

Public Perceptions of Climate Change and Energy Futures Before and After the Fukushima Accident: A Comparison between Britain and Japan

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Abstract

The threats posed by climate change call for strong action from the international community to limit carbon emissions. Before the Fukushima accident that followed the earthquake and tsunami on 11 March 2011, both Britain and Japan were considering an ambitious expansion of nuclear power as part of their strategy to reduce carbon emissions. However, the accident may have thrown nuclear as a publicly acceptable energy technology into doubt. This study uses several nationally representative surveys from before and after the Fukushima accident to examine how it may have changed public perceptions of climate change and energy futures in Britain and Japan. The study found that already before the accident the Japanese public were less supportive of nuclear power than the British. Whereas British attitudes have remained remarkably stable over time, the Japanese public appear to have lost complete trust in nuclear safety and regulation, and have become less accepting of nuclear power, even if it would contribute to climate change mitigation or energy security. In Japan the public are now less likely to think that any specific energy source will contribute to a reliable and secure supply of energy. The implications for energy policy are discussed.

Key Words: Fukushima; Public Perceptions; Nuclear Power; Climate Change; Cross-Cultural Comparison

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Introduction

Background

Climate change is arguably the greatest challenge the world is currently facing. The threats posed by climate change calls for strong action from the international community to limit Greenhouse Gas (GHG) emissions. Both UK and Japan Governments have set themselves ambitious long-term domestic targets that go well beyond the Kyoto Protocol. The UK Climate Change Act 2008 provides a legally binding target of an 80% reduction in GHG emissions by 2050, with an interim target of 34% by 2020. Japan's policy is to achieve an emission reduction of 25% by 2020 and 80% by 2050. These targets necessitate fundamental changes to the way energy is used and produced, and are unlikely to be met without widespread engagement and approval from the general public. Not only does the public need to personally change their behaviour in order to reduce energy consumption and to comply with wider policies aimed at motivating these changes, they also need to accept new low-carbon technologies and facilities to de-carbonise their energy use (Spence & Pidgeon, 2009).

Within this context, nuclear power has in recent years been promoted as a low-carbon technology that may help to mitigate climate change and at the same time increase energy security (Bickerstaff et al., 2008). While arguments regarding the role of nuclear power in delivering a secure supply of energy have been made since the oil crises in the 1970s, it is only since the early 2000s that nuclear power has been framed explicitly as a means to address climate change (Pidgeon et al., 2008). Over the last decade various industry and government actors in the UK, as well as a number of prominent environmentalists, including James Lovelock (2004) and George Monbiot (2009), have expressed support for new nuclear built to help combat climate change. Previous studies suggest that this reframing argument has resulted in some changes in public attitudes towards nuclear power over the past decade. A significant proportion of the British public is now willing to '*reluctantly accept*' nuclear power as a means of addressing the greater threat of climate change (e.g. Pidgeon et al., 2008; Corner, et al., 2011). However, while the public is willing to consider the nuclear option, it is not embraced wholeheartedly. It has therefore been suggested that this 'conditional support' is fragile. Pidgeon et al. (2008) argued that, in the absence of any major accident since Chernobyl, the public may have become less attentive to the risks of nuclear power, and that latent concerns are likely to re-emerge in case of major accident, possibly amplified with considerable force.

Nuclear energy has for a long time been a national strategic priority in Japan and was one of the main pillars of Japan's policy to achieve future carbon emission reductions. The 2010 Strategic Energy Plan committed to radical reductions in GHG emissions through investments in renewable energy, the promotion of energy conservation, and an ambitious expansion of Japan's nuclear energy generating capacity from 26% in 2010 to nearly 50% in 2030 (Cyranoski, 2012). However, the accident at the *Fukushima Dai-ichi* nuclear power plant that followed the devastating *Great East Japan earthquake and tsunami* on the 11th of March 2011 has thrown nuclear power as a publicly acceptable energy technology into doubt.

Before the accident, public support and trust in the regulation of nuclear power had already been seriously tested following a series of accidents in Japan, most notably the criticality accident at the *Tokai-mura* uranium reprocessing facility killing two workers (and exposing many others to high doses of radiation), the steam explosion at *Mihama* nuclear power plant killing 4 workers and injuring 7 more, and the leakage of radioactive water from the *Kashiwazaki-Kariwa* nuclear power plant after the 2007 Chūetsu offshore earthquake (Cyranoski, 2010). Various scholars have argued that these accidents show that the Japanese Government and the nuclear industry have been far too lax in the development and operation of nuclear policies and facilities, and that public safety has not been their main priority (Nkamura & Kikuchi, 2012; NAIIC, 2012). Indeed, at the turn of the century, after a series of accidents, public support for nuclear power reached an all-time low in Japan, as did trust in Japan's nuclear energy policy (OECD, 2010).

The investigations into the causes of the Fukushima disaster show that public distrust in the safety and management of nuclear power installations was to some degree warranted. Both the investigation of the privately funded *Rebuild Japan Initiative Foundation* and the *NAIIC⁽¹⁾ investigation* ordered by the National Diet of Japan concluded that Fukushima was a man-made disaster rather than caused directly by the earthquake and ensuing tsunami (Funabashi & Kitazawa, 2012; NAIIC, 2012). The reports suggest that, notwithstanding the complexity of the situation or the cascading effects of the unfolding emergency, the Fukushima accident was ultimately preventable (Funabashi & Kitazawa, 2012). That is, all the direct causes of the accident were foreseeable prior to the accident. However, the operator, Government, and regulators failed to meet the most basic safety requirements or to put appropriate procedures and training in place for an effective response to critical situations (NAIIC, 2012). The conclusions of the independent commissions are likely to have further eroded public trust in the safety and management of the nuclear power stations. Earthquakes and tsunamis are unpredictable but unavoidable events in Japan and should therefore have been central to any risk assessment and emergency planning in nuclear installations. However, even after a number of nuclear accidents in the 1990s and 2000s, some of which were triggered by an earthquake, the industry and its regulators failed to ensure that appropriate emergency procedures were in place (NAIIC, 2012).

After the Fukushima accident all Japan's nuclear power plants have either been closed or had their operation suspended for safety inspections and maintenance, leaving Japan temporarily without nuclear-produced electricity in 2012. The announcement of the decision to restart two nuclear reactors led to – for Japan – unprecedented demonstrations (BBC, 2012), showing the extent of public opposition and distrust in the safety and management of nuclear power in the wake of Fukushima accident. While there have been sizable and well-organised anti-nuclear movements in both Europe and the US since the 1970s, the anti-nuclear movement in Japan has generally been smaller than its Western counterparts and tended to focus on military applications of nuclear technology rather than civilian nuclear power (Valentine & Sovacool, 2010; Hasegawa, 2011). The Fukushima accident and – perhaps more importantly – the nationwide loss of trust in Japan's nuclear industry and government, may have sparked the beginning of a better organised anti-nuclear movement

⁽¹⁾ National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission

resisting the use of civilian nuclear technology. This may have profound consequences for the future direction of Japan's energy policy, as shown by the relative success of anti-nuclear movements in the US and Europe to slow down the expansion of nuclear power (Hasegawa, 2011). Indeed, in a dramatic departure from its pre-Fukushima energy policy, the Japanese Government unveiled in September 2012 plans to phase out nuclear power before 2040 –although it declared a number of days later that Japan's future energy policy would be developed “*with flexibility based on tireless verification and re-examination*”, leaving open the option of continuing Japan's existing nuclear power plants. This shows that Fukushima has fundamentally changed the debate on the role of nuclear power in Japan's future energy mix and strained the relationship between the general public and the Japanese Government. However, the change in policy can of course not solely be attributed to the influence of public opinion.

The accident at the Fukushima Dai-ichi nuclear power plant has had ramifications beyond Japan, substantially reshaping nuclear agendas and policies across the world (Jorant, 2011). This is perhaps most dramatically shown in Germany's decision to phase out nuclear power by 2022 in response to continuing public opposition and demonstrations in the wake of the accident – thereby revoking recent preceding policy decisions to continue its use (Pfister & Böhm, 2012). While Germany has already established itself as a leader in renewable energy technology and generation (Wittneben, 2012), it will face major challenges in replacing the lost capacity by other forms of low-carbon energy generation in order to meet its carbon reduction targets. In contrast, UK policymakers remain fully committed to their decision to increase the share of nuclear power in the energy mix. These show very different policy responses to one of the most serious nuclear accidents in history. The UK Office for Nuclear Regulation concluded that “*In considering the direct causes of the Fukushima accident we see no reason for curtailing the operation of nuclear power plants or other nuclear facilities in the UK*” (cited in Butler et al., 2011). Crucially, this was before the damning conclusions of the independent investigations that the Fukushima accident was a man-made rather than a natural disaster. UK policy makers however still consider nuclear power as an important part of the transition to a low-carbon economy (Schneider et al., 2012).

If Japan is to phase out nuclear from its energy mix, it is imperative that the lost capacity is met by other low-carbon sources so that it still can meet its carbon reduction targets. Japan has seen a substantial increase in carbon emissions as it has been forced to import more oil and natural gas to fill the energy gap created by the shutdown of its nuclear power stations. A continued reliance on oil and natural gas may call into question Japan's ability to reduce CO₂ emissions by 25% by 2020. If conventional fossil fuels were to replace nuclear in the longer term, CO₂ emissions would soar by between 60 and 250 million tonnes (IEE, 2012). This shows the need for the development of other low-carbon technologies to avoid the shortfall in energy generating capacity is being met by high-carbon alternatives, such as coal and oil. While there are other low-carbon scenarios that can lead to the targeted carbon reductions in Japan, including the large-scale deployment of renewable sources and energy demand reduction (e.g. Shimada et al., 2007; Fujino et al., 2008), these alternative pathways need to be supported by the general public as well. Case studies from around the world have shown that community opposition can lead to delays or even cancelation of the deployment and siting of low-carbon energy technologies (Pidgeon et al., 2008), while

mitigating climate change through energy demand reduction requires serious commitment from the general public to change their own behaviour (Poortinga et al., 2012).

The Research

In this study we compare public perceptions of climate change and energy futures in Britain and Japan using a series of quantitative surveys that were conducted at different stages before and after the Fukushima accident. This comparison is conducted to identify how the Fukushima accident may have changed public opinion on climate change and nuclear power in the two countries, as well as the acceptability of alternative energy options. These cross-cultural comparisons are relevant, as nuclear power was part of both Britain's and Japan's strategy to achieve future carbon emission reductions. While Fukushima is likely to have seriously affected Japanese public attitudes to nuclear power, its impact on British public opinion is less clear. While the studies were conducted for a number of reasons and under different circumstances, they all contained items that can be used for cross-national comparisons. The datasets include the "*Public Risk Perceptions, Climate Change and Reframing of UK Energy*" and "*Public Perceptions of Climate Change and Energy Choices in Britain*" surveys that were conducted in Britain in 2005 and 2010 respectively. The third British dataset is a survey commissioned by the British Science Foundation (BSA) in 2011 as part of the British Science festival. These British surveys will be compared with a series of nation-wide public opinion surveys conducted in 2007 and 2011 in Japan. The surveys covered widely similar topics and items, although not all items were included in each of the surveys. We therefore will only make cross-national and pre and post Fukushima comparisons where possible. Although these comparisons are admittedly crude – as the studies were not specifically designed to examine the impacts of Fukushima – the surveys are the only nationally representative datasets that are available for that purpose. Box A provides details of the five datasets. The studies will be referred to as GB2005, GB2010 and GB2011, and JP2007 and JP2011, respectively.

Box A: The Surveys

GB2005: The first British survey was conducted between 1 October and 6 November 2005. A national representative quota sample of 1,491 people aged 15 years and older was interviewed face-to-face in their own homes by the market and opinion research company MORI (see Poortinga et al., 2006 for more details).

GB2010: The second British survey was conducted between 6 January and 26 March, 2010. A nationally representative quota sample of the British population aged 15 years and older (i.e. England, Scotland and Wales; n=1,822) were interviewed face-to-face in their own homes by trained Ipsos-MORI interviewers (see Spence et al., 2010 for more details).

GB2011: The third British survey was conducted between 26 August 2011 and 29 August 2011. Populus interviewed a random sample of 2,050 adults online and subsequently weighted the sample to make it representative of the British adult population. The data were collected by the British Science Association (BSA) for the 2012 British Science Festival.

JP2007: The first Japan survey was conducted between 11 and 28 January 2007 (which is in the 2006 Fiscal Year). The data collection was done by Shin Joho Center Inc. A nationally representative sample of 959 people aged 20 years and older was interviewed face-to-face in their own homes.

JP2011: The second Japan survey was conducted between 7 and 24 of July 2011. A quantitative survey was undertaken nation-wide in Japan by Central Research Services Inc. A nationally representative sample of 1,399 people aged 20 years and older was interviewed face-to-face in their own homes (Aoyagi et al., 2011).

Results

Public Perceptions of Climate Change

Table 1 shows public perceptions of the reality of climate change in Britain and Japan respectively. In 2005 an overwhelming majority (91%) of the British public thought that the world's climate is changing. This majority dropped significantly to 78% in 2010. At the same time, the group of individuals who expressed trend sceptical views, i.e. those who do not think that the world's climate is changing, grew from 4% in 2005 to 15% in 2010 (Poortinga et al., 2011).

No major differences were found in Japan between 2007 and 2011. In 2007 an overwhelming majority (95%) of the Japanese public thought that the world's climate is changing, with only very few (3%) thinking it was not. A similar pattern was found when the survey was repeated in 2011: while 92% thought that the world's climate is changing, 5% thought it is not.

Table 1. As far as you know, do you personally think that the world's climate is changing (in %).

		Yes	No	Don't Know
Great Britain	2010 (n=1,822)	78	15	6
	2005 (n=1,491)	91	4	5
Japan	2011 (n=1,339)	92	5	3
	2007 (n=911)	95	3	2

Note: The percentages in the table may not always add up to 100% due to rounding.

These results show that, while trend scepticism has gained some ground in Britain, it is still virtually non-existent in Japan. It is however important to note that, despite the increase, trend scepticism still not very common in Britain either. Furthermore there are indications that the observed drop in public belief in climate change in 2010 is due to a unique convergence of circumstances, including '*climategate*' and the *economic downturn*. The most recent evidence suggests that the decline in public belief in climate change has been temporary, and may be returning to higher levels of concern. Given that the economic downturn is still ongoing, it may take some time before concerns reach pre-crisis levels (Whitmarsh et al., under review).

Attitudes to Different Forms of Electricity Generation

Attitudes to different form of electricity generation were assessed differently in Britain and Japan. Whereas respondents in Britain were asked *how favourable or unfavourable their overall opinions or impressions are of the different forms of electricity generation*, in Japan they were asked *to what degree they agreed that the different forms of electricity generation will make a substantial contribution to reliable and secure supplies of electricity in Japan in the future*. The results in Britain are therefore more likely to reflect a person's general affective response to the different energy sources, while in Japan they are more likely to represent expectations regarding future electricity generation. As affective responses tend to be more stable over time than cognitive responses (e.g. Diener & Larsen, 1984), it can be expected that the Japan results are more changeable and will more closely track changes in energy policy. Despite these differences, we will report the findings for the two countries so that we will be able to track opinions regarding the different form of electricity generation over time in both Britain and Japan without claiming to make cross-national comparisons.

Figure 1a. How favourable are your overall opinions or impressions of the following energy sources for producing electricity currently (% mainly or very favourable)

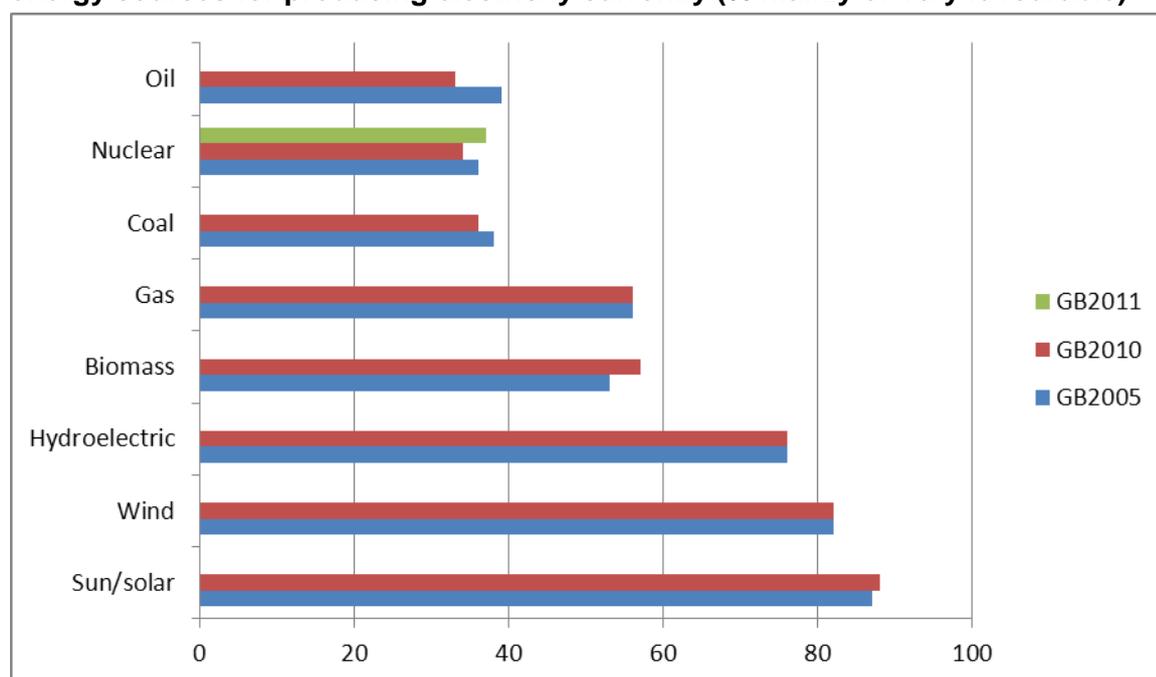


Figure 1a shows that the overall patterns of favourability judgments were to a large extent comparable in 2010 and 2005. Overall, the renewable options were regarded most favourably (solar, wind hydroelectric), followed by biomass and gas. Nuclear and fossil fuels were by far the least favoured forms of electricity generation. Biomass was perceived slightly more favourably, while oil was perceived slightly less favourably in 2010 as compared to 2005. Figure 1a also shows that only around a third of the British public had mainly or very favourable impressions of nuclear power in 2005, 2010, and 2011, and that these impressions remained surprisingly stable over the six year period. These results suggest that the Fukushima accident has had no substantive impact on the perceived favourability of nuclear power in Britain.

Figure 1b. To what extent do you agree or disagree that the following energy sources will make a substantial contribution to reliable and secure supplies of electricity in Japan (% tend to/strongly agree)

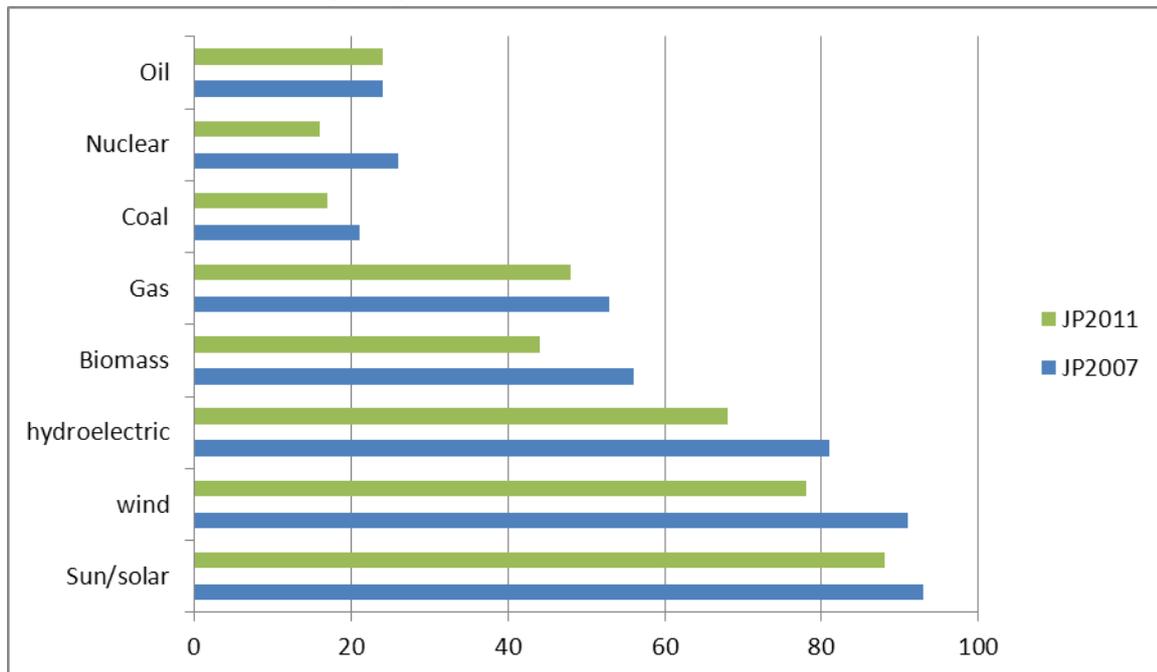


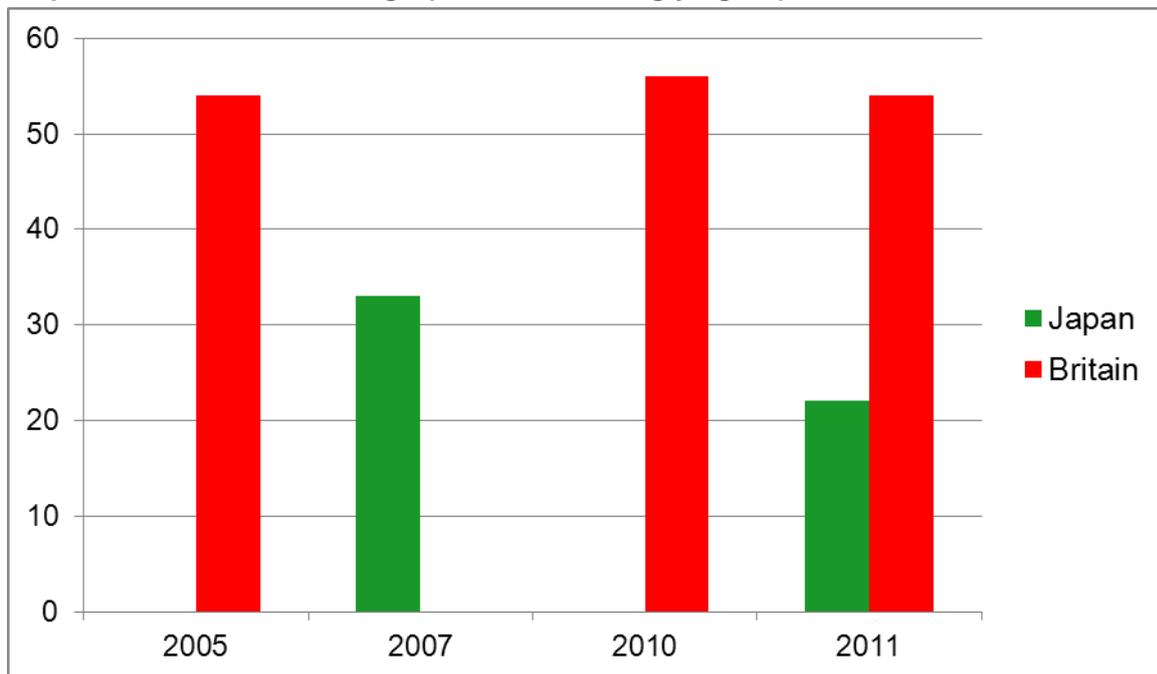
Figure 1b shows the level of agreement that the different energy sources will make a substantial contribution to reliable and secure supplies of electricity in Japan in the future. The overall pattern of responses is comparable to the one observed for Britain. In 2007, a clear majority of the Japanese public thought that sun/solar, wind and hydroelectric power will make a substantial contribution to reliable and secure supplies of energy in Japan, followed by biomass and gas. A minority of less than 30% thought that nuclear, oil and gas will make a substantial contribution to energy security.

Fewer people in 2011 than in 2007 thought that any of the eight energy sources will make a substantial contribution to energy security in the future. The biggest decrease was found for renewables (in particular wind, hydroelectric and biomass) and nuclear power. The results regarding nuclear power are perhaps not surprising in the light of the Fukushima accident and the consequent shutdown of most nuclear power stations in Japan. However, the other changes are more difficult to interpret. The most likely explanation is that the Japanese public think that renewables may not be sufficient or cannot be developed fast enough to plug the energy gap left by the closure of nuclear power plants. It is also a possibility that the results reflect more generic concerns regarding energy security, considering there was a reduction for all eight energy sources.

Attitudes to Nuclear Power

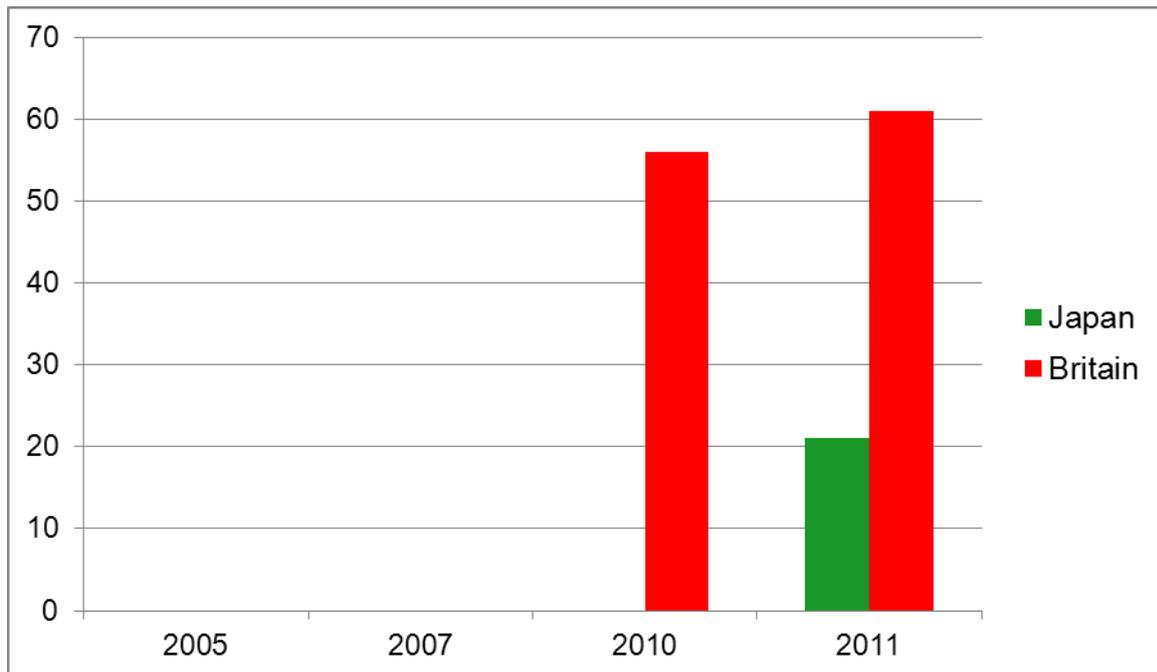
The surveys in Britain and Japan contained a variety of items to assess different aspects of public attitudes towards nuclear power, including 'conditional support' for nuclear power in the context of climate change and energy security (see Corner et al., 2011). Figure 2 shows that more than half of the British population are willing to accept the building of new nuclear power stations if it would help to tackle climate change. In contrast, conditional support for nuclear power in Japan dropped from just over 30% in 2007 to just over 20% in 2011.

Figure 2. I am willing to accept the building of new nuclear power stations if it would help to tackle climate change (% tend to/strongly agree)



These results suggest a number of things. First, in Japan there is lower level of support for nuclear power than the UK. Already before the accident the Japanese public were less supportive of nuclear power than the British, even if it would contribute to climate change mitigation. This can best be explained by the series of nuclear incidents and accidents that took place throughout the 1990s and 2000s. Second, the British public appear more receptive to the reframing argument than the Japanese public. Third, while conditional support for nuclear power as a solution to climate change remained surprisingly stable in Britain over a six year period, it decreased significantly in Japan in the wake of the Fukushima accident.

Figure 3. I am willing to accept the building of new nuclear power stations if it would help to improve energy security (% tend to/strongly agree)



The GB2010, GB2011 and JP 2011 surveys included a similar question on conditional support for nuclear power in the context of energy security. Figure 3 shows that more than half of the British public are willing to accept the building of new nuclear power stations if it would help to improve energy security. Only around 20% of the Japanese public agreed with this statement in 2011. This again shows that 'conditional support' for nuclear power is much higher in Britain than in Japan. Although no pre-Fukushima data is available for Japan, the similarities with the previous item suggest that the accident may also have dampened public Japan's enthusiasm for nuclear power, irrespective of its contribution to climate change and/or energy security. In contrast, conditional support for nuclear power in the context of energy security even appears to have increased in Britain after the Fukushima accident.

Figure 4 shows that a majority of both the British and Japanese publics agree that we shouldn't think of nuclear power as a solution for climate change before exploring all other energy options. This illustrates that, even if many people in Britain are willing to consider nuclear power to tackle climate change, they still think there are better alternatives. Overall, the responses to the different items suggest that many people in Britain 'reluctantly accept' nuclear power (cf., Bickerstaff et al., 2008; Corner et al., 2011). Attitudes in Japan cannot be characterised as 'reluctant acceptance', as – in contrast to Britain – support for nuclear power is low, even in the context of climate change and energy security. In Japan, agreement that all other energy options should be explored before considering nuclear power remained at the same high after the Fukushima accident. No post Fukushima data on this item is available for Britain. Figure 4 suggests that public preferences for alternative energy options over nuclear power are fairly stable in both Britain and Japan. Responses to other questions (not reported here) show that both the British and Japanese publics think that renewable energy sources and lifestyle changes/energy efficiency are better ways of tackling climate change than nuclear power

Figure 4. We shouldn't think of nuclear power as a solution for climate change before exploring all other energy options (% tend to/strongly agree)

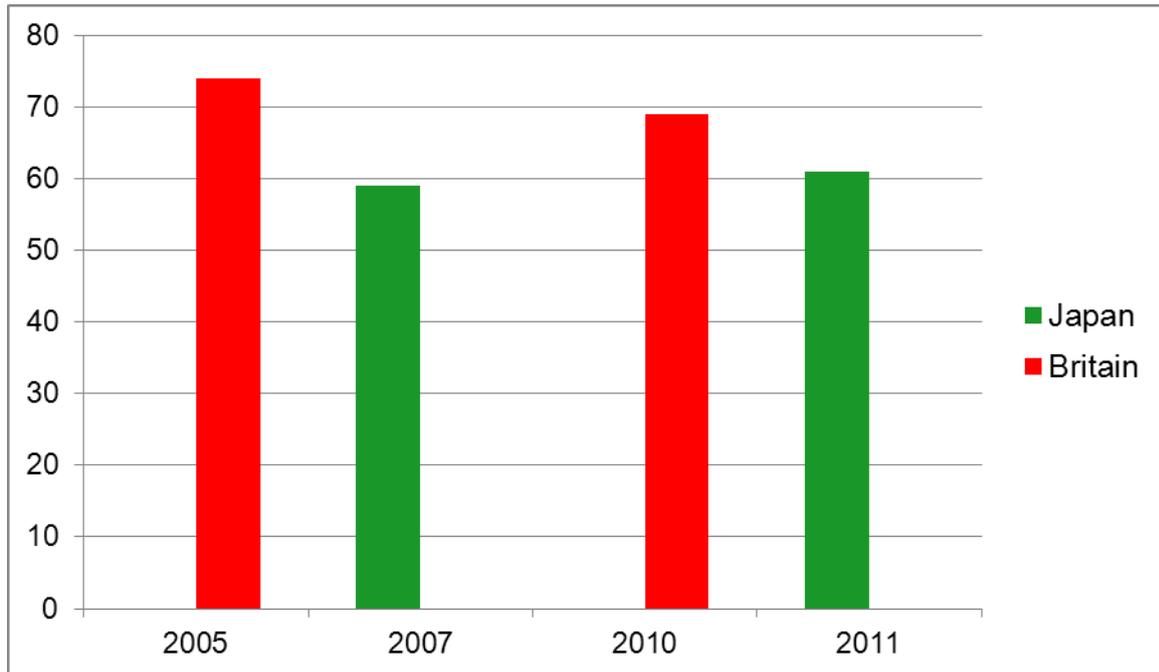


Figure 5. If we had safer nuclear power stations, I'd be prepared to support new ones being built (% tend to/strongly agree)

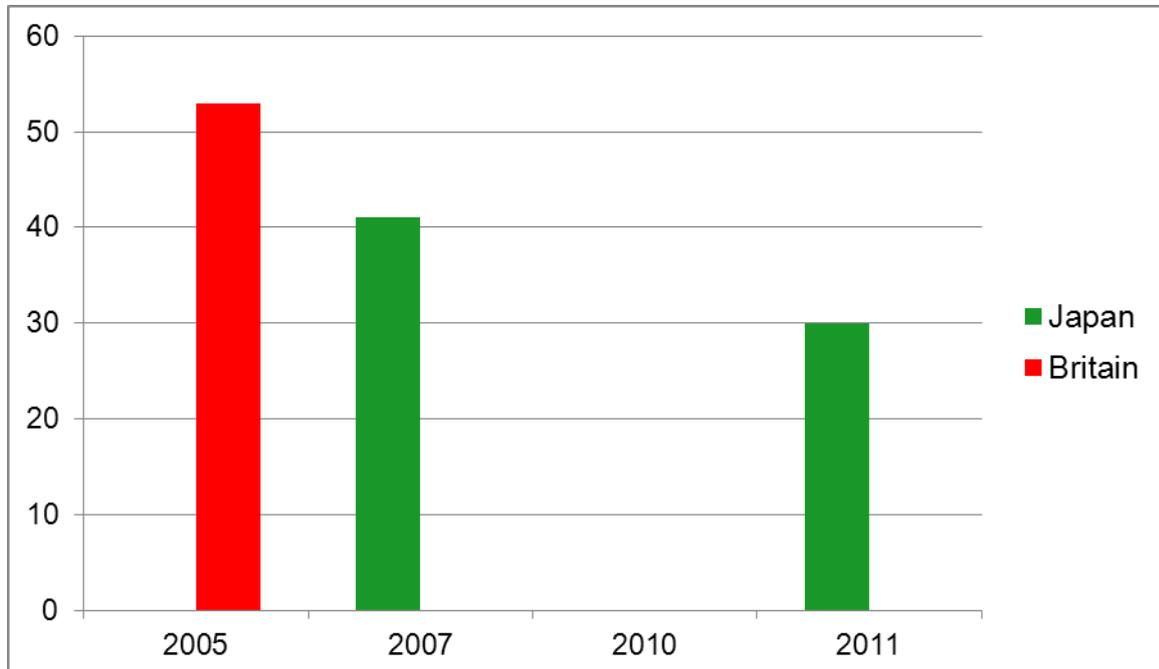
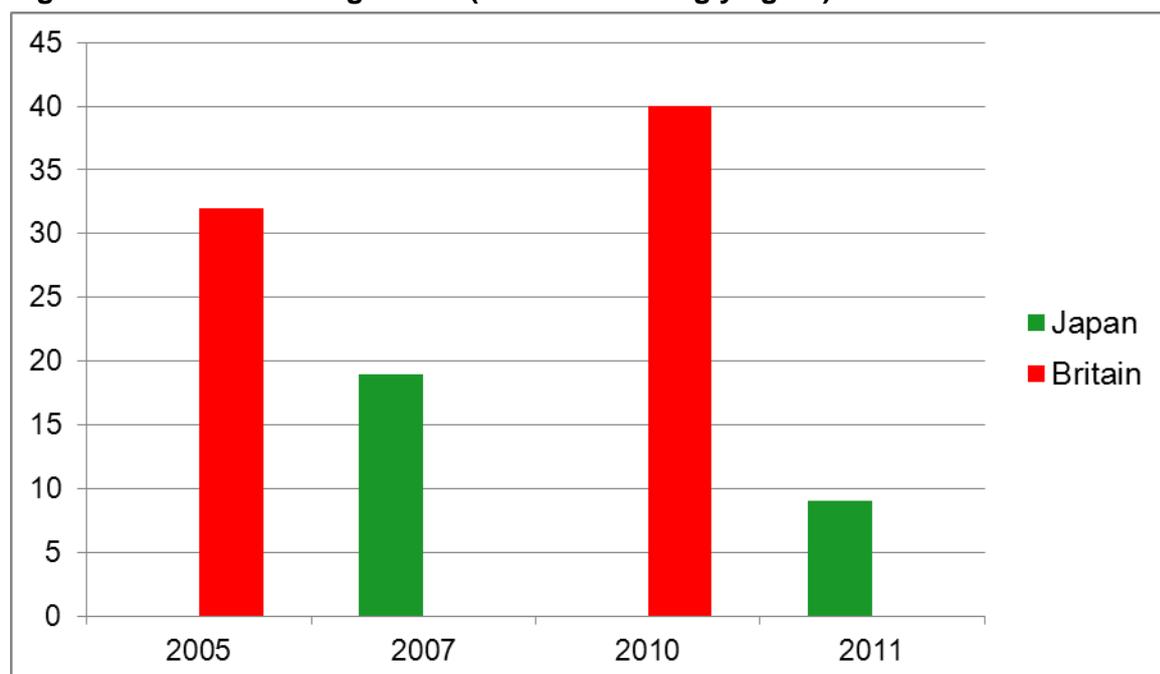


Figure 5 presents agreement in Britain and Japan with the statement “If we had safer nuclear power stations, I’d be prepared to support new ones being built”. Comparison between the GB2005 and JP2007 surveys shows that more people in Britain than in Japan are willing to support nuclear power if it is safe. In Japan, agreement with the statement decreased from 41% in 2007 to 30% in 2011, probably reflecting both a loss of trust in the safety of nuclear power and a drop in support for new nuclear built. No post Fukushima data on this item is available for Britain

Figure 6 shows the responses to a number of items that were used to assess public trust in the regulation of nuclear power plants. Although different items were used in Britain and Japan (see Appendix), the results are presented to show changes over time in the two countries. Furthermore, the similarity in responses and high correlation between the two items in the GB2005 survey ($r=0.65$; Cronbach’s $\alpha=0.79$) suggests that they capture largely the same thing, and that therefore the items may tentatively be used to make cross-national comparisons over time.

Figure 6. Trust in risk regulation (% tend to/strongly agree)²



² Different questions were asked in Great Britain and Japan. GB: “I feel confident that the British Government adequately regulates nuclear power”; JP: “I feel that current rules and regulations are sufficient to control nuclear power”.

Trust in the British government to adequately regulate nuclear power increased from 32% in 2005 to 41% in 2010. In contrast, trust in current rules and regulation decreased in Japan from 19% in 2006 to 9% in 2011. While trust in the regulation of nuclear power was already low in Japan before the accident, it collapsed to an even lower level after the Fukushima accident. Although no post-Fukushima data is available for Britain, responses to an alternative trust question (“How confident or unconfident are you that the UK is prepared to handle a major nuclear accident if one were to happen in one of our existing power facilities”) suggests that there is still a considerable level of trust in the management of nuclear power after the accident (31% responded to be fairly or very confident).

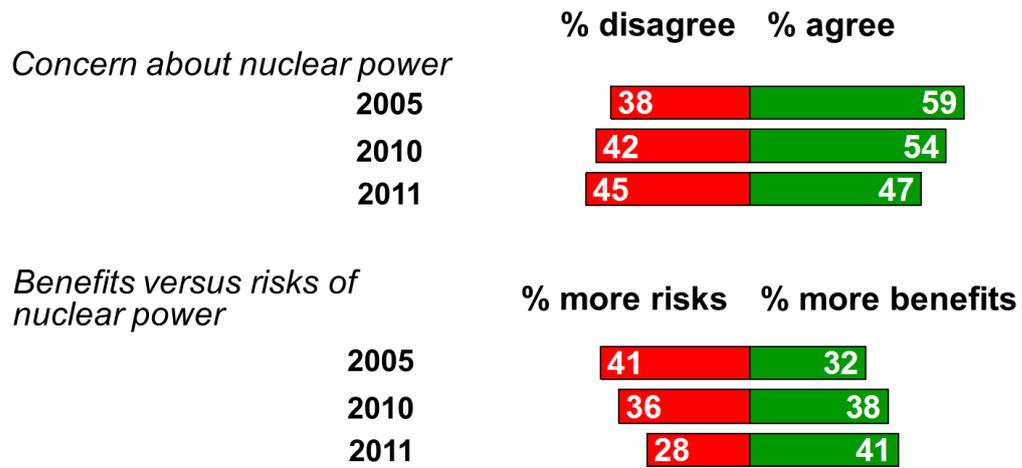
In addition to the items described above, the three British surveys included a number of questions that can be used to show the development of public attitudes to nuclear power over a six year period from before to after the Fukushima accident. Table 2 shows that in 2005 and 2011 a similar number of people want to continue nuclear power in Britain. It also shows that, while overall support for the continuation of nuclear power stayed the same, more people thought that the number of nuclear power stations should be increased *after* the Fukushima accident. Overall, the number of people wanting to phase out nuclear power decreased from 2010 to 2011, with more people now using the “don’t know” or “none of these” options.

Table 2. Which, if any, of the following statements most closely describes your own opinion about nuclear power in Britain today? (in %)

	GB2005	GB2010	GB2011
We should increase the number of power stations	9	17	23
We should continue using the existing NP stations and replace them with new ones when they reach the end of their life	34	29	21
We should continue using the existing NP stations but <u>not</u> replace them with new ones when they reach the end of their life	34	33	21
We should shut down all existing NP stations now and not replace them with new ones	15	13	11
Don't know/none of these	7	7	14

Figure 7 shows that concern about nuclear power has decreased substantially between 2005 and 2011. Fewer people are fairly or very concerned about nuclear power *after* the Fukushima accident as compared to before. Similarly, Figure 7 shows that fewer people perceive the risks of nuclear power to outweigh the benefits of nuclear power *after* than *before* the Fukushima accident. Accordingly, more people perceived the benefits of nuclear power to outweigh the risks after than before the Fukushima accident. These results paint a picture of attitudes towards nuclear power having softened over the years, and suggest that Fukushima has not substantially changed attitudes to nuclear in Britain. If at all, the British public has become more positive about nuclear power in the wake of the accident.

Figure 7. (a) Concern about nuclear power, and (b) Perceived benefits and risks of nuclear power



Main Findings and Conclusions

This report describes the findings of a number of British and Japanese surveys on public perceptions of climate change and energy futures that were conducted at different stages before and after the Fukushima accident. The nationally representative surveys contained a variety of items that can be used for cross-national comparisons between Britain and Japan, to explore how the Fukushima accident may have changed public attitudes to nuclear power in the context of energy security and climate change.

The comparison found that public belief in the reality of climate change is high in both Britain and Japan. While trend scepticism increased significantly in Britain between 2005 and 2010 (also see Poortinga et al., 2011), it was virtually non-existent in Japan in 2007 as well as in 2011. The study does not include more recent (i.e. post-Fukushima) data on public perceptions of climate change in Britain. The most recent evidence suggests that the observed decline in belief in climate change was caused by a unique convergence of circumstances, and that public perceptions may be returning to higher levels of concern (Whitmarsh et al., under review). Further research should provide more clarity about how perceptions of climate change have developed over time, in particular in the wake of the Fukushima accident. The indications for Japan are that, notwithstanding the high levels of belief in the reality of climate change, concerns about its risks may have taken second place to other more immediate and devastating risks and concerns (Nakayachi, 2012). While it is unlikely that concerns about Fukushima will have pushed out concerns about climate change in the UK, ongoing concerns about the economy may still divert attention from environmental issues (cf., Weber, 2006). Recent research found that elite cues and structural economic factors as expressed in news coverage have the largest effect on the level of public concern about climate change (Brulle et al., 2012). Expanding the time series together with detailed media analysis would improve our understanding of the dynamics of public opinions about climate change in relation to other issues.

There were distinct differences in public attitudes towards nuclear power in between Britain and Japan. The results show that the Japanese are generally far less supportive of nuclear power and have lower levels of trust in the regulation of nuclear power than the British. The differences between the two countries were already apparent before the Fukushima accident and have become even more pronounced after. The Japanese public are less willing to accept the building of new nuclear power stations, even if it would help to tackle climate change or improve energy security, and are more likely to consider renewable energy sources and lifestyle changes/energy efficiency as better ways to tackle climate change. It is likely that a history of nuclear accidents in Japan has contributed to the initial lower levels of support and trust (Cyranoski, 2010). The Japanese nuclear industry and its regulators have not shown great regard for the safety of the general public, as concluded by the public investigations into the causes of the Fukushima accident (e.g. NAIIC, 2012). Furthermore, despite nuclear power playing an important part in Japan's strategy to reduce their CO₂ emissions before the Fukushima accident, the reframing argument has not been made as explicitly in Japan as in the UK media (cf., Doyle 2011). In contrast, the lack of any visible accidents in the UK and Europe may have made the British public less attentive to the risks of nuclear power and perhaps as a result more open to the reframing argument. Research in

Britain suggests that even environmentally concerned individuals are receptive to the reframing argument, if reluctantly so (Corner et al., 2011).

Although it is recognised that the available data are not sufficient to determine the long-term impacts of Fukushima on public opinion in the two countries, it is clear that the British and Japanese publics have responded very differently to the accident, just as their respective governments. Whereas British attitudes towards nuclear have remained remarkably stable over the years, and even appear to have softened somewhat in the wake of the accident, Japanese attitudes have changed dramatically. There is a clear need to establish the long-term impacts of the Fukushima accident. The collapse in public trust in the safety and regulation of nuclear power may have far-reaching implications for Japan's energy and environmental policies. The demonstration in mid-2012 show the challenge Japanese authorities are facing to re-establish its nuclear energy generating capacity. The notion that trust is difficult to regain once it is lost (Slovic, 1993; Poortinga & Pidgeon, 2004) suggests that public opposition to nuclear power is likely to remain strong in Japan for some time to come.

It is not clear as to why the Fukushima accident has not negatively impact upon public attitudes in Britain. It was expected that latent concerns about the risk of nuclear power would re-emerge in the case of a major accident (Pidgeon et al., 2008). However, these expectations did not materialise. A possible explanation is that some may think that the perceived causes of the accident (i.e. earthquake and tsunami) are not likely to occur in Britain (cf., Butler et al., 2011), while a lack of radiation-related fatalities may have convinced others that nuclear technology is safe (cf., Monbiot, 2011). This does however not take into account the loss of life as a direct result of the evacuation of vulnerable elderly patients (Tanigawa et al., 2012) and the conclusions of the independent Rebuild Japan and NAIIC investigations that Fukushima was a man-made disaster rather than a natural one (Funabashi & Kitazawa, 2012; NAIIC, 2012). There is a need to further explore the processes that underlie the apparent robustness of British attitudes in light of a major nuclear accident. Research conducted after the Chernobyl disaster suggests that the public use various 'defensive attributions' in order to make them feel safe (Eiser et al., 1989; Van der Pligt, 1993). Eiser and colleagues (1989) found that post-Chernobyl attitudes were closely related to alternative interpretations of the accident (i.e. if the cause of the accident was attributed to specific aspects of the reactor, modes of operation, or context OR nuclear technology in general). Similar processes may have contributed to the 'rebound' in public support for nuclear power in Britain (see Ipsos MORI, 2012). It is likely that the causes of Fukushima have been attributed to specific conditions (i.e. earthquake and tsunami) that are not common to Britain, and that the conclusions of the independent investigations have not filtered through to the British public.

Although different questions were used to assess public attitudes towards different forms of electricity generation in Britain and Japan, the pattern of responses were remarkably similar. Overall, renewable sources were perceived most favourably; while fossil fuels and nuclear power were perceived least favourably. In Britain, favourability ratings of the different forms of electricity generation remained stable between 2005 and 2010. In Japan, however, the public were less likely to think that any specific energy source will contribute to a reliable and

secure supply of energy in the future after the Fukushima accident. While the perceived reduced contribution of nuclear power may reflect the government's commitment to reduce Japan's reliance on nuclear power, it is less clear as to why the public are now less certain about the contribution of the other sources to energy security. The finding that *all* energy sources are now thought to be less able to contribute to a reliable and secure supply of energy suggests more generic concerns about fixing the energy shortfall in the short term and creating systemic energy security in the longer term. Japan currently stands at an important crossroads that will determine its future in energy generation and use. Our research has shown that nuclear energy is no longer a publicly acceptable option in Japan. The Japanese public have understandably become wary of the risks of nuclear power in earthquake and tsunami-prone areas and appear to have completely lost trust in the government and industry to manage nuclear power plants safely. The question now is which alternative direction energy policy should take according to the general public. While there are several alternative pathways to a low-carbon Japan, these need to be supported and accepted by the public as well. Further quantitative and qualitative research is needed to determine the public acceptability of the different energy futures, while public involvement in all steps of the decision-making process is necessary to create socially acceptable solutions.

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Appendix

Public Perceptions of Climate Change

As far as you know, so you personally think that the world's climate is changing (in %).

		Yes	No	DK
Great Britain	2010 (n=1,822)	78	15	6
	2005 (n=1,491)	91	4	5
Japan	2011 (n=1,339)	92	5	3
	2007 (n=911)	95	3	2

Note: The percentages in the table may not always add up to 100% due to rounding; DK= Don't know.

Attitudes towards Different Forms of Electricity Generation

		(1)	(2)	(3)	(4)	(5)	NHOI	NO/DK
Biomass	GB2010	24	34	19	9	5	7	3
	GB2005	18	36	17	6	2	10	9
	JP2011	13	31	26	12	4		14
	JP2007	26	31	19	10	3		12
Coal	GB2010	9	27	19	30	13	*	2
	GB2005	7	31	24	25	8	*	3
	JP2011	2	16	28	36	11		8
	JP2007	3	18	29	34	9		7
Gas	GB2010	14	42	20	18	4	*	2
	GB2005	10	45	21	14	4	*	3
	JP2011	11	37	27	14	3		8
	JP2007	14	39	28	11	2		6
Hydroelectric power	GB2010	39	37	13	3	1	5	3
	GB2005	36	40	11	2	1	3	7
	JP2011	24	44	19	7	1		4
	JP2007	40	42	11	3	1		4
Nuclear power	GB2011	13	24	27	18	13	-	5
	GB2010	10	24	20	21	20	1	3
	GB2005	9	27	22	20	17	1	6
	JP2011	3	13	26	30	24		5
	JP2007	7	19	28	27	14		5
Oil	GB2010	5	27	26	28	10	1	2
	GB2005	6	33	22	25	8	*	4
	JP2011	4	20	29	34	8		5
	JP2007	4	20	33	30	8		5
Sun/Solar power	GB2010	56	32	6	3	1	*	1
	GB2005	55	32	6	2	1	*	2
	JP2011	56	32	7	3	1		3
	JP2007	71	22	3	2	1		3
Wind power	GB2010	49	33	9	5	3	1	1
	GB2005	50	31	8	5	2	*	2
	JP2011	41	37	12	6	1		4
	JP2007	66	26	5	1	*		3

Note: In Japan the question was "To what extent do you agree or disagree that the following energy sources will make a substantial contribution to reliable and secure supplies of electricity in Japan" with a 5-point agree disagree scale. In Great Britain the question was "How favourable are your overall opinions or impressions of the following energy sources for producing electricity currently". The percentages in the table may not always add up to 100% due to missing values and rounding; NHOI= Never Heard Of It; NO=No Opinion; DK= Don't Know; * denotes a value of less than 1% but greater than zero.

Attitudes to Nuclear Power

To what extent do you agree or disagree with each of the following statements?

		(1)	(2)	(3)	(4)	(5)	NO/DK
Conditional Support							
I am willing to accept the building of new nuclear power stations if it would help to tackle climate change	GB2011	15	39	19	11	11	5
	GB2010	17	39	14	16	11	3
	GB2005	11	43	18	15	8	3
	JP2011	9	13	23	19	33	4
	JP2007	10	23	26	22	14	5
I am willing to accept the building of new nuclear power stations if it would help to improve energy security (i.e. a reliable supply of affordable energy)	GB2011	22	39	14	10	10	4
	GB2010	20	36	14	16	11	3
	GB2005	-	-	-	-	-	-
	JP2011	8	13	28	18	28	5
	JP2007	-	-	-	-	-	-
Alternatives to Nuclear Power							
We shouldn't think of nuclear power as a solution for climate change before exploring all other energy options	GB2010	30	39	12	11	4	3
	GB2005	29	45	10	7	3	3
	JP2011	36	25	19	8	6	7
	JP2007	31	28	23	89	3	7
Promoting renewable energy sources, such as solar and wind power, is a better way of tackling climate change than nuclear power	GB2010	37	33	14	9	4	2
	GB2005	40	38	10	6	2	2
	JP2011	51	31	11	3	2	4
	JP2007	48	32	12	3	1	5
Reducing energy use through lifestyle changes and energy efficiency is a better way of tackling climate change than nuclear power	GB2010	-	-	-	-	-	-
	GB2005	31	44	13	6	2	2
	JP2011	36	36	18	5	2	4
	JP2007	37	37	17	3	1	6
Safety of Nuclear Power							
If we had safer nuclear power stations, I'd be prepared to support new ones being built	GB2010	-	-	-	-	-	-
	GB2005	15	38	19	15	8	3
	JP2011	11	19	23	18	25	5
	JP2007	15	26	28	15	10	6
We should stop using nuclear power stations because we do not know how to store radioactive waste safely	GB2010	-	-	-	-	-	-
	GB2005	19	25	23	21	8	3
	JP2011	26	23	31	8	6	6
	JP2007	15	26	28	15	10	6
Trust							
(1) I feel confident that the British Government adequately regulates nuclear power (2) I feel that current rules and regulations are sufficient to control nuclear power	GB2010 ⁽¹⁾	7	33	22	20	12	8
	GB2005 ⁽¹⁾	4	28	26	23	10	8
	GB2005 ⁽²⁾	4	28	30	18	7	12
	JP2011 ⁽²⁾	3	6	19	26	34	12
	JP2007 ⁽²⁾	6	13	36	21	9	16

Note: the scale included the response options of (1) strongly agree, (2) tend to agree, (3) neither agree nor disagree, (4) tend to disagree, (5) strongly disagree; The percentages in the table may not always add up to

100% due to missing values and rounding; NO=No Opinion; DK= Don't Know; * denotes a value of less than 1% but greater than zero.

Attitudes in Britain

Which, if any, of the following statements most closely describes your own opinion about nuclear power in Britain today?

	GB2005	GB2010	GB2011
We should increase the number of nuclear power stations	9	17	31
We should continue using the existing nuclear power stations, and replace them with new ones when they reach the end of their life	34	29	23
We should continue using the existing nuclear power stations, but not replace them when they reach the end of their life	34	33	21
We should shut down all existing nuclear power stations now, and not replace them with new ones.	15	13	11
None of these	1	1	3
Don't know	6	6	11

From what you know or have heard about using nuclear power for generating electricity in Britain, on balance, which of these statements, if any, most closely reflects your own opinion?

	GB2005	GB2010	GB2011
The benefits of nuclear power far outweigh the risks	13	16	20
The benefits of nuclear power slightly outweigh the risks	19	22	21
The benefits and risks of nuclear power are about the same	20	17	16
The risks of nuclear power slightly outweigh the benefits	16	19	12
The risks of nuclear power far outweigh the benefits	25	17	16
None of these	1	1	2
Don't know	6	7	12

How concerned, if at all, are you about nuclear power?

	GB2005	GB2010	GB2011
Very concerned	28	16	12
Fairly concerned	31	38	35
Not very concerned	27	30	34
Not at all concerned	11	12	11
No opinion/ Don't know	3	4	8