UNIVERSITY OF CAMBRIDGE
Electricity Policy Research Group

Nuclear Energy Policy in the United States 1990-2010: A Federal or State Responsibility?

EPRG Working Paper 1301

Cambridge Working Paper in Economics 1303

Raphael J. Heffron

This paper examines from a policy perspective nuclear energy policy in the United States (US) from 1990 to 2010 and questions whether it is or has become a Federal or State responsibility. The present study, as befits policy research, engages with many disciplines (for example, in particular, law and politics) and hence the contributions move beyond that of nuclear energy policy literature and in particular to that on nuclear new build and other assessments of large infrastructure projects. Several examples at the Federal level are identified that demonstrate that the nuclear industry has evolved to a stage where it requires a focus on the power of actions at a more localised (state) level in order to re-ignite the industry. The research concludes that there remains a misunderstanding of the issue of project management for complex construction projects, and it is highly arguable whether many of its issues have been resolved. Further, the research asserts that the economics of nuclear energy are not the most influential reason for no nuclear new build in the US. >

Keywords Nuclear energy; Policy inaction; project management; public administration

JEL Classification K32, L94, Q48

Contact rjh211@cam.ac.uk
Publication January 2013
Financial Support Electricity Policy Research Group, University of Cambridge

Nuclear Energy Policy in the United States 1990-2010: A Federal or State Responsibility?

Raphael J. Heffron

1: Introduction

This paper examines from a policy perspective nuclear energy policy in the United States (US) from 1990 to 2010 and questions whether it is or has become a Federal or State responsibility. This paper seeks to identify and clarify those aspects of the legal, economic, and political requirements of the United States (US) in the nuclear energy sector and in particular those which affect prospects for nuclear new build but which, so far, have not been well understood by experts. The nuclear energy industry has a structure that is led by policies and institutions at a Federal (national) and even international level. This research demonstrates through several examples at a Federal level that the nuclear industry has evolved to a stage where it now requires a focus on the power of actions at a more localised (state) level in order to re-ignite the industry. Through the exploration of policy inaction at Federal level, state policy emerges as a key driver in encouraging the growth and operation of the nuclear energy industry.

The present study, as befits policy research, engages with many disciplines (for example, in particular, law and politics). Hence, contributions are made not only at an academic policy level, but also in identifying misunderstood conceptions of public administration, as well as project management, and legal structure issues that exist for the planning of large infrastructure in the US through a focus on the nuclear energy industry but with a particular focus on nuclear new build and long-term waste management.

Finally, the research contributes to the nuclear energy policy literature and in particular to that on nuclear new build. In this regard, guiding this research are other in-depth examinations of nuclear energy policy (see, Jasper 1990; Hecht, 2008; Pope, 2009) and other assessments of large infrastructure projects (Flyvbjerg, Bruzelius and Rothengatter, 2003; Altshuler and Luberoff, 2003; American Planning Association, 2005; Flyvbjerg, 2011). The 59 interviews used here have been carried out across the USA. While the focus is placed on nuclear energy policy in the USA from 1990 to 2010, it does factor in the release of a few publications relevant to the nuclear sector after 2010. However, the effect of the nuclear energy incident at Fukushima, Japan, in 2011 is beyond the scope of this research.

2: A Brief Background to the US Electricity and Nuclear Industries

Civilian nuclear energy accounts for 22 *percent* of the total electricity supply in the US (see Table 1 below). There are 104 nuclear reactors across the US, representing a quarter of the total number of nuclear reactors in the world. The nuclear power industry in the US grew to its present capacity primarily through the construction programmes initiated during the 1960s and 1970s.

Renewable energy is playing a growing role in the US electricity market. Renewable energy sources are projected to have the strongest growth over the medium term due to Federal and State level programs – such as the Federal Renewable Fuels Standard (RFS) and the various State Renewable Portfolio Standards (RPS) programs, and the rise in fossil fuel prices. In some projections renewables will account for 45 *percent* of the increase in total generation from 2008 to 2035 (EIA, 2010a).

Table 1: Electricity Generated by Source in the US 2009

Supply Source	Share of Electricity Generated by Source in Percentage	Electricity Generating Capacity TWh	Installed Capacity TWh
Coal	42%	1755	3422
Natural Gas	25%	920	4672
Nuclear	19%	798	1067
Renewable Energy	13%	417	135
Other	1%	39	62

Source: Compiled by the Author from the EIA 2011

Nevertheless, despite many reactor closures (23 reactors have been permanently shut down – NRC, 2011) and no new nuclear build, nuclear energy has maintained its position in the US electricity market in the period 1990-2010 due to the better utilisation of generating capacity, uprates and life extensions see Table 2.

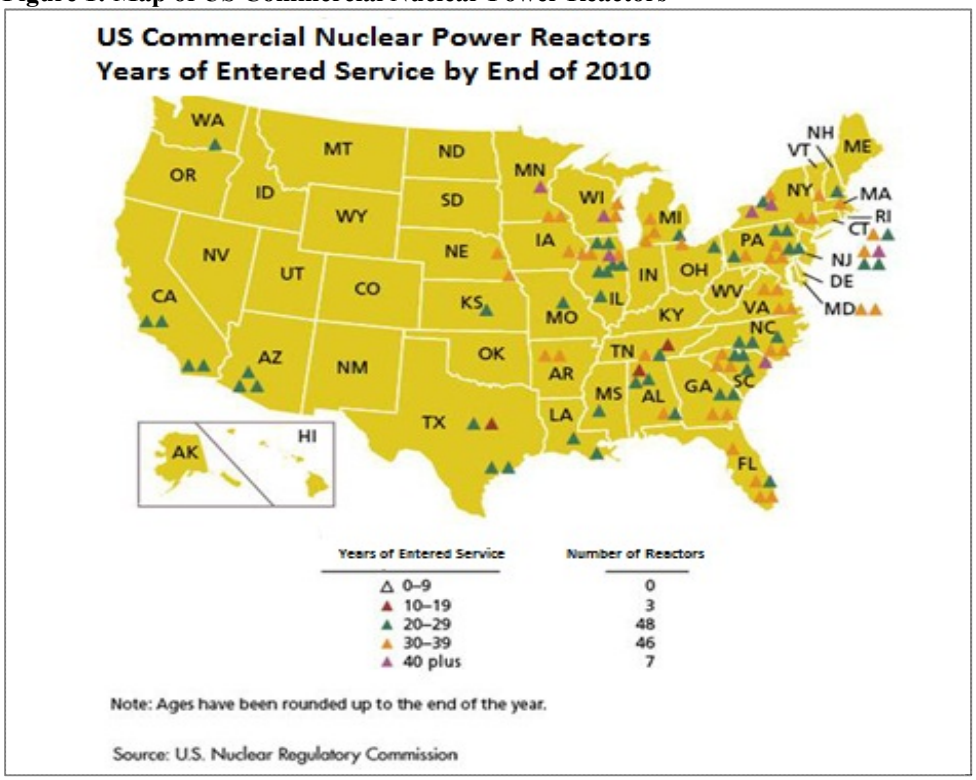
Table 2: Licence Renewals and Power Uprates in the US Nuclear Sector

Licence Renewals		Power Uprates	
Total Reactors in the US	104	**Power Uprates**	No. and Electricity Added
Licence Renewals Granted	71	**Power Uprates Granted**	139 and 5,960.7 MWe*
Under Review	14	**Under Review**	10 and 1,335 MWe
Expected Future Applications	15	**Expected Future Applications (2011-2015)**	35 and 1,855 MWe

Source: Compiled by the Author as of October 2011 from NRC statistics (2011)
*Equivalent to around 6 new nuclear reactors.

Reactors are located at 65 sites (plants) in the US with the majority of plants located in the eastern half of the country in 33 states as Figure A demonstrates. 69 of the reactors in operation are pressurised water reactors, and 35 are boiling water reactors. Figure A locates the current reactors in operation and also identifies how long the reactors have been in operation. Evident is that there are no new reactors in the 0-9 year category in the US.

Figure 1: Map of US Commercial Nuclear Power Reactors



Source: Adapted by the Author as of October 2011 from NRC (2011)

The Major Legislation in the Civil Nuclear Energy Sector in the US

The centrepiece of nuclear legislation in the US is the Atomic Energy Act of 1954 [42 USC 2011 *et seq*.] which is a comprehensive Federal statute that regulates possession and use of radioactive material and facilities that produce or use such material. There are also several other statutes that cover more specific aspects of the regulation of radioactive material and facilities, for example, in radiological protection, radiological waste management, non-proliferation, exports and nuclear security.

The key laws in the nuclear energy sector are:

- Atomic Energy Act of 1954 – as mentioned above
- Price-Anderson Act of 1957 – This was inserted into the Atomic Energy Act 1954 as S.170 and has been revised several times, and more recently so by the Energy Policy Act of 2005. The purpose of the act is to provide a Federal compensation fund of $10 billion should there be a nuclear accident. The Act does limit liability and does not guarantee payment should possible funds be exhausted already.
- Energy Reorganisation Act of 1974 – The Atomic Energy Commission (AEC) was abolished and the Nuclear Regulatory Commission created, with other functions going to what later became the Department of Energy.

- Department of Energy Organisation Act of 1977 – This combined several government energy agencies together to form the Department of Energy (DOE). The DOE then became responsible for the development and production of nuclear weapons, the promotion of nuclear energy and other energy related work.
- Nuclear Waste Policy Act 1982 – This aimed to provide for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel. Its other main aims were to establish a program of research, development, and demonstration regarding the disposal of high-level radioactive waste and spent nuclear fuel.
- The Energy Policy Act of 2005 – This encourages the development of specifically nuclear power, with several forms of incentives introduced. These take the form of loan guarantees, carbon free production tax credits, protection tax credits, and a new form of risk insurance for the first 6 reactors. The aim of the legislation is to move the US towards a national goal of energy independence with the aid of nuclear power. It also continued the Price-Anderson Act.

3: Methodology

The research methodology used here is contrast explanation. At its core is dialectical learning that has a three step process whereby the researcher: (1) explores the research topic in depth; (2) enters the field and conducts the research; and finally (3) revises what was learnt at the first step (Lawson, 2009). Contrast explanation occurs at step 2, and involves the testing of hypotheses created in step 1. These research hypotheses are debated with the interviewees who state whether they are proponents or critics of the hypothesis. The research method is useful where an affirmative or negative policy action occurs – i.e. a nuclear power plant is to be built or it is not. The results are then presented visually on a graph demonstrating which hypotheses are contested and thus worthy of further analysis. Only hypotheses that are contested by interviewees to a sufficient degree (where there is no 75 percent majority of interviewees in favour or against) are further analysed. Hence a majority is needed and the majority figure of 75 *per cent* is chosen. In civil court trials a verdict can be reached with 10 out of 12 jurors in agreement or 9 out of ten (s.17, Juries Act 1974). The threshold of 75 *per cent* chosen here is to reflect that but is adjusted so as not to be as severe since these are policy related decisions that are under analysis rather that actual court proceedings but nevertheless the aim is to secure a high majority who are in favour of/against the policy action. The method aims to achieve a consensus view and the results are based on the experts' (those interviewed) knowledge and understanding of the policy and legislative issues. Similar to the aforementioned Expert Elicitation methodology of the US EPA the contributions of this research can be thought of as: (1) a description of the state of knowledge, and what we know and do not know; (2) a process by which we obtain better information (to reduce primarily uncertainty); and (3) both the latter improve understanding of existing observations (US EPA Expert Elicitation Task Force White Paper, 2011: 28).

Then the stage three analysis begins, and this determines whether the hypothesis is proven or unproven. This decision is based on in depth interview analyses (coded and managed through using *Atlas.ti* qualitative data analysis software), analysis

of policy actions and documents (including those suggested by interviewees), and further literature review. Lessons from the analysis of each contested hypothesis emerge and are stated at the end.

Contrast methodology is used in a variety of forms across many disciplines in the social sciences and humanities: in philosophy (political – Carlson, 1990), psychology (in studying legal outcomes - Pepitone and DeNubile, 1976; Nagao and Davis, 1980; Ross and Simonson, 1991), increasingly in management (in examining consumer behaviour - Folkes, Martin and Gupta, 1993; Drolet, 2002; Aaker, Stayman and Hagerty, 1986; Sherif and Hovland, 1961) and economics (Pinkstone, 2002; Lawson, 1997; 2003; 2009). The method is similar to the US Environmental Protection Agency (EPA) methodology of Expert Elicitation (see US EPA Expert Elicitation Task Force White Paper, 2011) however it is noted in the White Paper (pg. 68) that Expert Elicitation is a financially expensive methodology, and hence contrast explanation is more suitable for a single researcher. An earlier form of the methodology employed here is also used by Heffron (2012a) who examined progress in nuclear energy policy in Romania, while the methodology is also based on that used by Heffron (2012b: 2012c) to examine nuclear energy policy in three US states.

However, at its core is always dialectical learning which has existed as a method for learning since Socrates and Plato introduced it in its initial form (Lawson, 2009). It enables a researcher to focus and provide observations and lessons on long term trends (Argyris and Schon, 1978; Seo and Creed, 2002). For instance, dialectical learning was employed by the Dutch stakeholder dialogue project *Climate OptiOns for the Long term* (COOL). This project had as its key aim the provision and assessment of stakeholder viewpoints on a wide range of long-term policy options for climate change. Dialectical learning was a key part of the process. This involved identifying and understanding the dominant issues; then exploring contrasting viewpoints or outcomes; then the third step of deliberating, reflecting, and revising the original understanding (Van de Kerkhof, 2006). Further at the core of the COOL project were stakeholder interviews similar to the interviews conducted for this research.

Contrast explanation has been employed in many other areas too: such as in corporate strategic planning (Mason, 1969; Mitroff 1971; Mason and Mitroff, 1981) for complex problems – where problems/issues are drawn from current understandings and then examined from previous or potential outcomes. This is similar to this study, as nuclear energy policy is noted as a complex subject matter (Breyer, 1978; MacKerron, 2004). Mitroff and Mason (1981) have argued that the policy and planning field is beyond the scope of traditional scientific experimentation. For example, Corbey (1995) used dialectal learning for analysis of EU policy where he assessed the various phases and process in the development and integration of the EU. Similarly this research examines the processes behind the development of nuclear new build. The central issue for contrast explanation is not really about what is possible within different perspectives but rather as Bernstein (1979) noted: "*it's about what's emphasized, illuminated, or made more likely; what's relegated to the background as unimportant or impractical; and what the impact of these prevailing emphases is on the actual practices of social scientists and the communities they study and serve*" (Moss, 1998:56).

Interviews form the essence of primary data for this research. Stakeholders in the nuclear energy sector were identified following that outlined in Table 3 below. This follows other efforts of researchers who identify stakeholders prior to conducting their analysis. For example, Jasper (1990) too conducted a similar study to this research with over 100 stakeholder interviews in examining nuclear energy policy. However, his focus was on three countries (the US, France, and Sweden) from the point of the 1970s oil crisis to *circa* 1990. He conducted 100 interviews with managers, policymakers and activists in the three countries. The focus of the work was exclusively on political and economic structures to account for public policy decision making for the nuclear energy sector.

Table 3: Stakeholder Categories Identified and Interviewed

Interview Reference Code	Category Name	Function, Organisation
1	Elected Politicians	State Politicians on State Legislature Energy Committees
2	Public Sector	Federal and State Agencies: Finance, Environment, Energy and Nuclear Safety, State Electricity Regulator, State Transmission Grid System
3	Private Sector	Nuclear Energy Companies
4	Academic Researchers	National Academic Researchers
5	NGOs	Non-Governmental Organisations (NGOs)

Interviews were conducted nationally across the US. For a full list of interviewees see Appendix A. 59 interviews were completed by the end of the process which lasted from June 2010 to August 2010. Interviews lasted between 25 minutes and 150 minutes. Interviewees included state politicians, state regulators of electricity, national and state nuclear safety offices, electricity grid operators, national electricity and nuclear energy company operators, national academic experts, and members of various national non-governmental organisations. In the text, the reference for each interview is given in accordance with their category and letter to which interviewee they are – see Appendix A for the list of interviewees – for example, 1A, 2A etc.

4: Research Hypothesis

The research question is directed towards how Federal level policy can impact upon state level policy in the US. In essence, it examines the operation of Federal law and policy and deliberates on the consequence effect for state policy. The case of nuclear energy is used as an example. The research also identifies several characteristics of an industry - where large infrastructure development is at the core – to improve and renew the industry so as to create more favourable conditions for further investment and growth.

The methodology of contrast explanation, which is applied in this research, has particular advantages. It is emergent, in the sense that it acknowledges that the researcher will acquire knowledge throughout each research phase and this can be incorporated into the research – in the form of the emergent hypotheses being examined. The research offers in-depth insight and policy development analysis of the contested hypotheses and advances a methodology to further knowledge on a complex

policy issue. It is adversarial and incremental in its approach. The developed hypotheses that were uncontested are conclusions to the research themselves and these are discussed in brief before the analysis of the contested hypotheses. After the literature review had been conducted, 11 research hypotheses were developed (see Table 4 below and Appendix A) and tested in the interview process.

Only three of the eleven hypotheses qualified for further analysis under the research methodology and these are specified below in Table 4.

Table 4: List of Hypotheses

Number	Hypothesis (H)	Contested Hypothesis (CH)	Uncontested Hypothesis (UH)
H1	There is too much competition by other energy sources to enable nuclear energy expansion in some states		**Accepted (UH)**
H2	Federal laws favour the development of the nuclear energy sector	**CH1**	
H3	The Nuclear Regulatory Commission (NRC) is too slow in its approval of licensing for a new nuclear plant		**Accepted (UH)**
H4	The slow construction times of the previous nuclear new build still have a negative impact		**Accepted (UH)**
H5	Nuclear operating companies do not have the financial capacity to build a nuclear new build project		**Accepted (UH)**
H6	Nuclear energy is an example of the failure to deliver a large construction project in the US on time and on budget	**CH2**	
H7	Nuclear lobby groups are weak in comparison to environmental lobbying groups		**Accepted (UH)**
H8	Environmental lobbying groups no longer see nuclear energy as the primary opposition		**Accepted (UH)**
H9	The unattractive economics of nuclear energy are the major reason the US nuclear industry has slowed down	**CH3**	
H10	Information dissemination about nuclear energy is not sufficient		**Accepted (UH)**
H11	Education on nuclear energy issues and education of the next generation of staff for the sector are weaknesses in the sector		**Accepted (UH)**

Discussion of Uncontested Hypotheses

Nuclear energy in the US has significant competition as an electricity supply source, however, not just from coal and gas, but increasingly from renewable energy (wind in particular). Indeed, there is too much competition by other energy sources to enable nuclear energy expansion in many US states at present (H1). Further, the potential of shale gas in the US (for example, in Pennsylvania with the discovery of the Marcellus Shale gas reserves) is adding to the competition. Nevertheless, some interviewees expressed that nuclear energy is still needed, for example one interviewee (2P) stated that: "*When you look at long term growth numbers, if the nuclear plants are not built, you are going to have to do a lot of something else, and I do not know who is ready to step up to that one yet.....*".

There are other factors which have played a role in nuclear energy development in the US, in particular, the regulator, the Nuclear Regulatory Commission (NRC). The

NRC has struggled in the past in taking a long time to approve projects, and although it has undergone changes, there remains a need to improve (H3):

> "What impressed me about the NRC was their ability to make good technical decisions and that they made decisions. I was concerned before I went there. The fact that, you know, we had all heard that there had not been a new reactor license application since Three Mile Island. There were a lot of licenses in process but there had not been a new one. So I was concerned about the NRC's ability to make decisions but it turned out that that was an unfounded concern because they had done power upgrades, they had done license renewals so I was impressed with the agency. I thought they were a good focused organisation but like any organisation you can do much better" (3B).

Electricity policy suffers from fragmentation in the US with each state having significant control of their own electricity policy – except for those in regional electricity markets, for example PJM. This fragmentation led to an element of individuality with the technical design of nuclear power plants and when coupled with the slow regulatory regime contributed to slow construction times in the past (H4). Further, the fragmentation resulted in the weakness in the financial capacity of energy companies in the US to build a new nuclear project (H5) with companies operating within states and not having without major public funds access to the financial resources needed to build a nuclear power project.

Nuclear energy lobby groups are weak in comparison to environmental lobbying groups (H7). For many years during the 1960s, nuclear had no need for lobbying because of the link between nuclear energy, the military and politics. As a result lobby groups, lobby formations and networks do not as readily exist or are at a later stage of development than lobby groups, networks and associations for other energy sources. A positive issue related to this is that environmental lobbying groups no longer see nuclear energy as the primary opposition (H8). This because of the association of nuclear energy with clean energy sources in that it produces no carbon dioxide. Indeed, many environmental lobby groups are transferring their efforts to tackle carbon dioxide producing energy sources.

Information dissemination about nuclear energy is not sufficient in the US (H10). This is linked intrinsically to the problem of education on and surrounding nuclear energy issues. Nuclear energy is a complex subject and topic – there is an educational gap surrounding the subject area (H11). Indeed many of those interviewed expressed the view that employees across energy and nuclear energy institutions not to mention the public do not understand all the issues involved. They state that there is a shortage of current and prospective employees who can envisage the holistic picture of nuclear energy, and as a result decision-making from organisations in the nuclear energy decision-making sectors lack holistic decision-making ability; therefore decision-making on nuclear energy matters suffers from a piecemeal or fragmented approach, i.e. where a decision is made regarding a particular part of nuclear energy policy or regulation.

5: Research Analysis

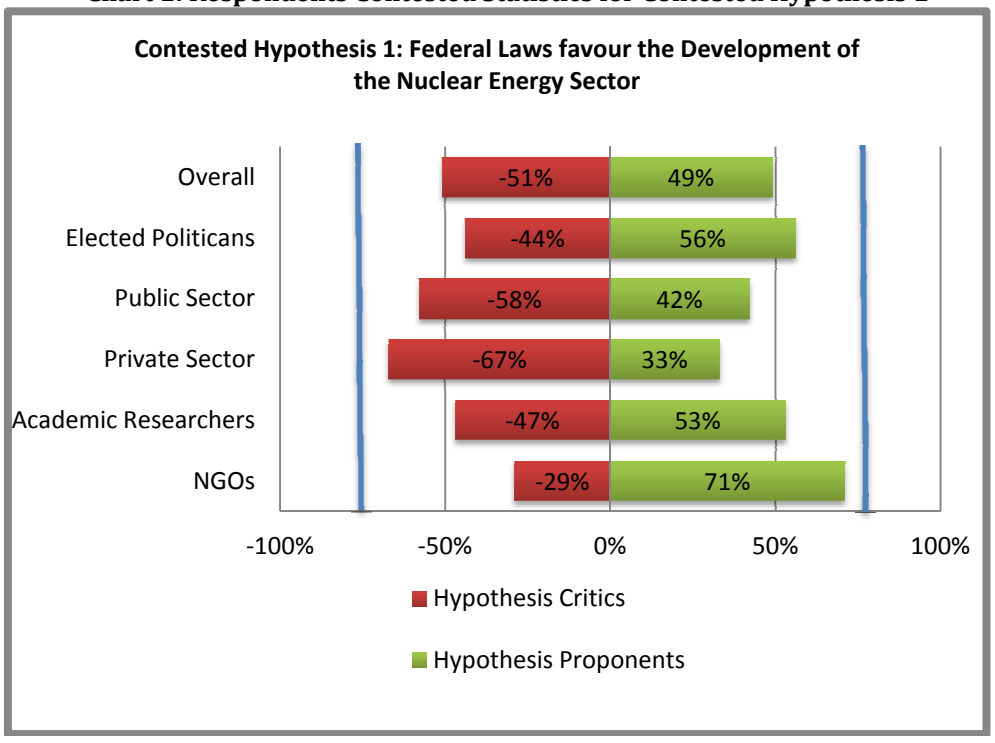
5.1: Contested Hypothesis 1 (CH1)

Federal Laws favour the Development of the Nuclear Energy Sector

The judgement of interviewees is assessed in Chart 1 below. This chart analyses whether interviewees were proponents (positive) or critics (negative) of the researcher's hypothesis. For a hypothesis to be further analysed, the hypothesis must be a 'contested' hypothesis, which is where there is less than a majority of 75 *percent* of respondents either for or against. If it is more than 75 *percent* then it will not be considered contested and thus not further analysed, with this decision being based on the overall response of respondents. The blue line (see Chart 1) indicates the 75 *percent* threshold. The number 0 represents the hypothesis decision line – for or against. Interviewee responses (where total n=59) are recalculated to represent a value of 100 *percent*. On the chart, the overall respondent result is given first followed by each stakeholder category of interviewees.

Whether a contested hypothesis is proven or unproven is achieved by further analysis that follows (previously referred to as the stage three analysis in dialectical learning), conducted on the interviewee data (through the use of *Atlas.ti* software), the analysis of legal and policy actions and documents in the US, and updating the literature review through documents recommended and given by interviewees. Further, statements in the analysis that follows are supported by the critics or proponents of the hypothesis and in these cases the reference code is CVP which is the consensus view of proponents, and CVC consensus view of the critics.

Chart 1: Respondents Contested Statistics for Contested Hypothesis 1



n=59, nElected Politicians=9, nPublic Sector=19, nPrivate Sector=9, nAcademic Researchers=15, nNGOs=7

From Chart 1 it is evident that the hypothesis is near evenly contested. There is a minor majority against the hypothesis. The view expressed by the hypothesis proponents was that it was at the Federal level that nuclear energy should be incentivised (CVP). There was also the belief that it was not within a state's function, or remit, to be incentivising new energy infrastructure (CVP). Nevertheless, actions within a number of states demonstrate that there is the capability to incentivise or encourage new nuclear power plants. The research analysis that follows demonstrates the inaction at Federal level and the effect on state policy, and hence the contested hypothesis (CH1) is unproven.

The main reason for the hypothesis not been proven is four-fold. First, the Energy Policy Act of 2005 was meant to re-ignite the industry, and has so far failed to have a significant influence (CVC). Second, critics of the hypothesis argue that there is a misconception or at least an incorrect interpretation that the Energy Policy Act of 2005 was created to benefit nuclear (CVC). Third, while the NRC (Nuclear Regulatory Commission) has improved as an institution it has achieved this improvement from a very low base (CVP). Finally, at a federal level in nuclear energy issues there is a general state of policy inaction.

The Misconception of who benefits from the Energy Policy Act of 2005

The recent law, the Energy Policy of Act 2005 (hereafter also referred to as the '2005 Act') has been significant for nuclear energy in terms of the incentives it has offered but has not yet delivered any for nuclear new build. Indeed, only one state, Georgia has to benefitted from the loan guarantees system. Overall despite the surge of 18 applications to build new nuclear projects after the 2005 Act "*...it (the 2005 Act) has taken years to implement*" (4A). Further, the amount stated to be available under the loan guarantee system has been demonstrated to have been significantly too low. This is because the 2005 Act allowed for $18.5 billion for loan guarantees, with the Georgia project claiming near 50 percent ($8.33 billion) of these. Hence, it is likely that the only two projects will be able to use the loan guarantee system based on the amount already allocated to the Georgia project. It is because of this that the Obama administration has debated and sought unsuccessfully an increase of up to $36 billion in 2010 (Chu, 2010) and $54.5 billion in 2011 (Holt, 2011).

Nuclear energy was not the only energy sector to receive subsidy support through loan guarantees under the 2005 Act. Table 5 below shows that incentives were given to all energy sectors. Gas, and oil received subsidies of various types, and in particular the permit process was shortened to deliver quicker supplies of oil and gas (s. 265, s.366). Renewables and coal (CCS technology) also received a subsidy through the form of the loan guarantee system. Further, CCS technology also received further subsidies through The American Recovery and Reinvestment Act of 2009 (Pu. L. No. 115-5). Despite the loan guarantee system having been established under the 2005 Act for all clean energy sources (non-carbon dioxide emitting electricity sources), the same negative publicity received by the nuclear sector regarding the loan system has not been received by the renewable energy and coal CCS technology industries (CVC).

However, that said, some renewable technology projects and coal CCS technology projects have been met with similar delays to nuclear new build projects in terms of final funding approval and finally beginning construction – such as the Cape Wind offshore project in Massachusetts. The latter project has only in April 2012 had approval for a long-term contract for sale of electricity approved by the Massachusetts Supreme Judicial Court (Cape Wind, 2012). The construction of a coal CCS technology plant planned for Illinois, the FutureGen project has also suffered a similar delay before construction and finance were approved. At one stage its DOE funding was withdrawn after an accounting error estimated the project would run 100 *per cent* over cost instead of 39 *per cent* (Wald, 2009), and construction is finally to begin in 2012.

Table 5: Selection of Incentives from the Energy Policy Act of 2005

Issue	Incentive Offered
Construction Risk (S.638)	Offers risk assurance to cover 100 percent of delays (up to $500 million) for the first two nuclear plants and 50 percent of delays (up to $250 million) for plants three to six.
Insurance (Title VI, Subtitle A)	Extends the Price-Anderson Act that applies to the civil nuclear energy sector for a further 20 years.
Loan Guarantee System (Title XVII)	Creation of new loan guarantee office for any clean energy technologies. Authorises loan guarantee (up to 80 percent of project cost for nuclear) but also for IGCC (Integrated gasification combined cycle) plants and renewable energy projects, hydrogen fuel cell technology, carbon capture and sequestration projects, and the construction of refineries for gasoline, ethanol and biodiesel
Production Tax Credits (S.1306)	Production tax credit 1.8 cents per kilowatt-hour for 6,000 megawatts of capacity from nuclear power plants for the first eight years of operation. Wind and closed loop biomass have received a production tax credit since 1992 and received a further extension of this (S. 1301 for federal land projects)
Permit Process (S.365)	Permitting process for oil and gas was streamlined and this cuts out years and months of delays in a western states pilot program – it will bring new gas and oil to the market sooner. S. 366 even states it is possible for a permit to drill to be issued within 30 days – though this is for a pilot project across western states only.

Source: Compiled by the Author as of October 2011 from NRC statistics (2011)

Furthermore, critics of the hypothesis state that there is in particular, a misguided notion of exactly what the loan guarantee system entails (CVC). There is a view that this is a Federal subsidy. However, it is a subsidy for which the industry is paying itself. Among those who are entitled to the loan guarantee system within the clean energy sector (carbon dioxide free emitting sources) it is only the nuclear energy sector that project sponsors must pay a subsidy cost. This latter cost is the estimated average by the government of their future cost from defaulted loans in the loan guarantee system. This can have an impact on the viability of a project if it is too high as it adds another significant cost to the overall project cost – for example, if the rate was 10 *percent* or indeed if it was the 11.8 *percent* ($880million) quoted to Constellation Energy for the Calvert Cliff project (Wallace, 2010). Arguably therefore it is not the subsidy that others argue (CVP). In addition, the nuclear industry, as of yet, is unable to secure what the subsidy cost will be (6 years after the introduction of the legislation).

The Price-Anderson Act however, was renewed for a further 20 years by the Energy Policy Act of 2005. This Act does however seem to benefit nuclear energy and in particular in the light of the BP Deepwater Horizon oil spill in 2010. Oil companies under the Oil Pollution Act of 1990 are only liable for $75million yet BP were obliged to make available $20billion and pay their own costs associated with the disaster

(estimated to be near $3billion) (NC, 2011). Risk and the financial amount stated in the Price-Anderson Act may need to be re-examined in this light, however, this is an area of future research given that all financial data from the BP Horizon spill are not yet available for a full examination – only around 25% of the spill response fund has been claimed to-date (NC, 2011). Nevertheless, the question arises would the Price-Anderson Act would be enforced were there a nuclear accident? Based on the BP Deepwater Horizon oil spill it is unlikely that this would be the case and hence, is an area requiring further examnation.

The Improvement of the Nuclear Regulatory Commission

The NRC has improved as an institution over the 1990-2010 period since its previous existence in the 1960s and 1970s (H-1). The NRC was conceptualised as an independent regulatory agency which replaced the AEC in 1974. The late 1970s and 1980s was a very tough period for nuclear energy in the US due to the oil crisis, and a financial crisis, and was also subject to a period of continuous regulatory change (2B, 2C). The NRC in the late 1980s aimed to address the concerns regarding and the lessons learned from the licensing of the 104 plants that were operating in the US. This involved the revision of the entire system and the introduction of a new one – the Combined Operating and Licensing system (COL) [see Bredimas and Nuttall (2008)]. This new licensing system was designed to minimise delays in the process of awarding licenses, and also aims to standardise design applications.

It must be stated, however that the NRC was improving from a poor performance level and there remains a need for further improvement (CVC). Prior poor performance can be attributed to the NRC having just been established as a new agency and it facing the severe problem of the Three Mile Island accident almost immediately thereafter (FNI-5, FNI-6). However, despite no nuclear new build having been approved by the NRC under the new COL system, they have been active through the 1990s and 2000s. They have approved power upgrades license renewals for many of the 104 reactors as shown earlier in Table 2.

There is however, recognition by the majority of respondents that the NRC can continue to improve and needs to do so if more projects are to begin (CVC). Improvements according to those interviewed centred on three core areas: that the NRC needs to (1) become more predictable; (2) decrease the length of the licensing process; and (3) become more adaptable to change (CVC). For example, the NRC has to play a more active role in ensuring safety, and to address concerns which may arise from nuclear problems at other reactor sites across the world (CVC). Hence, there remains the need for further change at the NRC.

Policy Inaction

Federal laws have over time become less effective in the nuclear energy sector, and this highlights the three issues analysed here. The Energy Policy Act of 2005 and its implementation need to be re-examined, and the NRC regulatory process needs to improve and have a faster approval process.

At a Federal level, this policy inaction is also evident in nuclear waste management policy which remains unresolved (H-3). There is widespread agreement that one of the major obstacles to a nuclear revival is the management and storage of spent nuclear reactor fuel and other high level radioactive waste (2A, 4A, 4E, 4F, 5B). According to the literature, the nuclear industry has concentrated on and solved many of its problems, however, it has not resolved this one. Indeed, the conclusions of Weinberg (1972), former Director of the Oak Ridge National Laboratory, still resonate today. He stated that a problem for nuclear energy is social institutions. Nuclear energy in comparison to other energy sources offered clean energy, however, it has a waste disposal issue that requires the best expertise to be involved in nuclear energy and that social institutions responsible for nuclear do not have the longevity of existence (or in perception of existence) to help protect the public (Weinberg, 1972).

The US Federal government assumed the responsibility to deal with the disposal of high level radioactive waste. This was due to take the form of a long-term deep underground geological depository storage facility and its location was to be in the Yucca Mountain in Nevada. However, no state welcomed the idea of being a nuclear waste ground (CVP), despite the existence of a small high level nuclear waste facility in New Mexico for the military (Moore, 2011). Indeed, Moore (2011) calls for states to take an increased role in the nuclear waste issue due to Federal indecision on the matter. Public opposition is high in Nevada, though a fraction of the population in Nevada were in favour of it for the economic benefit of having the facility in their state. The Senator Harry Reid (Nevada), as Senate leader was responsible for ensuring that the vote never came before the Senate, as an election loomed and a new Senate would be formed (5B).

The Nuclear Waste Policy Act 1982 initially scheduled that a first repository site would be chosen by March 1987, with a second by March 1990. However, neither requirements were met, but by 1989 Yucca Mountain had emerged has the choice. The 1987 Amendments to the Nuclear Waste Policy Act (NWPA) did however specifically state that the waste management program would be at Yucca Mountain. Nevertheless it was not until 2008 that a license application was submitted to the NRC (NRC, 2008) before been withdrawn in 2010. Nevertheless, the US Federal government have been slow to examine alternatives sites, or to resolve and fund research into alternatives, though debate on nuclear fuel recycling is growing (CVP). An example of state led action in the nuclear energy sector on the nuclear waste issue has occurred however with the development of storage of low level radioactive waste in Andrews County in Texas. This facility was give permission in April 2012, and may accept low level nuclear waste from up to 36 states (Plushick-Masti, 2011; Schecter, 2011).

The nuclear waste issue also suffers from being a "wicked problem" – this is a problem which has a circular property where the question is shaped by the solution (Conklin, 2003 in Nuttall, 2005). Nuttall (2005) draws the connection between a wicked problem and radioactive waste management when considering the UK nuclear energy sector. According to Nuttall (2005) a wicked problem means that:

> "As each solution is proposed it exposes new aspects of the problem. Wicked problems are not amenable to the conventional linear approaches to solving complex problems. Such linear approaches go from gathering the necessary data, through analysing the

> data and formulating a solution towards implementation of a final agreed solution. By contrast, wicked problems can at one moment seem to be on the verge of solution, yet the next moment the problem has to be taken back to its complete fundamentals for further progress to be made. As such any opinion that the problem is almost solved is no indication that it actually is. Wicked problems can persist for decades and, for a true wicked problem, no solution will ever be possible. Wicked problems typically combine technical factors and social factors in complex multi-attribute trade-offs. A problem that is not wicked is said to be 'tame'. One thing is certain: in the UK, at least, radioactive waste management is not a tame problem.

It is evident that the nuclear waste issue in the US also features these wicked problem characteristics. The Blue Ribbon Commission (BRC) have been given the task of suggesting solutions to the nuclear waste issue in the US and in 2011 they stated that one of the primary motivations of solving the nuclear waste issue is to restore federal-state relations which have digressed over the 20 years of court battles and indecision (BRC, 2011). Indeed, their report which does not suggest alternative sites to Yucca Mountain acknowledges that public administration of the issue needs to be rectified, and in that context they state that a new organisation, independent of the Department of Energy (DOE) needs to be established (BRC, 2011). This latter organisation will have full responsibility for the US nuclear waste program. Further, it recommended that the Nuclear Waste Fund ($750 million per year) needed to be set aside in the Federal budget and treated separately so it can be used for its intended purpose (BRC, 2011).

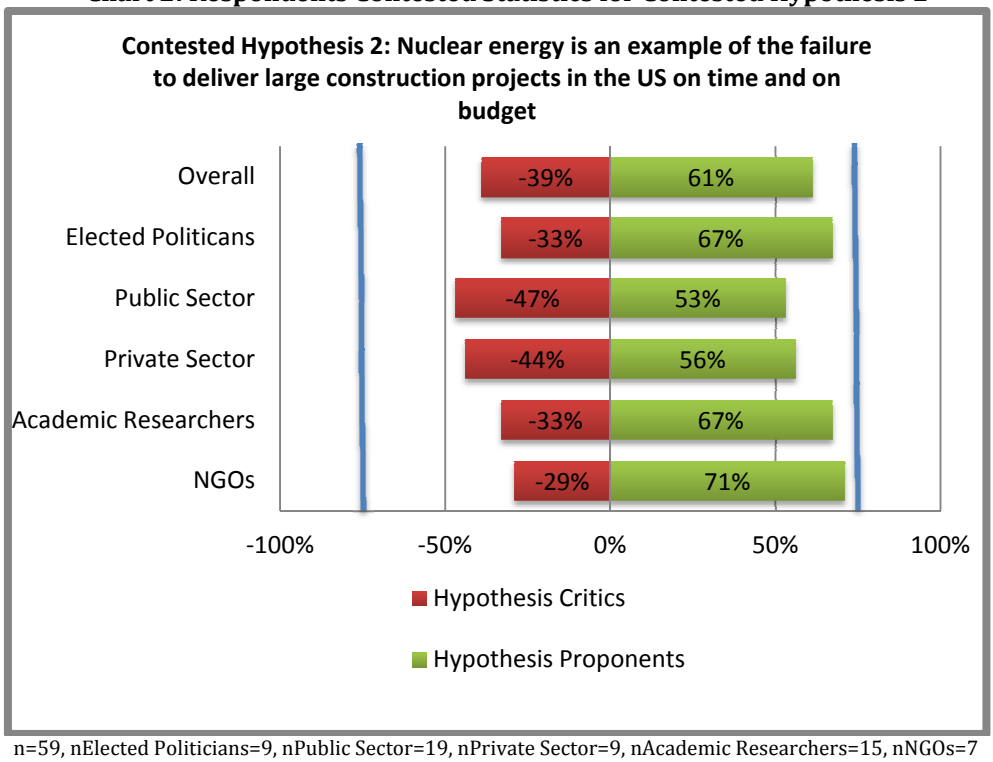
However, there are some positives occurring at the Federal level that may benefit nuclear energy and that are surmounting the policy inaction there. Laws drafted at other Federal level institutions can have an effect on the nuclear industry (H-2). This was not a consideration by many of those interviewed, but it was accepted as possible (CVP). Further, in light of the unwillingness of the Senate to vote on legislation creating a carbon market or a carbon tax it may happen to an increasing effect that laws drafted at other Federal institutions have an increasing effect on the nuclear industry (4A, 4C, 4E). Already the US EPA is trying to move and regulate the polluting effects from the oil, gas, and coal industries via the Clean Air Act. The EPA asserts that it is protecting public health and the environment in targeting greenhouse gas emitting power plants – and it has power do so through a 2007 Supreme Court ruling - Massachusetts v. Environmental Protection Agency, 549 U. S. 497 (2007). There is opposition to the EPA in this regard who state that EPA action will increase electricity prices, but the mere fact that this is happening demonstrates the potential of legislation created by other Federal institutions (beyond the DOE or NRC) to have an effect on the nuclear energy sector.

5.2: Contested Hypothesis 2

Nuclear energy is an example of the failure to deliver large construction projects in the US on time and on budget

There are contrasting views surrounding this contested hypothesis. There is a belief that nuclear projects can be built on time. However, other interviewees argue that they cannot. One interviewee (2B) summarises it in saying that in such a big project there will always be surprises *"I think there will be challenges on any big construction project and nuclear is a big one so I think there will be some challenges that they're gonna have to overcome... so I think on a project like Vogtle 3 and 4 (Georgia) as they get into some detail there will be some surprises"*. This hypothesis although, a contested hypothesis (see Chart 2) was accepted. The majority of interviewees in every respondent category were in favour of its acceptance. The principal reason for its acceptance and the perspective advanced in this research is that there has been a failure to understand the role of project management in the nuclear industry.

Chart 2: Respondents Contested Statistics for Contested Hypothesis 2



n=59, nElected Politicians=9, nPublic Sector=19, nPrivate Sector=9, nAcademic Researchers=15, nNGOs=7

According to the majority of interviewees, new nuclear build is one of the most complex construction projects and has proved difficult to deliver on time and on budget in the past (CVP). Project management was poor in the US during the last nuclear build phase, and remains so (FNI-8). In the last period of nuclear new build, the projects were dominated by the classical problems cited in literature that lead to the failure of projects to deliver on time and on budget (see Table 7). Further, conditions have not improved yet in the US to successfully deliver a nuclear new build project on time and on budget (4B). These problems identified by Flyvberg (2011) are not unique to the nuclear

sector, however, nuclear energy projects seem to feature the majority of them. Indeed, Flyvberg (2011) states that the majority, nearly nine out of ten major projects are not built on time or on budget.

Table 7: Reasons for Failure in Project Management

Characteristics of Projects Which have Failed to Deliver on Time or on Budget
• **Complex projects with long planning horizons** • **Decision-making, planning, and management are typically multi-actor processes with conflicting interests** • **Technology and designs are non-standard** • **Project scope changes over time** • **Over-commitment to a certain project concept** • **Due to large sums of money involved, principal-agent problems are common** • **Complexity and unplanned events are often unaccounted for leaving budget and time contingencies sorely inadequate** • **As a result of the latter misinformation about costs, schedules, benefits, and risks is the norm throughout project development and decision-making** • **And therefore there are cost overruns and benefit shortfalls that undermine project viability during project implementation**

Source: Compiled by the Author from Flyvbjerg (2011: 322) "Managing Major Projects".

There are arguments that other countries can build nuclear power projects on time. However, there are three central reasons why other countries have built new reactors on time: (1) these projects were not the latest in nuclear technology - in countries where Generation III nuclear technology is being built, for example in France and Finland, there are major budgeted cost over-runs of €2.7 billion at the Finnish Olkiluto reactor, and €1 billion at the French Flamanville reactor (De Beaupuy, 2010); (2) working conditions in the US are not similar to those in China and South Korea; and (3) the companies building nuclear power in China and South Korea are government owned and avail of lower rates of interest for finance.

Proponents of the hypothesis state that not a lot has changed since the last period when nuclear new build projects began construction (CVP), and this does not augur well for new projects. For example, public administration has not improved in terms of delivering a coherent long term energy policy (CVP). Decision-making processes in the nuclear sector which involve multi-level actor groups are still not made in a unified approach. For example, nuclear energy is cited as being one of the solutions in the battle against climate change, and also for US energy security and US energy independence, yet, this is not supported at an administrative level to date. The Energy Policy Act of 2005 which incentivised nuclear new build, and was responsible for 18 applications for nuclear new build projects has been slow in its implementation as stated earlier. A major constant remains in the system in that mechanisms to deliver on policy in the form of outcomes remain a weakness of the US public administration system (CVP).

The NRC having been viewed as a contributor to the time delays and cost overruns in the last nuclear new built projects has aimed to standardise the design process for new projects (CVP). As one interviewee (2D) stated "*Cost overruns were just enormous and the Nuclear Regulatory Commission and the Department of Energy, they would have one formula to do criteria that you needed to meet and you'd meet it, and they'd change their mind and you had to go in and tear it out and start over again. Real expensive*".

However, since then it has implemented a new licensing process in order to decrease the length of time it takes to go through the licensing process and provide more certainty in the process to potential operators. However, no one company has tested the regime, and the Southern Nuclear project in Georgia will be the first to do so, hence delays can be expected there. These delays should not deter the nuclear industry as the new legal processes of the NRC will need to be modified, and these modifications will only benefit future applicants (CVP).

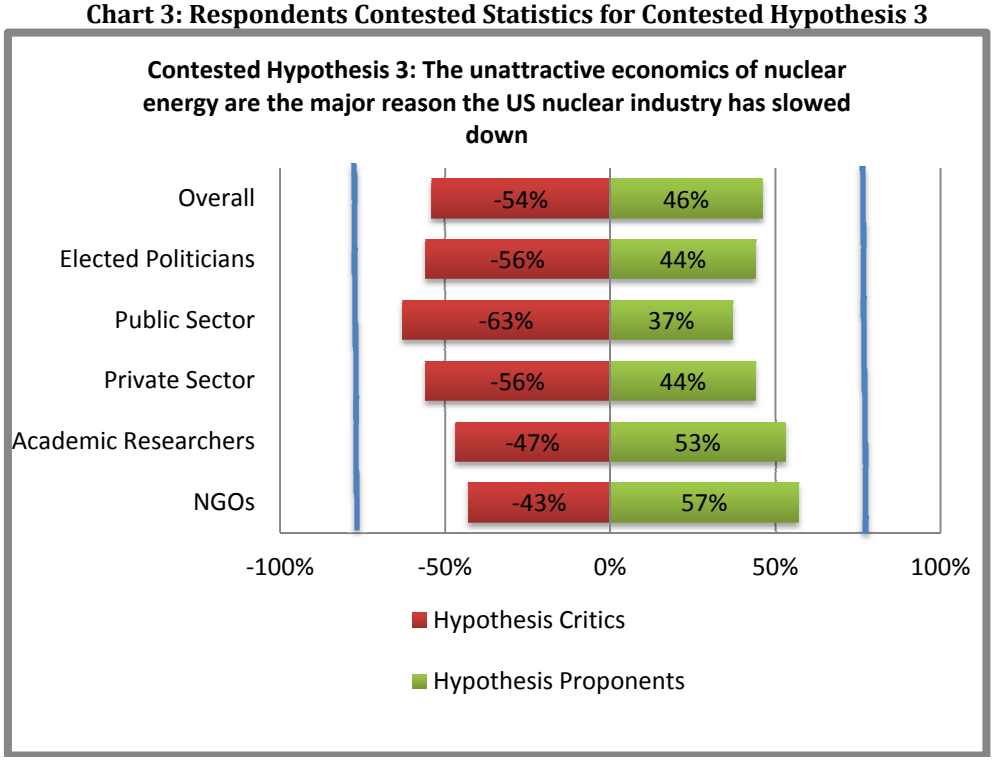
Conditions have not improved yet in the US to deliver a nuclear new build project on time and on budget (4B). Prospective nuclear new build projects face too much uncertainty in attempting to deliver projects on time and on budget (CVP). This problem will have to be rectified to increase the number of projects in the immediate future and requires more acting in unison by actors in the nuclear sector (CVP). Public administration at a Federal level needs to improve as in essence they have the responsibility to ensure that uncertainty in the nuclear sector is reduced, not increased by their involvement (CVP). The example of the Georgia new nuclear project demonstrates that, despite the success so far in the management of the Southern Nuclear project in Georgia – scheduled to be awarded its licence (COL) so that it can begin construction in 2012 - they have been accused of going over budget and of being non-transparent about the issue by the Southern Alliance for Clean Energy environmental group (5G). Hence, project management issues remain, but as Flyvberg (2011) stated, it is imperative that complexity and unplanned events have been accounted for in the project time schedule and financial budget. For the nuclear industry in the US, the Georgia project will have a significant effect on future nuclear new build (CVP).

5.3: Contested Hypothesis 3

The unattractive economics of nuclear energy are the major reason the US nuclear industry has slowed down

There are contrasting viewpoints on why the nuclear renaissance has not occurred in the US. The unattractive economics of nuclear energy was cited by many of the interviewees as the main reason for the stalled level of nuclear new build projects in the US. The large upfront capital cost of a nuclear project increases the investment risk deeming a nuclear project as unattractive economically. However, the evidence points away from the economics of nuclear energy as the main reason of why the nuclear renaissance has not happened in the US, and therefore this hypothesis is rejected with a slim majority of the interviewees being critics of the hypothesis (see Chart 3). In essence, economic risk attached with such large upfront investments is not the majority issue but just one reason of many in why the nuclear industry in the US has slowed down.

Chart 3: Respondents Contested Statistics for Contested Hypothesis 3



n=59, nElected Politicians=9, nPublic Sector=19, nPrivate Sector=9, nAcademic Researchers=15, nNGOs=7

The cost-effectiveness (or economics) of nuclear energy have made building nuclear new build unattractive, however, there are a variety of other important reasons as to why new nuclear projects have stalled. In particular, these centre on the lack of improvement made to the public administrative system regarding nuclear energy in the US. Indeed, the problems due to the latter issues result in uncertainty surrounding the continued growth of the nuclear sector. This uncertainty in the nuclear sector deters new investment.

Lack of Public Administration Improvement at Federal Level

Nuclear energy has also suffered due to a lack of improvements made to the public administrative system at a federal level in the nuclear sector. As one interviewee (4E) states *"I think the big hurdles for nuclear are all technology and capital risk subsidies that .... have to come from the Federal government...and you have to get a NRC permit and that is a pain in the neck and takes a long time...so it is mostly Federal issue for nuclear"*. Nuclear power has received no support from the US government through climate change and environmental incentive mechanisms. The Energy Policy Act of 2005 supported nuclear energy development through incentives but, Federal institutions have been slow to deliver these as demonstrated earlier. There is no united action among Federal institutions and indeed some interviewees point towards too much bureaucracy and the failure of public administration in the US (2B, 4A, 4B). Critics of the hypothesis - that the unattractive economics of nuclear energy are the major reason the US nuclear industry has slowed down - also state that with the current political tensions between Republicans and Democrats in the Senate mean that no Federal institutions want to implement new policies or changes (CVC). Further, inaction on a carbon market or carbon tax has failed to give nuclear energy a cost advantage regarding its non-CO_2 producing electricity production. The *status quo* of favouring the oil, gas and coal industries remain for fear of hurting the US economy (CVC).

It is difficult however, for the Federal institutions to operate as there is a question surrounding state rights. Where there are no rights or legislation explicitly given to the Federal system then the issue in question will reside under the jurisdiction of the state [i.e. because of the supremacy clause Article VI Clause 2 of the US Constitution]. This has been documented in the literature and in particular in relation to the energy sector. Timney (2002) highlights the problem in the electricity sector where a lack of federal regulation let speculators cause the California energy crisis. As a result states had to become more proactive in the management of their energy sector or be susceptible to the lack of Federal governance (Timney, 2002). Further, Kincaid and Cole (2005) in a public survey on state and US Federal issues assert that there will be public support for national initiatives but enthusiasm for federal programmes quickly recedes – they demonstrate this by using the 2011 terrorist attacks as an example. Hence, some critics of the hypothesis argued that too much expectation is placed at a Federal level for implementing new policy (CVC). They state similar to Lutz (1992) that the Federal system in the US will guarantee a floor of rights and that development in rights for the individual will arise where states enter into competition with each other. If a similar scenario is said to be in existence in the US, it places more responsibility on the state rather than the federal system in relation to finding a solution. Indeed, an individual state should be the innovator regarding new policy and legislation. However, there is an ongoing sway of power between the state and the federal system aided by the pre-emptive statute where state and local feedback is sought prior to final amendment of statutes (Zimmerman, 1990; Kincaid, 1990).

The majority of energy policies emanating from Federal institutions that are implemented are short term in nature so as to have a limited effect on electricity prices (4A, 4E, 4F, 5B). However, electricity policy does suffer from fragmentation with each state having significant control of their own electricity policy – except for those in

regional electricity markets, for example PJM. It is rather difficult therefore at a Federal level to impact upon state policy, as there will most likely be significant opposition by politicians to any Federal policies that will push energy prices in their state. Hence, most action at Federal level is taken in the form of financial incentives or environmental and safety legislation but all this has been limited as has been stated earlier. Any action that does transpire on these latter issues tends to be reduced in remit by the powerful lobby groups of which the nuclear lobby is not one, hence action at a Federal level that results in positive outcomes for nuclear are rare (4A, 5B). For example, the 2005 Act stated that energy security (energy independence) was a key goal in US energy policy and nuclear was to assist in these goals. However, support for this policy has not materialised to any degree at Federal level, and the nuclear industry has been left to the private sector with a slow implementation process for any of the incentive schemes established in the 2005 Act.

It follows from the above that nuclear energy issues are under-represented at a Federal level. During the wave of nuclear expansion in the 1960s and 1970s the development of a national nuclear lobby group received little attention. As a result national lobby groups, lobby formations and networks do not as readily exist or are at an earlier stage of development than lobby groups, networks and associations for other energy sources – the Nuclear Energy Institute was only established in 1994. The NRC has the most significant role in the US nuclear energy sector. The Department of Energy also still plays a role with the Office of Nuclear Energy at the forefront however, notably the Blue Ribbon Commission (2011) suggest the establishment of a new independent institution to deal with the long-term radioactive waste issue. The Blue Ribbon Commission was a new institution established in 2010 and consists of 15 members who were given responsibility to produce a report on the backend of the nuclear fuel cycle in the US.

Linked intrinsically to this issue is the problem of education on and surrounding nuclear energy issues. Nuclear energy is a complex subject and topic – there is an educational gap surrounding the subject area (CVC). Indeed many employees across energy and nuclear energy institutions not to mention the public, do not understand all the issues involved (2B, 4A, 5B). There is a shortage of current and prospective employees who can envisage the holistic picture of nuclear energy, and as a result decision-making from organisations in the nuclear energy decision-making sectors lack holistic decision-making ability; therefore decision-making on nuclear energy matters suffers from a piecemeal or fragmented approach, i.e. where a decision is made regarding a particular part of nuclear energy policy or regulation (2B).

President Obama is a particular public advocate of the need to maintain expertise in nuclear energy. He stated: "*So make no mistake: Whether it's nuclear energy, or solar or wind energy, if we fail to invest in the technologies of tomorrow, then we're going to be importing those technologies instead of exporting them. We will fall behind. Jobs will be produced overseas, instead of here in the United States of America. And that's not a future that I accept.*" (February 17th, 2010). In any country beset by the recent financial crisis (the subprime crisis 2007-2010), the issue of employment is of importance to the economy as the employment rates increase. The nuclear energy sector is an important employer and has a highly educated workforce, and this should be maintained (CVC). The above problems concerning the need for expertise of

expertise has long been recognised in nuclear law and risk literature (Breyer, 1978; Kasperson et al. 1980; Yellin 1981; Nelkin, 1995; Palfreman, 2006), and more recently in the Blue Ribbon Commission (2011) report on the future of nuclear energy in the US.

6: Conclusion

This paper has examined from a policy perspective Federal and State policy in the nuclear energy sector in the US from 1990 to 2010, with a particular focus on nuclear new build policy and questions whether it is or has become a Federal or State responsibility. 11 research hypotheses were developed and tested during an interview process with key stakeholders in the sector however only three qualified for further in-depth analysis.

The Uncontested Hypotheses however, are conclusions in themselves. There was consensus that there is too much competition by other energy sources to enable widespread nuclear energy expansion in many US states at present. There are other factors which have played a role in nuclear energy development in the US, in particular, the long regulatory regime which contributed to slow construction times, different technical designs in different states, and a weak nuclear lobby. However, the latter has seen some positive change and environmental lobbying groups even no longer see nuclear energy as the primary opposition. There however, remains a problem with information dissemination to the public regarding nuclear energy and this corresponds with a similar gap in knowledge and skills development in the educational sector.

The Contested Hypotheses revealed that that there are public misconceptions or at the very least incorrect interpretations of public administration, and project management, and legal structure issues that exist for the planning of large infrastructure in the US have been identified. It has also been shown that there are cases of Federal policy inaction, and that consequently state policy can be a key driver in encouraging the growth and operation of the nuclear industry.

First, the strength of Federal law towards the nuclear energy sector was assessed. In general it was determined there was policy inaction towards nuclear power at Federal level. An example of this inaction is evident in the weak application of the law such as the Energy Policy Act of 2005 which had as its remit to re-ignite the industry, but has so far failed to have a significant influence or even to be applied to a significant degree for nuclear energy. In addition to this, while the regulatory body for the sector, the NRC (Nuclear Regulatory Commission) has improved as an institution, it has achieved this improvement from a very low base. Consequently, there is the example of one state (Georgia) intervening in the sector and introducing its own law to provide more certainty to the nuclear sector by the introduction of the Bill 31 which enacted the "Georgia Nuclear Energy Financing Act" in 2009 (see Heffron, 2012b for more analysis on this). This permits the state utility, Georgia Power, to recover costs of construction from the beginning of the construction phase - these are known as Construction Work In Progress (CWIP) payments. Further, many of those interviewees expressed surprise about the progress of the project and that the project was near to being awarded the combined licence (COL) despite the inaction at Federal towards nuclear.

Second, in the last period of nuclear new build, the projects were dominated by the failure of projects to deliver on time and on budget. In the US, there remains a misunderstanding of the issue of project management for complex construction projects, and it is highly arguable whether many of these issues have been resolved. There remains some level of discord between many of the actor groups in the nuclear energy sector, as evidence by delays in the regulatory process, and actions being taken by environmental groups. Yet, it should be noted that the nuclear project in Georgia will be a test case for the regulatory process of the NRC and for many other factors in how to bring a nuclear project into operation in the US.

The final key issue discussed concerns the view that the economics, in essence, the cost effectiveness and investment risk of a nuclear energy project is the major reason that has made building nuclear new build unattractive. The majority of those interviewed for this research oppose this latter view that economics of nuclear energy are the majority reason and argues that there are a variety of other important reasons as to why new nuclear projects have stalled. In particular, this centres on the lack of improvement made to the public administrative system regarding nuclear energy in the US. Indeed, the problems due to the latter issues result in major uncertainty surrounding the continued growth of the nuclear sector. This uncertainty in the nuclear sector deters new investment. However, the planned nuclear power project in Georgia demonstrates that a nuclear project can happen despite the negative attitudes that emanates from the investment risk that is attached to nuclear energy projects. President Obama's initial positive statements concerning growth in the nuclear sector have been re-buffed and negated. Public administrators have a role to play in the electricity sector and as the Georgia case demonstrates state level action where there is widespread Federal policy inaction can be highly effective.

It is not a stated aim of this research to consider the effects of the incident at Fukushima on the nuclear sector, as many will not materialise or become evident for some time. Nevertheless, there is an increased emphasis on safety since Fukushima, and this may lengthen the regulatory approval times to a degree of future reactor designs that need to go through the approval process. However, the Westinghouse AP1000 has had the benefit of being in the process for some time and, the NRC has finally approved the two reactors at Plant Vogtle in Georgia (February, 2012), and a further two at the Virgil C. Summer plant in South Carolina (March 2012). These projects can now proceed with construction. By co-incidence the earlier mentioned and also similar upfront capital intensive low carbon emitting energy projects such as the offshore wind project (Cape Wind) and the coal CCS project (FutureGen) which faced similar problems to nuclear new build projects, will also begin construction in 2012. The capability of Federal policy through the Energy Policy Act of 2005 to deliver on its intentions has taken time. Consequently, the state has assumed the responsibility for encouraging nuclear new build. And as this research suggests there is a need for further reform in the administrative and organisational capacity of the public administration system to ensure that future legislation is more responsive in meeting its purpose and objectives within a faster time period. Time delays for large infrastructure projects increase costs and have an important role in the project management process, which this research highlights needs to improve also for the continued development of these capital intensive large energy infrastructure projects. A cross case comparison of the three

latter projects in nuclear energy, coal and wind will provide interesting opportunities for future research in the area.

Acknowledgements

The author is most grateful to all those who have provided insights and advice in particular Dr. William J. Nuttall, and Mr. Angus Johnston. Thanks also for their support and advice is expressed to Dr. John Parsons, Dr. Bruce Collison, Dr. Dave Gibson, Mrs. Coral Franke; and others who proved invaluable in their assistance, Professor Tony Lawson, Professor Andrew Gamble, Mr. Tim Bellis, all interviewees listed in Appendix A, and the EPRG Working Paper Series anonymous reviewers. The opinions expressed in this paper are not necessarily shared by all those that have provided assistance, and all responsibility for errors and omissions rests solely with the author. The author expresses thanks to the Electricity Policy Research Group, Trinity Hall, the Judge Business School, and Cambridge European Trusts, all based at the University of Cambridge for financial support which enabled this research. The author also wishes to thank the staff at the Center for Energy & Environmental Policy Research, Massachusetts Institute of Technology (MIT), Cambridge, Massachusetts, USA and The IC^2 Institute, The University of Texas at Austin, Austin, Texas, USA for their generous help during his stay as a visiting student.

Appendices

Appendix A: List of Interviewees

Interviews were completed with the individuals listed below. Other interviews completed which provided no new insight have been excluded. All those interviewed are thanked. All interviews were recorded with the permission of the interviewee. Interviews were conducted in the United States during June to August 2010. Many of the interviews were from four states all east of the Rockies where there the majority of nuclear power plants are located as shown in Figure 1. These four states are Pennsylvania, Texas, Georgia, and Massachusetts which account for near 20 *percent* of the US reactors and nuclear electricity generation (EIA, 2010b).

59 interviews had been completed by the end of the process. Interviewees lasted between 25 - 150 minutes. Interviewees included state politicians, state regulators of electricity, state nuclear safety offices, electricity grid operators, electricity and nuclear energy company operators, academic experts, and members of various other state institutions, and environmental groups in all three states. All state senators and state house members were member of the state energy committees responsible for nuclear energy.

In interview, interviewees were asked to focus on the period 1990-2010. This was achieved by asking them what were the major developments in the nuclear sector over that period of time. The interviewer asked in question form the hypotheses above (AppendixA) or elicited the answer by making a statement and asking the interviewee their opinion. In other cases the interviewee stated their view on the issues without the need for intervention. The interviews followed a semi-structured approach based around the 12 hypothesis. Hypotheses are asked as statements to gather the interviewee's opinion but are deliberate statements, and so the attempt is made not to lead the interviewee in a certain direction.

The empirical data was analysed using *Atlas.ti qualitative data analysis v.6*. Coding categories were developed from the literature review that reflected the key issues in nuclear new build, for example, as legal development, regulation, technology, political change. The data was sorted, with further sub-categories developed. The advantage of such a qualitative data analysis is that it allows for statements and claims of various interviewees to be corroborated against other interviewees. This is also a validity process which is of central importance to qualitative research (Miles and Huberman, 1994).

Category 1: Elected Politicians (9)
State Politicians on State Legislature Energy Committees

Interview	Interviewee Position	Organisation

Code		
1A	State Senator	Georgia State Senate
1B	State Senator	Pennsylvania State Senate
1C	State Senator	Pennsylvania State Senate
1D	State House Member	Pennsylvania State House of Representatives
1E	State House Member	Pennsylvania State House of Representatives
1F	State House Member	Pennsylvania State House of Representatives
1G	State Senator	Texas State Senate
1H	State House Member	Texas State House of Representatives
1I	State House Member	Texas State House of Representatives

Category 2: Public Sector
Federal and State Agencies: Finance, Environment, Energy and Nuclear Safety, State Electricity Regulator, State Transmission Grid System (19)

Interview Code	Interviewee Position	Organisation
2A	Program Analyst	Office of Nuclear Energy, US Department of Energy
2B	Former Chairman and Commissioner of the NRC	US Nuclear Regulatory Commission
2C	Director of the Division of New Reactor Licensing	US Nuclear Regulatory Commission
2D	Commissioner	Georgia Public Service Commission
2E	Manager	Georgia Department of Natural Resources – Environmental Protection Division, Environmental Radiation Program
2F	President and CEO	SERC Reliability Corporation
2G	Engineer	Georgia Public Service Commission
2H	Director	Center of Innovation for Energy. Georgia Environmental Finance Authority (GEFA)
2I	Chief, Division of Nuclear Safety	Pennsylvania Department of Environmental Protection
2J	Nuclear Safety Specialist	Pennsylvania Department of Environmental Protection
2K	Utility Energy Analyst	Pennsylvania Public Utility Commission
2L	Client Manager, Market Services Division	PJM Interconnection, LLC
2M	Head of Office of Consumer Advocate	Office of Attorney General - Pennsylvania
2N	Director of Competitive Markets Division	Public Utility Commission

2O	Director of Communications	Public Utility Commission
2P	Senior Research Analyst	Texas Comptroller of Public Accounts
2Q	Assistant Director of Regulatory Analysis	Office of Attorney General
2R	Assistant Director of Regulatory Affairs	Office of Public Utility Counsel, Texas.
2S	Director Of Media Affairs	ERCOT, Texas

Category 3: Nuclear Energy Companies (9)

Interview Code	Interviewee Position	Organisation
3A	Public Relations Officer	Southern Company
3B	Board of Directors	Southern Company
3C	Supervisor – PPL Susquehanna Energy Information Center	PPL - Susquehanna Energy PA
3D	Principal Market Planning Analyst	Exelon
3E	Corporate Communications	Austin Energy
3F	Director, Market Policy at CPS Energy	San Antonio Energy (CPS)
3G	Director of Communications	NRG Texas LLC.
3H	Vice President of Nuclear Project Development	Exelon
3I	Vice President of Regulatory Affairs	South Texas Project Nuclear Operating Company

Category 4: Academic Researchers (15)

Interview Code	Interviewee Position	Organisation
4A	Professor	Department of Nuclear Science and Engineering, MIT
4B	Research Scientist, adn Executive Director of the MIT Nuclear Fuel Cycle Project	Department of Nuclear Science and Engineering, MIT
4C	Director – Alliance for Global Sustainability Energy Flagship Program	MIT Laboratory for Energy and the Environment, MIT
4D	Professor, Director of the Energy Initiative	Department of Physics, MIT
4E	Professor of Global Energy Policy, Director of the Harvard Electricity Policy Group	John F. Kennedy School of Government, Harvard University
4F	Senior Lecturer	Department of Economics, Stanford University
4G	Professor, School of	Georgia Institute of

	Public Policy	Technology, & Oak Ridge National Laboratory
4H	Professor of Law	Emory Law School, Emory University, Atlanta
4I	Research Associate	Centre for International Energy & Environmental Policy, LBJ School of Public Affairs, The University of Texas at Austin.
4J	Research Assistant and PhD Candidate	Centre for International Energy & Environmental Policy, LBJ School of Public Affairs, The University of Texas at Austin.
4K	Assistant Professor	Cockrell School of Engineering, The University of Texas at Austin.
4L	Senior Research Scientist	Institute for Fusion Studies, The University of Texas at Austin.
4M	Professor of Technology, Executive Director of Carnegie Mellon Electricity Industry Center	Tepper School of Business, and Engineering and Public Policy, Carnegie Mellon University, PA
4N	Professor of Economics and Co-Director of Carnegie Mellon Electricity Industry Center	Tepper School of Business, and Engineering and Public Policy, Carnegie Mellon University, PA
4O	Assistant Professor of Energy Policy and Economics	Department of Energy and Mineral Engineering, and Electricity Markets Initiative Pennsylvania State University – Electricity Centre

Category 5: Non-Governmental Organisations (6)

Interview Code	Interviewee Position	Organisation
5A	Director of Energy Program	Public Citizen
5B	Senior Director	Nuclear Energy Institute
5C	Director	Center for Energy, Enterprise and the Environment, Penn Future
5D	Director	Citizen Power (PA)
5E	CEO	Former Luminant/Energy Start-Up (TX) – Clean Energy Technology Association
5F	Energy Specialist	Environmental Defense Fund
5G	High Risk Energy Director	Southern Alliance for Clean Energy

References

1. Aaker, D. A., Stayman, D, M. and Hagerty, M. R. 1986. Warmth in Advertising: Measurement, Impact, and Sequence Effects. The Journal of Consumer Research, 12 (4), 365-381.
2. Altshuler, A. and Luberoff, D. 2003. Mega-Projects: The Changing Politics of Urban Public Investment. Brookings institution: Washington D. C., US.
3. American Planning Association, 2005. "JAPA Article Calls on Planners to Help End Inaccuracies in Public Project Revenue Forecasting. Available online: [Last Accessed October 2011: http://www.planning.org/newsreleases/2005/ftp040705.html]
4. Argyris, C & Schon, D. 1978. Organisational Learning: A theory of action perspective. Jossey-Bass: San Francisco, CA, United States.
5. Bernstein, R. J.: 1976, The Restructuring of Social and Political Theory. The University of Pennsylvania Press: Philadelphia, PA, US.
6. Blue Ribbon Commission, 2011. Blue Ribbon Commission on America's Nuclear Future: Report to the Secretary of Energy, January 2012. US Department of Energy: Washington DC.
7. Bradford, P. A. 2009. The nuclear renaissance meets economic reality. Bulletin of the Atomic Scientists, 65 (6), 60–64.
8. Bredimas, A. and Nuttall, W.J. 2008. An international comparison of regulatory organizations and licensing procedures for new nuclear power plants. Energy Policy, 36 (4), 1344-1354.
9. Breyer, S. 1978. *Vermont Yankee* and the courts' role in the nuclear energy controversy. Harvard Law Review, 91, 1833, 1977-1978.
10. Cape Wind, 2012. Cape Wind Project is a Good Deal for Massachusetts. Available online: [Last accessed April 2012: http://www.capewind.org/index.php].
11. Carlson, J. M. 1990. Subjective Ideological Similarity between Candidates and Supporters: A Study of Party Elites. Political Psychology, 11 (3), 485-492.
12. Chu, S. 2010. Secretary of the US Department of Energy. Statement on the February 4th 2010 FY 2011 Budget Hearing before the Senate Committee on Energy and Natural Resources. Available

from: [Last accessed online August 2011 http://energy.gov/sites/prod/files/ciprod/documents/2-4-10_Final_Testimony_(Chu).pdf]

13. Conklin, J. 2003. Wicked Problems and Social Complexity. Cognexus Institute, 2001-2003. Available online: [Last accessed Jan 2011: http://cognexus.org/wpf/wickedproblems.pdf].
14. Corbey, D. 1995. Dialectical Functionalism: Stagnation as a Booster of European Integration. International Organization, 49 (2), 253-284.
15. De Beaupuy, F. 2010. Areva Finnish Nuclear Plant Overruns Approach Initial Cost After Provision. [Available online: last Accessed Nov 10th, 2010: from http://www.bloomberg.com/news/2010-06-24/areva-finnish-nuclear-plant-overruns-approach-initial-cost-after-provision.html]
16. Drolet, A. 2002. Inherent Rule Variability in Consumer Choice: Changing Rules for Change's Sake. The Journal of Consumer Research, 29 (3) 293-305.
17. EIA, 2010a. Executive Summary: Annual Energy Outlook 2010 with Projections to 2035. Available online: [Last Accessed December 2010: http://www.eia.gov/oiaf/aeo/pdf/execsummary.pdf]
18. EIA, 2010b. EIA Annual Energy Review 2009 Available online: [Last Accessed August 2011: ftp://ftp.eia.doe.gov/multifuel/038409.pdf]
19. Flyvberg, B. 2011. Managing Major Projects. In Morris, P. W. G., Pinto, J.K. and Soderlund, J. (eds). The Oxford Handbook of Project Management. Oxford University Press: Oxford, UK.
20. Flyvbjerg, B., Bruzelius, N., and Rothengatter, W. 2003. Megaprojects and Risk: An Anatomy of Ambition. Cambridge University Press: Cambridge, UK.
21. Folkes, V. S., Martin, I. M. and Gupta, K. 1993. When to Say When: Effects of Supply on Usage. The Journal of Consumer Research, 20 (3), 467-477.
22. Goodfellow, M. J., Williams, H. R. and Azapagic, A. 2011. Nuclear renaissance, public perception and design criteria: An exploratory review. Energy Policy, 39 (10), 6199-6210.
23. Grimes, R. W. and Nuttall, W. J. 2010. Generating the Option of a Two-Stage Nuclear Renaissance. Science, 329 (5993), 799-803.
24. Hecht, G. 1998. The Radiance of France: nuclear power and national identity after World War II. The MIT Press: Cambridge, MA, United States.
25. Hecht, G. 2009. (2nd Ed.). The Radiance of France: nuclear power and national identity after World War II. The MIT Press: Cambridge, MA, United States.

26. Heffron, R. J. 2012a. Romanian Nuclear New Build: Progress Amidst Turbulence. Progress in Nuclear Energy, 56, 43-60. – doi:10.1016/j.pnucene.2011.12.003
27. Heffron, R. J. 2012b. Nuclear New Build in the USA 1990-2010: A Three State Analysis. Technology Forecasting and Social Change. Forthcoming. – doi:10.1016/j.techfore.2012.10.023
28. Heffron, R. J. 2012c. Nuclear New Build in the USA 1990-2010: A Three State Analysis. Electricity Policy Research Working Paper Series, EPRG WP 1204, Cambridge: University of Cambridge.
29. Hisschemoller, M. and Mol, A.P.J. (Eds.), Climate OptiOns for the Long Term (COOL). Evaluating the Dialogues. Final Report - Volume E. Bilthoven: NRP report 410 200 119, Netherlands.
30. Holt, M. 2011. Nuclear Energy Policy. Congressional Research Service. Available from: [Last Accessed online October 2011: http://energy.gov/sites/prod/files/ciprod/documents/2-4-10_Final_Testimony_(Chu).pdf].
31. Jasper, J. M. 1990. Nuclear Politics:
Energy and the State in the United States, Sweden, and France. Princeton University Press: New Jersey, USA
32. Joskow, P. L. and Baughman, M. L. 1976. The Future of the U.S. Nuclear Energy Industry. The Bell Journal of Economics, 7 (1), 3-32.
33. Kasperson, R. E., Berk, G., Pijawka, D., Sharaf, A.B., Wood, J. 1980. Public Opposition to Nuclear Energy: Retrospect and Prospect. Science, Technology, & Human Values, 5 (31), 11-23.
34. Kincaid, J. 1990. From Cooperative to Coercive Federalism. Annals of the American Academy of Political and Social Science, 509, 139-152.
35. Kincaid, J. and Cole, R. L. 2005. Public Opinion on Issues of U.S. Federalism in 2005: End of the Post-2001 Pro-Federal Surge? Publius, 35 (1) 169-185.
36. Lawson, T. 1997. Economics and Reality. Routledge: London, United Kingdom.
37. Lawson, T. 2003. Reorienting Economics. Routledge: London United Kingdom
38. Lawson, T. 2009. Applied Economics, contrast explanation and asymmetric information. Cambridge Journal of Economics, 33, 405-419.
39. Letter from Michael J. Wallace, Vice Chairman and Chief Operating Officer, Constellation Energy, to Dan Poneman, Deputy Secretary of Energy, October 8, 2010. Available online: [Last Accessed August 2010: http://media.washingtonpost.com/wp-srv/hp/ssi/wpc/constellationenergy.PDF?sid=ST2010100900005]

40. Lutz, D. S. 1992. The State Constitutional Pedigree of the U.S. Bill of Rights. Publius, 22 (2) 19-45.
41. MacKerron, G. 2004. Nuclear power and the characteristics of 'ordinariness' – the case of UK energy policy. Energy Policy, 32 (17), 1957-1965.
42. Mason, R. 0. 1969. A dialectical approach to strategic planning. Management Science, 15, B403-B414.
43. Mason, R. O. and Mitroff, I. I. 1981. Challenging Strategic Planning Assumptions: theory, cases and techniques. Wiley: New York, United States.
44. *Massachusets v. Environmental Protection Agency*, 549 U. S. 497 (2007)
45. Miles, M. B. and Huberman, A. M. 1994. (2nd Ed.) Qualitative Data Analysis. Sage Publications: London, UK.
46. Mitroff, I. I. 1971. A Communication Model of Dialectical Inquiring Systems-A Strategy for Strategic Planning. Management Science, 17 (10), B634-B648.
47. Mitroff, I. I., & Mason, R. 0. 1981. The metaphysics-of policy and planning: A reply to Cosier. Academy of Management Review, 6, 649-652.
48. Moore, R. C. 2011. Enhancing the Role of the State and Local Governments in America's Nuclear Future: An Idea Whose Time Has Come. Prepared for the The Blue Ribbon Commission: Pronghorn Engineering, Clancy, MT 59634.
49. Moss, P. A. 1998. Recovering a Dialectical View of Rationality. Social Indicators Research, 45 (1/3), Validity Theory and the Methods Used in Validation: Perspectives from Social and Behavioral Sciences, 55-67.
50. Nagao, D. H. and Davis, J. H. 1980. The Effects of Prior Experience on Mock Juror Case Judgments. Social Psychology Quarterly, 43 (2), 190-199.
51. National Commission, 2011. Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President. National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Available online: [Last accessed Dec 2011: http://www.oilspillcommission.gov/sites/default/files/documents/DEEPWATER_ReporttothePresident_FINAL.pdf].
52. Nelkin, D. 1995. Selling Science: How the press covers science and technology. W. II. Freeman: New York, US.

53. NRC, 2008, Yucca Mountain Licence Application. Available online: [Last accessed Dec 2011 http://www.nrc.gov/waste/hlw-disposal/yucca-lic-app.html].
54. NRC, 2011. Statistics on Licence Renewals and Power Upgrades. NRC, 2011. Available from:[Last Accessed online October 2011: http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html; http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/power-uprates.html]
55. Nuttall, W. J. 2005. Nuclear Renaissance: Technologies and Policies for the Future of Nuclear Power. Institute of Physics Publishing: Bristol and Philadelphia.
56. Nuttall, W. J. and Taylor, S. 2009. Financing the Nuclear Renaissance. European Review of Energy Markets, 3 (2), 187-202.
57. Obama, B. 17th February Announcement of 48.3 billion Federal Loan Guarantee. Available online: Last accessed August 2011 http://abcnews.go.com/blogs/politics/2010/02/obama-says-safe-nuclear-power-plants-are-a-necessary-investment/]
58. Palfreman, J. 2006. A Tale of Two Fears: Exploring Media Depictions of Nuclear Power and Global Warming. Review of Policy Research, 23, (1), 23-43.
59. Pepitone, A. and M. DeNubile. 1976. Contrast effects in judgments of crime severity and the punishment of criminal violators. Journal of Personality and Social Psychology, 33, 448-459.
60. Pinkstone, B. 2002. Persistent demi-regs and robust tendencies: critical realism and the Singer-Prebisch Thesis. Cambridge Journal of Economics, 36, 561-583.
61. Plushnick-Masti, R. 2011. Commission Lets 36 States Dump Nuclear Waste in Texas. Available online: [Last accessed Dec 2011 http://www.huffingtonpost.com/2011/01/05/commission-36-states-nuclear-waste-texas_n_804527.html].
62. Pope, D. 2008. Nuclear Implosions: The Rise and Fall of the Washington Public Power Supply System. Cambridge University Press: Cambridge, UK.
63. Ross, W. T. and Simonson, I. 1991. Evaluations of Pairs of Experiences: A Preference for Happy Endings. Journal of Behavioural Decision Making, 4 (4), 273-282.
64. Rossin, A. D. and Rieck, T. A. 1978. Economics of Nuclear Power. Science, New Series, 201 (4356), 582-589.

65. Schechter, D. 2011. WestTexas facility read for nuclear waste. Available online: [Last accessed Dec 2011: http://www.wfaa.com/news/texas-news/West-Texas-facility-ready-for-nuclear-waste-115543929.html]

66. Seo, M. & Creed, W. E. D. 2002. Institutional contradictions, praxis, and institutional change: A dialectical perspective. *Academy of Management Review*, 27, 222–247.

67. Sherif, M. and Hovland, C. I. 1961. Social Judgment: Assimilation and Contrast Effects in Communication and Attitude Change. Yale University Press: New Haven, CT.

68. Timney, M. M. 2002. Short Circuit: Federal-State Relations in the California Energy Crisis. Publius, 32 (4) 109-122.

69. U.S. Nuclear Regulatory Commission (NRC), 2010. US Commercial Nuclear Power Reactors – Years of Operation. Available online: [Last accessed August 2011 http://www.nrc.gov/reactors/operating/map-power-reactors.html].

70. US Environmental Protection Agency (EPA). 2011. US EPA Expert Elicitation Task Force White Paper, 2011. Available from: [http://www.epa.gov/stpc/pdfs/ee-white-paper-final.pdf. Previous 2009 draft version available from http://www.epa.gov/osa/pdfs/elicitation/Expert_Elicitation_White_Paper-January_06_2009.pdf].

71. Van de Kerkhof, M. 2006. Making a Difference: On the Constraints of Consensus Building and the Relevance of Deliberation in Stakeholder Dialogues. Policy Sciences, 39 (3), 279-299.

72. Wald, M. 2009. Energy Dept. Said to Err on Coal Project. March 10, 2009, New York Times. [Last Accessed online April 2012: http://www.nytimes.com/2009/03/11/science/earth/11coal.html?_r=2&ref=business]

73. Wallace, M. J. 2010. Letter from Michael J. Wallace, Vice Chairman and Chief Operating Officer, Constellation Energy, to Dan Poneman, Deputy Secretary of Energy, October 8, 2010, Available from: [Last Accessed online October 2011: http://media.washingtonpost.com/wp-srv/hp/ssi/wpc/constellationenergy.PDF?sid=ST2010100900005].

74. Weinberg, A. M. 1972. Social Institutions and Nuclear Energy. Science, New Series, 177, (4043), 27-34.

75. Yellin, J. 1981. High Technology and the Courts: Nuclear Power and the Need for Institutional Reform. Harvard Law Review, 94 (3), 489-560.

76. Zimmerman, J. F. 1990. Regulating Intergovernmental Relations in the 1990s. Annals of the American Academy of Political and Social Science, 509, 48-59.