportionate number of individuals with interests in energy and environment.

6.2.2. Sub-condition comparability: Assignment of participants between the 6 conditions was roughly comparable. Four of the conditions comprised between 27 and 31 participants. The 'security' condition (anchored version) had fewest participants (N = 21) and the 'climate' condition (unanchored version) had the most (N = 39).

Participants within each condition were comparable with respect to age, knowledge, belief in climate change and trends in their initial attitudes towards the 5 energy sources ($ps \geq .458$). Equal proportions of male and female participants took part in the anchored version of the task ($p = .154$), however, males were slightly under-represented within the unanchored version of the task (p = .025) (see Table C1 in the Appendix for descriptive data).

Despite the slight discrepancy in participant numbers and the under-representation of male participants in the unanchored task, the conditions were overall considered suitable for direct comparative analysis.

6.2.3. Electricity Mix Analysis: Participants in all conditions were in general agreement about the broad shape of their favoured electricity mix. Participants again foremostly favoured investment in renewables, combining this with a low reliance on the fossil fuels and import and a low-moderate reliance on NP (see Figure 5).

A series of 2 (Anchoring: anchored vs. unanchored) x 3 (Framing condition: control vs. climate vs. security) univariate ANOVAs were again conducted to investigate the impact of the experimental framing and anchoring on participants' inclusion of each of the five energy sources. The results for each energy source are considered below.

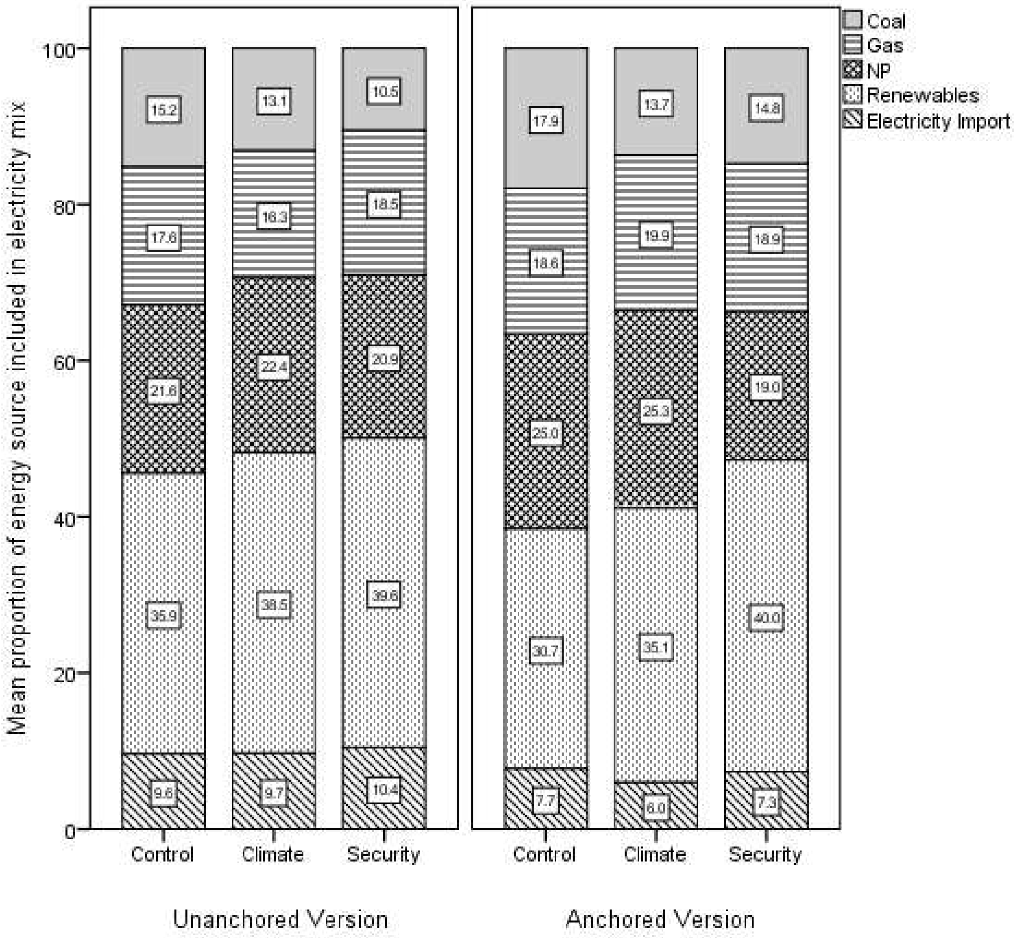

Figure 5. Mean electricity mix portfolios generated within each framing condition (study 3). Overall means for each energy source in rank order of inclusion: (A) Anchored: [1] Renewables = 34.7%; [2] NP = 23.6%; [3] Gas = 19.2%; [4] Coal = 15.6%; [5] Import = 6.7%. (B) Unanchored: [1] Renewables = 38.1%; [2] NP = 21.7%; [3] Gas = 17.4%; [4] Coal = 12.9%; [5] Import = 9.9%. Note: Patterns of responding between conditions and between the unanchored and anchored versions of the task were broadly comparable.

Coal: While not achieving conventional statistical significance, the main effects of anchoring, F (1, 172) = 2.98, p = .086, η_p^2 = .017, and framing condition, F (1, 172) = 2.62, p = .076, η_p^2 = .030 tended towards significance (interaction: p = .577). Analysis of the planned simple contrasts indicated that there was a tendency for participants in the ‘pro-nuclear’ conditions to include less coal than those in the ‘control’ condition (‘security’: $p = .038$; ‘climate’: $p = .067$). In terms of anchoring, the observed trend was towards the lower inclusion of coal within the unanchored task (see Figure 5).

Gas and NP: The analyses for gas and NP revealed no significant main effects of anchoring ($ps \geq .285$) or framing condition ($ps \geq .422$) and no interactions ($ps \geq .645$).

Renewables: There was no main effect of anchoring ($p = .197$) and no significant interaction between anchoring and framing ($p = .585$). The main effect of framing achieved marginal significance and was explored further, $F(1, 172) = 2.90$, $p = .058$, $\eta_p^2 = .033$. This marginal effect was principally found to result from participants in the ‘security’ conditions using more renewables than those in the ‘control’ conditions ($p = .018$) (‘control’ vs. ‘climate’: $p = .161$).

Import: There was a significant main effect of anchoring only, $F(1, 172) = 4.73$, $p = .031$, $\eta_p^2 = .027$ (framing condition, $p = .787$; interaction, $p = .843$). Participants in the unanchored task included significantly less electricity import on average than those in the anchored task (see Figure 5).

6.3. Discussion

Study 3 was designed to assess the findings of the previous two studies in a more general sample. Modifications to the task also meant that we could examine the competing explanations for why participants in study 2 might have endorsed similar levels of NP to those in study 1 in spite of having no access to the status quo information.

Consistent with the previous studies, participants again opted for a low reliance on fossil fuels and import, high reliance on renewables and a low-moderate reliance on NP (circa. 20-25%). These results not only confirmed the status of renewables as the most favoured generating option but also confirmed participants' general willingness to incorporate NP within their mix. Furthermore, the finding that participants tended to include between 20-25% of NP within their mixes – particularly in the unanchored task – tended to argue against the suggestion that inclusion of NP in study 2 had been overly influenced by our decision to set the initial energy-source contributions to 20%.

There was again some evidence that the pro-nuclear framing had impacted participants' choices within the 'electricity calculator' task; however, these effects did not manifest as significant increases in the inclusion of NP. Rather, the 'climate' and 'security' arguments again exerted a more appreciable impact upon participants' inclusion of coal and renewables. Importantly, the absence of a significantly elevated endorsement of NP in response to 'climate' framing in either of the anchored or unanchored tasks, added weight to the suggestion that the trend observed in study 1 was not evidence of a genuine pro-nuclear framing effect.[11]

Study 3 showed less clear-cut evidence of anchoring, which perhaps reflects the greater diversity of participants within the sample and/or the fact that the task was conducted in a less controlled environment (e.g. participants' homes) where people might have had access to additional information. The exception to this rule related to the inclusion of electricity import, which was found to be much higher in the unanchored task. It is likely that the influence of anchoring was observed principally in the inclusion of electricity import not only because the status quo contribution from this energy source is relatively low, but also due to the relative unfamiliarity of this option compared to the other specified energy sources.[12]

7. General Discussion

In 2007 the UK government held a public consultation on the future of NP in the country (see BERR, 2008; DTI, 2007b). A series of three studies sought to assess what impact key arguments used by government within this consultation (to ostensibly promote acceptance of NP) might have upon preferences for NP in electrical power generation relative to other generating options. While the results do not speak to the suggestion that government deliberately sought to sway public opinion, they do offer insight into what impact the use of repetitive, pro-nuclear framing might have had on opinions about the technology during the period of consultation.

7.1. The impact of framing and anchoring

The results of these studies revealed little evidence of the hypothesised impact of pro-nuclear framing on participants' preferences for NP and suggested that anchoring as opposed to framing was having the greater impact upon participants' decisions. Indeed, even when it appeared that the 'climate' frame had directly increased inclusion of NP (study 1), subsequent analyses indicated that this probably represented a reluctant acceptance of this option, produced by the necessity to meet demand and the anchoring provided by the status quo figures (see also Bickerstaff et al., 2008; Pidgeon et al., 2008).

The lack of an impact of framing on preferences for NP could perhaps stem from participants having strong pre-formed attitudes about NP. The nuclear debate is certainly a divisive issue in the UK and strong pre-existing attitudes have been shown to limit the power of persuasive appeals (e.g. Brewer, 2001; Zuwerink and Devine, 1996). Thus, while there was evidence that participants had registered the content of the 'climate' and 'security' frames, perhaps it is unsurprising that they stopped short of elevating participants' reliance on NP.

7.2. A significant role for nuclear power?

While there was little evidence for the impact of framing upon participants' inclusion of NP within our task, NP was still found to play a major role in participants' favoured mixes. Largely independent of anchoring or framing NP accounted for around 20-25% of electricity generated and typically ranked second among the available energy source options.

On the surface, these findings would appear to suggest that our participants not only saw NP to be a vital component of the UK's generating portfolio but that NP should make a similar contribution to generation as it does at present. While not taking issue with the first part of this statement (as it was clear that the on average participants saw a substantial role for NP) we would advise caution in directly generalising the values produced by the electricity generator task to a real-world context.

While certain design features (e.g. the inability to reject all generating options) were built into the 'electricity calculator' task in order to more closely align participants' decision-making with real-world scenarios (e.g. where a rejection of all options is not practicable), the task was never designed to fully reflect reality but to experimentally investigate emphasis framing within a setting offering a purposefully limited number of choice options. As such, while our results might be taken as indicative of genuine relative real-world preferences, the actual figures observed should only be considered in the context of the choices that were available to participants.

In order to develop the 'electricity calculator' tool to be more reflective of real-world preferences in the future, we would argue for the need to incorporate a greater range of energy-source options (including a demand reduction option) and to more obviously relate participants' decisions to key outcome variables (e.g. impacts on generating cost and carbon emissions). Other calculator tools that incorporate some of these additional features can currently be found on the UK government (see http://my2050.decc.gov.uk/) and BBC (see http://news.bbc.co.uk/1/shared/spl/hi/uk/06/electricity_calc/html/1.stm) websites.[13]

7.3 The desire for renewables

Arguably the most prominent finding from this research was the clear desire for investment in renewables among our participants. In all conditions people were most reliant on this option, which is perhaps unsurprising considering the positive attitudes participants registered for this option before completing the task. However, beyond simply confirming the popularity of renewables, we would argue that our results perhaps hold additional implications.

For instance, from a policy perspective, this favourability could be taken to offer indirect support for the UK government's ambitious renewable energy targets (see DECC, 2009a; 2009b). That said, while the general desire for expansion of renewables among the general public might be welcomed by government, we would argue that this general support should not be used as a means to justify specific renewable projects. Not only did our renewables category fail to distinguish between different renewable technologies (e.g. hydroelectric, wind, solar) but a burgeoning literature now attests to discrepancy that often exists between general attitudes towards a technology and attitudes towards specific projects (e.g. Jones and Eiser, 2009; Krohn and Damborg, 1999; van der Horst, 2007).

The popularity of renewables could also have implications for how to frame and discuss investment in other energy sources, like NP, particularly when arguments centre upon the issue of climate change mitigation. Recent research shows that attitudes towards NP and other low-carbon technology options, e.g., carbon capture and storage (CCS) tend to be more favourable if they are seen not to affect investment in renewables (see e.g. Oltra et al., 2010; Pidgeon et al., 2008). The high levels of support for renewables relative to NP within our studies could be taken as evidence for this caveat on the endorsement of NP and would support attempts to delineate, where possible, the non-competitive nature of these options. That said, it should be highlighted that the complementary or rival nature of these electricity generating options remains a major source of disagreement within current debates around energy (e.g. Verbruggen, 2008)

7.4 Limitations of task

There are several limitations within the current experimental design which should be noted if using the results of these studies to directly critique of the 2007 consultation.

First, our decision to separately investigate the impacts of the ‘climate’ and security’ arguments might have limited the strength of our framing manipulation compared to the 2007 consultation (i.e. where both frames were presented simultaneously and on more occasions). While our chosen method allowed us to keep the experimental procedure brief and to investigate the comparative influence of each argument, it is possible that combining these arguments and presenting them in a more sustained and repetitive manner (as was the case in the consultation) may have had a larger impact upon participants’ preferences for NP within the task. That said, the individual ‘climate’ and ‘security’ frames were strong enough to significantly influence participants’ inclusion of other energy sources (e.g. coal and renewables), thus supporting the conclusion that the experimental framing was simply ineffective in influencing participants’ preferences for NP within the task.

Second, our choice to test participants in a non-deliberative context did not accurately reflect how members of the public reached decisions within the public consultation events. Within the consultation participants’ decisions were made in a small-group setting and in response to more extensive and complex information. It could perhaps be argued that in a more sustained deliberative setting, stronger framing effects might have been observed. That said, recent research demonstrates that in such small-group deliberative contexts, people are often exposed to a number of competing viewpoints and opinions that can reduce the persuasive influence of elitist framing (e.g. Druckman and Nelson, 2003). As such, our decision to test people individually could have arguably increased the strength of the framing manipulations.

Finally, it is possible that our decision to provide participants with five energy-source options might have accounted for their tendency to incorporate around 20% of NP in their mix. This is the level you would anticipate people to incorporate by chance. However, while we would advise that future studies incorporate a greater number of response options in order to test this assumption, the clear deviations from chance-level responding shown in the use of other energy-sources argues against the levels of NP included being simply the result of chance-level responding.

8. Conclusion

The three studies outlined above illustrate that, among our sample, the pro-nuclear framing used by the UK government within the 2007 public consultation events had very little impact upon preferences for NP. Rather, the findings suggest that this framing actually served to bolster a desire for investment in renewables and a reduced reliance on coal. These findings can perhaps provide insight into the influence that such framing might have had upon participants of the actual consultation. However, care should be taken if drawing such comparisons due to the relatively narrow definition of framing used within these studies, the differences in the populations assessed and the notable differences in the decision-making context employed in our studies compared with the citizen deliberative events.

In addition to the empirical findings of these studies, we would also argue that the 'electricity calculator' task developed for use in this research holds real potential for future assessment of public opinion energy policy options. Not only does this tool stand to provide a more realistic picture of the kinds of trade-offs and decisions that people might be willing to endorse (or tolerate) in complex choice settings, but employed alongside other engagement and outreach efforts these tools could stand to: (a) enhance broader public understanding of challenges faced by energy companies and policy makers in the energy sector; and (b) build capacity within the general public to assist in deciding how these challenges should be addressed (see Beierle and Cayford, 2002; Stern and Fineberg, 1996).

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Table C1.

Demographic details of participants and mean initial energy-source attitudes within each sub-condition of Studies 1 – 3 (Standard deviations are in parentheses).

	Study 1				**Study 2**				**Study 3**					
	Anchored				Unanchored				Anchored			Unanchored		
	Control	Climate	Security	Waste	Control	Climate	Security	Waste	Control	Climate	Security	Control	Climate	Security
N	25	25	25	25	30	30	30	30	31	31	21	27	39	29
Mean Age	22.0	21.0	19.8	21.9	20.6	19.5	19.6	19.5	44.6	43.1	44.9	42.4	44.9	39.4
	(4.9)	(4.0)	(2.5)	(3.9)	(7.9)	(2.7)	(3.8)	(4.4)	(18.7)	(17.5)	(14.7)	(19.0)	(15.3)	(16.8)
Knowledge[a]	2.64	2.64	2.64	2.64	2.40	2.67	2.53	2.47	2.94	3.06	2.81	2.85	2.95	3.07
	(1.00)	(0.91)	(0.81)	(0.76)	(0.86)	(0.73)	(0.71)	(0.78)	(0.93)	(0.85)	(0.93)	(0.99)	(0.86)	(0.65)
% Male [b]	40.0%	20.0%	24.0%	40.0%	16.6%	20.0%	10.0%	20.0%	54.8%	64.5%	52.4%	37.0%	38.5%	48.3%
Climate [c]	88.0%	88.0%	88.0%	92.0%	83.3%	86.6%	80.0%	76.6%	83.9%	90.3%	81.0%	85.2%	84.6%	93.1%
Initial Attitudes to Energy Sources [d]														
Coal	2.80	2.44	2.28	2.60	2.83	2.50	2.57	2.70	3.00	2.68	2.62	2.96	2.95	2.66
	(0.91)	(0.87)	(0.94)	(0.87)	(0.95)	(0.90)	(0.82)	(0.84)	(0.86)	(1.01)	(0.87)	(0.94)	(1.05)	(1.01)
Gas	3.08	3.20	3.20	3.28	3.10	2.97	3.20	3.07	3.13	3.23	3.10	3.30	3.23	2.97
	(0.95)	(0.76)	(0.96)	(0.74)	(1.13)	(0.77)	(0.85)	(0.76)	(0.76)	(0.99)	(0.89)	(0.91)	(0.96)	(1.12)
Nuclear	2.80	2.52	2.64	3.00	2.93	2.60	2.73	2.63	3.32	3.10	2.76	3.11	3.05	2.76
	(1.38)	(1.01)	(1.25)	(1.26)	(1.02)	(1.13)	(1.17)	(1.38)	(1.38)	(1.47)	(1.34)	(1.22)	(1.32)	(1.46)
Renewables	4.64	4.88	4.76	4.80	4.83	4.77	4.87	4.83	4.29	4.58	4.71	4.44	4.51	4.52
	(0.49)	(0.33)	(0.44)	(0.41)	(0.38)	(0.50)	(0.35)	(0.38)	(1.07)	(0.81)	(0.56)	(0.64)	(0.68)	(0.76)
Import	2.44	2.72	2.44	2.88	2.60	2.80	2.93	2.47	2.65	2.52	2.52	2.67	2.62	2.76
	(1.39)	(1.37)	(1.04)	(0.83)	(1.28)	(0.76)	(0.91)	(1.04)	(1.02)	(1.00)	(0.87)	(1.07)	(1.02)	(1.06)

[a] Mean self-assessed knowledge of how electrical power is generated in the UK.

[b] Percentage of male participants in condition

[c] Percentage of participants believing in anthropogenic climate change (ACC).

[d] All attitudes recorded on 5-point scale: 1 = Strongly opposed to use in UK power generation; 5 = Strongly in favour of use in UK power generation

FOOTNOTES

[1] The Online Research Participation Scheme (ORPS) is a scheme used in the Department of Psychology at the University of Sheffield in order to provide a participant pool for researchers. Level 1 undergraduates are required to participate in experimental studies run by staff and students. These undergraduates are then provided with the opportunity of using the same participant pool when they conduct studies later in their course.

[2] Defined as “The import of electricity from continental Europe”. Participants were informed that the UK can receive electricity directly from France via an underwater cable.

[3] We use the term ‘condition(s)’ in an experimental sense in order to describe the parts of the experimental procedure that were varied in order to assess the impact of particular independent variables (i.e. anchoring and framing) on a specified dependent variable (i.e. electricity mix decisions). The first 75 participants were assigned to either the ‘climate’, ‘security’ or ‘control’ conditions. Assignment between these conditions was random until such a time as one of the conditions became full (N = 25). Assignment to the full condition was then suspended and participants were randomly assigned between the remaining conditions. The ‘waste’ condition was only latterly added to study 1 and, as such, the final 25 participants of this study were directly assigned to this condition.

[4] Participants were not provided with a demand reduction option. While demand reduction will play a role in increasing energy security and decreasing carbon emissions, within these studies our focus was on generation and how people would make trade-offs between available generating options.

[5] These figures were based upon those provided to participants in the NP consultation and reflected the UK electricity generation mix as it stood in 2006 (see DTI, 2007b), with three exceptions: (1) oil (which accounted for just 1% of electricity in 2006) was combined with coal (the largest contributing fossil-fuel source) to form a single category (i.e. coal); (2) The figures provided within the consultation only equated to 99%. Thus, an additional 1% of generating capacity was added to the 'others' category to round up total generation to 100%; and (3) Because we wished to see how people would make trade-offs between specific energy-source options, the 'others' category was referred to as 'electricity import' on account of the fact that direct import of electricity from continental Europe (via interconnectors) accounted for the largest unique proportion of this 'others' category at the time of the consultation.

[6] Univariate tests were used on account of the dependence of energy-source decisions upon one-another within the electricity calculator task. In short, by the fact that a reduction in the use of one energy-source necessitated an equivalent increase in the inclusion of one or more of the other sources, we did not have the degrees of freedom required to perform a more general 4 (framing condition) x 5 (energy source) repeated measures ANOVA. Planned simple contrasts enable the assessment of whether mean responses registered in certain conditions (e.g. experimental conditions) differ significantly from a specified comparison condition (e.g. control condition).

[7] Open-day participants were tested in groups of 6-12. Participants in each group completed the task simultaneously although each sat at their own individual computers. In the UK, sixth-form students are students in their final two years of study before moving into higher education or employment. They are typically 16-18 years of age.

[8] This analysis was concerned with identifying any statistically significant differences between the experimental framing conditions and the 'control' condition. These are the important comparisons for illustrating the influence of the key pro-/anti-nuclear arguments on electricity mix decisions beyond any influence evoked by a simple consideration of NP as a source of energy. Thus, while there were frame-consistent trends in the differences between participants' preferences for NP in the 'waste' (15.4%)

condition compared to the 'climate' (23%) and 'security' (21.5%) conditions, the fact that these values did not differ significantly from the 'control' condition (19.7%) is evidence for the weak impact that the experimental framing was having on participants' preferences for NP within this study.

[9] This figure accounts for all participants approached within the national survey. Spence et al. (2010) report upon the unweighted dataset (N = 1822).

[10] Study 3 was conducted around 2-years after study 1; however, in order to maintain the broader comparability of the studies, the same status quo figures used in study 1 were again utilized in study 3.

[11] The results from the anchored paradigm testify the importance of having a suitable control condition. Without this control condition, the elevated use of NP within the 'climate' condition vs. the 'security' condition could have been misconstrued as evidence of a direct pro-nuclear framing effect.

[12] It is possible that other trends (e.g. the trend in coal use) might have achieved significance with a greater number of participants; however, the nature by which the sample was obtained (i.e. in association with a national survey) precluded further recruitment to this particular study.

[13] Both websites last accessed on 3rd March 2011.