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Original article

Policymakers and Stakeholders' Perceptions of Science-Driven Nuclear Energy Policy

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Abstract

This study surveyed 137 policymakers and key stakeholders involved in making decisions on nuclear energy policy (e.g., employees of government agencies, academic institutions, nonprofit organizations, industry, and advocacy groups), investigating how they differentially perceived the importance of scientific evidence in driving nuclear policy. We also identified the policy areas that each group of decision-makers are mostly concerned about and showed how such concerns might contextualize and ultimately shape their perceptions of science-driven policy.

Keywords: nuclear energy, nuclear fuel cycles, science-driven policy, scientist-policymaker communication

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1. Introduction

Scientific evidence has been commonly required to underpin the U.S. energy and environmental policy [1]. Government agencies such as the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA) offer scientists routine venues to help policymakers manage the uncertainty and risks associated with energy systems [2]. The EPA Science Advisory Board, for example, reviews the quality of the scientific information that serves as the basis for agency regulations. They also advise the agency on broad scientific matters and recommend policy options [1]. In recent decades, scientific evidence has played an essential role in shaping the U.S. nuclear energy policy. For example, university and national laboratory scientists oversee the performance of federal programs and offer informational inputs to legislation [3]. Recently, the Blue Ribbon Commission on America's Nuclear Future involved worldwide scientists to reassess the nuclear waste management program in the U.S [4].

Although scientific evidence is in need to reduce uncertainty and risk in energy policy decisions, there is little evidence that technical arguments have much of a direct impact on most policy outcomes [1]. Previous literature has documented an epistemological and cultural gap between scientists and those involved in making policy decisions in various contexts [5,6]. While offering informational input to nuclear energy policymaking, scientists often have to address a group of audience with various understanding of scientific concepts [7]. This group of audience is typically composed of policymakers and key stakeholders, such as the regulated industry or professionals, nonprofit organizations, the media, and the public (individuals, community groups and interest groups) [8]. The disconnect between scientists and their audiences' conceptual frames, as Knopman, a former member of the U.S. Nuclear Waste Technical Review Board

pointed out, “is one of several factors that contributed to the present stalemate [surrounding the Yucca Mountain program and nuclear waste management policies]” [7].

Scientists have provided a significant share of the knowledge base for nuclear policy decisions. However, the effectiveness of science-policy interface is constrained by scientists and policy decision-makers’ divergent views on the normative and pragmatic value of scientific evidence [1]. Whereas the U.S. federal government is generally supportive of the development of nuclear energy, no new commercial nuclear power plan has gone online since the 1990s [4]. Policymaking on nuclear waste management has reached a stalemate since the DOE terminated the Yucca Mountain project in 2011 [9]. While some argued that science should have dominated the site selection for a permanent nuclear waste repository, such decisions were made primarily for “policy reasons, not technical or safety reasons” [10]. Given the tension between science and politics, it is critical to understand how policy decision-makers, including policymakers and key stakeholders involved in policy decision-making, perceive the role of science in driving nuclear policy.

In this study, policymakers are defined as a group of government department and legislature who is responsible for making new rules and laws pertaining nuclear energy development. The term “stakeholders,” in contrast, refers to individuals, communities, and organizations involved in making high-level policy decisions on nuclear energy, which include but are not limited to academics, industry, nonprofit organizations, and interest groups. In particular, we focused on the attitudes of policymakers (i.e., regulatory and administrative agencies) and the attitudes of stakeholders (i.e., nonprofit/non-advocacy organizations, and industry/advocacy groups) toward evidence-based policymaking.

We surveyed 137 policymakers and stakeholders and examined how their attitudes toward science-driven policy vary as a function of institutional affiliation. We identified the policy areas of respondents' most salient concerns (defined as issue concerns) and investigated how each issue concern may have contextualized and ultimately shaped their perception of science-driven policy. Such understanding would help explain the reluctance of certain groups to adopt scientific evidence in their decision-making and reveal the source of documented miscommunication among policymakers, scientists, and other stakeholders [6]. Being aware of the specific concerns that prevent policy decision-makers from committing to science-driven policy, scientists will be able to develop effective communication strategies tackling such concerns.

1.1. Science and nuclear energy policy

Nuclear energy policy concerns many issues, such as reactor safety, nuclear weapon proliferation, economics, and environmental sustainability [11]. The earthquake and tsunami that damaged Japan's Fukushima Daiichi nuclear power plant in 2011 raised questions in U.S. Congress about the disaster's implications for plant safety regulation, on-site waste management, and U.S. nuclear energy expansion [12]. Since the 1970s, the nuclear policymaking community has been concerned about potential proliferation resulting from reprocessing of spent fuel [13]. More recently, the dispersion of centrifuge enrichment technology has increased concerns about proliferation resulting from uranium enrichment. In 1977, the Jimmy Carter administration permanently banned the reprocessing of commercial reactor spent fuel. More recently, policymakers have contested the economic competitiveness of nuclear energy [14,15]. While some believe that nuclear energy can be economically attractive, others raise concerns about the

high capital costs of building new reactors [16]. In addition, the long-term availability of fresh water may constrain the environmental sustainability of nuclear energy [16].

Due to the technical complexities involved in managing nuclear fuel cycles, scientists have played a critical role in making most nuclear policy decisions [3]. Nonetheless, policies on nuclear waste management present an arena where science and politics collide. As Samuel Walker, former historian of the Nuclear Regulatory Commission (NRC), highlighted, the Atomic Energy Commission (AEC) disregarded precautionary science and failed to obtain local and state agreement during its first attempt to site a waste repository in 1970s [17]. In 1982, the U.S. Congress passed the Nuclear Waste Policy Act, mandating the geological disposal of spent fuel and high-level waste. While multiple sites were under consideration, the Congress ultimately designated the Yucca Mountain, Nevada site to be the only one for permanent disposal.

Since then, technical and political disputes surrounding the choice of Yucca Mountain have never ceased. Supporters believe that the Yucca Mountain is optimal only because of its location and rock type; opponents, however, argue that "politics, not science" determines the decision on site selection [18]. In 2002, the U.S. Department of Energy, with the backing of the President George W. Bush and Congress, overrode the State of Nevada's objections and approved the Yucca Mountain site for a nuclear waste repository. His successor President Obama, however, proposed budget cuts for the project, stating that Yucca Mountain is "not workable" [9]. This decision has been widely criticized for its lack of scientific justification [9]. Considering these long-term disputes and policy contradictions, we investigated how competing policymakers and stakeholders perceive the role of scientific evidence in determining nuclear energy policies.

1.2. Policy decision-makers' perception of science-driven policy

Prior researchers have examined policy decision-makers' perception and use of scientific evidence in various policy contexts [6]. Research in this field has used different methods – qualitative, analytical, and quantitative and works at different levels of analysis, ranging from behavioral decision theory to systems theory [19]. One common conclusion emerging from these lines of literature is that policy decision-makers' attitudes toward and use of scientific evidence varies depending upon the responsibilities, needs, and goal-oriented interests. Following the Two Communities Theory [20], each member of scientific and policymaking communities has distinct "cultural baggage" that entails unique sets of communication styles, targets of interest, cognitive frameworks (e.g., perception, motivation, decision-making and goal setting), and focal interests to policy discussions. As a result, policy decision-makers' perception and use of scientific evidence is largely influenced by a combination of such cultural and psychological factors.

Specifically, employees of governmental bodies that have played an active role in funding and disseminating scientific research, such as DOE and EPA, might perceive a positive role of science in driving policy. Their positive attitudes can be explained by the availability of their on-site research resources and a strong motivation to promote research supportive of policy change [6]. In a similar vein, people working for nonprofit or for-profit organizations (e.g., think tanks, consulting firms, and private research institutions) that seek to provide expertise and knowledge-based advice to the government might also value the use of scientific evidence in policy debates [19]. Members of such groups have also frequently testified in Congress and served as information and commentary sources for mass media [21]. They would therefore need scientific evidence to back up their positions and establish intellectual legitimacy within society [22].

In addition, members of organizations that enter the policy process through organized interests (e.g., industry, advocacy groups) are willing to uptake scientific evidences that support their favored policies. However, they often "ignore, downplay, distort, or vociferously contest scientific knowledge that fails to support a group's desired policies" and tend to prioritize economic and political considerations over scientific evidence when initiating a new policy [19].

There has been a variety of institutions, organizations, and interest groups involved in making nuclear policy decisions in the U.S., ranging from state governments, nuclear industry, and nongovernmental bodies to concerned publics [8]. Given their distinct institutional responsibilities and interests, policymakers and stakeholders' perception toward the uptake of scientific evidence in policy decisions would vary across individuals with different institutional affiliations. Institutional affiliation, in this study, comprises associations and organizations that seek to achieve their proclaimed goals (e.g., regulatory, advocacy, business, or research) within or beyond their collectives [23].

To examine how institutional affiliation influences one's perceived view of the importance of science in driving nuclear policy, we identified three categories of institutional affiliations. The first category is administrative and regulatory agencies at both federal and state levels (e.g., DOE, EPA, DOD etc.). The second category is composed of nonprofits and non-advocacy groups that seek to offer advice and expertise to the government and the public (e.g., think tanks, consulting firms, law firms). The third category, however, included groups that enter the policy process through organized interests (e.g., advocacy group, industry companies). We posed two hypotheses contrasting the attitudes of special interest groups and those of government agencies and nonprofits/non-advocacy groups:

Hypothesis 1a. Employees of advocacy groups and industry companies perceive science of less importance in driving nuclear energy policy than those affiliated with government agencies.

Hypothesis 1b. Employees of advocacy groups and industry companies perceive science of less importance in driving nuclear energy policy than those affiliated with nonprofit organizations and non-advocacy groups.

1.3. Role of issue concern

The social sciences offer important knowledge about how cognition and mental models influence the behavior of decision makers. However, very limited insight has been gained regarding "when, why, how, even whether science is used in public policy making" [19]. As the National Research Council argued in its report, "[Social science] research can explain the cognitive operations that policymakers and scientists bring to their work" [19]. We attempted to fill this gap in the literature by examining the psychological mechanism underpinning policy decision-makers' attitudes toward science-based policymaking.

When perceiving the strength of science as a driver of nuclear policy, policymakers and stakeholders may rely on such salient concerns to form assessment. Researchers suggested that policymakers and key policy actors are "bounded rational" decision-makers, who tend to minimize cognitive efforts when dealing with complex information or decisions [24]. For instance, policymakers usually devote conscious attention to only one or a few things at a time when processing large amount of information from diverse sources [25]. As a result, policy decision-makers might rely on their most salient concerns (defined as issue concerns) as heuristics or mental shortcuts to form perceptions about science-driven policy [26,27]. Heuristics refer to simple, task-specific decision strategies that allow a decision-maker to determine how to

search information and how to integrate the processed information into a decision [28]. This notion, however, differs from paradigms that define heuristics as rules of thumb or as irrational shortcuts that result in cognitive biases [28].

In our case, issue concerns might function as availability heuristics that guide policy decision-makers' search of information and formation of attitudes toward science-driven policy [29]. Indeed, both experts and laypersons are prone to rely on their primary concerns as availability heuristics to form opinions about scientific issues [30]. For example, Cacciatore, Scheufele, and Corley (2009) showed that the "types of thoughts or applications that come to mind when people are asked to think about nanotechnology" are important cues that determine individuals' support for this technology [31]. These mental associations were powerful because they contextualized individuals' judgment and cued people to evaluate the relative risks and benefits when forming opinions.

Likewise, when perceiving science-driven policy, policymakers and stakeholders may rely on the issue of most salient concern (defined as issue concern) to contextualize their assessments (e.g., if science has ever driven policy change in certain area), while ignoring the role of scientific evidence in other policy contexts. For example, for someone who prioritized the issue of high-level waste management to the development of nuclear energy, his or her favor of science in policy debates might be diminished due to the Yucca Mountain controversy.

Previous research has systematically examined policymakers and key stakeholders' issue concerns using the mental modeling approach [32]. For instance, Li et al. (2016) analyzed and compared the primary concerns of government officials and think tank employees regarding the nuclear fuel cycle. Results showed that although both parties share common concerns on nuclear waste management, the economics of nuclear facilities, and proliferation, they tend to focus on

distinct aspects of each area [33]. While government officials were primarily concerned with the impacts of nuclear fuel cycles on local environment, think tank employees focused more on the relative advantages and disadvantages of nuclear energy compared to other alternative energy options, such as solar and wind [33]. Similarly, in an analysis of Congressional public hearings related to reactor safety, Del (1983) showed that while government officials focus on the technical aspects of nuclear safety, industry stakeholders cared more about energy independence.

These results demonstrated that issue concerns would vary for individuals affiliated with organizations and groups with different interest and responsibilities. We therefore propose a hypothesis on the relationship between institutional affiliation and issue concerns. Given the fact that issue concern might contextualize policy decision-makers' judgement of the role of science in driving policy, we propose another hypothesis on the mediating role of issue concern.

Hypothesis 2. Policymakers and stakeholders affiliated with different institutions are concerned about different aspects of nuclear energy development.

Hypothesis 3. Issue concern mediates the relationship between individuals' institutional affiliation and perceptions of science-driven policy.

2. Methodology

2.1. Survey

We fielded a mail survey to 557 policymakers and stakeholders dealing with energy policy between July and September 2013. The survey included four waves following Dillman's Total Design Method [34]. Wave 1 included a cover letter, a survey questionnaire, and a postage-paid return envelope. Wave 2 included a postcard reminder, followed by another full package to those who did not respond three to eight weeks after Wave 1. The sample included three groups of people: 404 attendees of the Congressional public hearings related to nuclear power between

May 2009 and January 2013, 63 former members of the 109th, 110th, and the 111th Congress and key congressional staff members, and 90 attendees of the Blue Ribbon Commission's regional public meetings on nuclear waste management. We collected the contact information of identified respondents via online records. At the closure of data collection, we received 137 valid responses and achieved a response rate of 27.4% [35].

2.2.Variables

Dependent variable. We measured respondents' perception of science-driven policy on a 4-point scale, asking them "compared with other concerns, how strong is scientific evidence as a driver of policy?" ("not at all" = 5.1%, "somewhat" = 54%, "very" = 31.4%, "extremely" = 9.5%).

Independent variables. We asked respondents to indicate the organization that currently employs them with a list of fourteen organizations[1] and then coded their responses into four groups. Two groups are labeled "government agencies" (including regulatory and administrative agencies) and "academics" (including universities and national laboratories). Another two groups are "nonprofits/non-advocacy organizations" (including consulting firms, law firms, and nonprofits that do not engage in advocacy activities, such as think tanks) and "advocacy groups/industry" (including lobbying firms and energy companies). Thirty-nine percent of respondents were from government agencies, 18.2% from academics, 27.7% were from nonprofits and non-advocacy groups, whereas 14.6% were from advocacy groups and industry.

[1] The fourteen organizations are academic institutions, citizen action groups, consulting firms, Department of Homeland Security, Department of Defense, Department of Energy, Department of State, Environmental Protection Agency, Government Accountability Office, lobbying firms, non-profit organizations, Nuclear Regulatory Commission, think tanks and other organizations.

Mediating variables. Issue concerns consisted of five variables measuring stakeholders' perceived importance of different issues to the development of nuclear fuel cycles. These issues were identified from a number of technical reports on the development of nuclear energy [11,16]. We used a four-point scale (1 = "not at all important," 4 = "extremely important"), asking respondents how important each of the five issues was to the development of nuclear fuel cycles: climate change mitigation ("not at all important" = 17.5%, "somewhat important" = 36.5%, "very important" = 23.4%, "extremely important" = 20.4%); economics of nuclear power-related facilities ("not at all important" = 4.5%, "somewhat important" = 15.7%, "very important" = 40.3%, "extremely important" = 39.6%); environmental health and safety ("not at all important" = 3%, "somewhat important" = 23.3%, "very important" = 39.1%, "extremely important" = 34.6%); nuclear non-proliferation ("not at all important" = 8.9%, "somewhat important" = 23.7%, "very important" = 31.1%, "extremely important" = 36.3%); and nuclear waste management ("not at all important" = 1.5%, "somewhat important" = 18.7%, "very important" = 33.6%, "extremely important" = 46.3%).

Control variables. Respondents also reported their experiences of work experience and gender. Sixty-eight percent of respondents had more than 15 years of experience (*SD* = .98). Sixteen percent was females. Educational attainment was an ordinal variable with four categories, ranging from "Bachelor degree and below" (16.8%) to "Doctoral degree" (29.9%). The sample median was "Master degree (M.S./M.A./M.B.A.)" (38.7%). Disciplinary field measured respondents' field of highest degrees. We dichotomized the measure into science/engineering related fields (54%) and other fields.

2.3. Analysis

First, we performed a series of ANCOVA tests to examine how issue concerns and perception of science-driven policy vary as a function of institutional affiliation, incorporating all control variables. In addition, we formulated a mediation model to test the role of issue concern in mediating the relationship between institutional affiliation and science-driven policy perception. A mediation model reflects a causal sequence in which independent variable affects outcome variable indirectly through mediator variable [36]. In our mediation model, mediating variables included the issue concern variables that significantly related to the outcome variable (i.e. environmental health and safety; waste management). The independent variables – institutional affiliations – were measured using three dummy variables contrasting each group to the reference group of governmental agencies. Furthermore, we performed a series of ordinal logistic regressions and computed a parameter of $Z_{mediation}$ [37] to examine the significance of the mediated effect. Given the relative small sample size (N=137), a baseline alpha value of .10 was used, allowing us to achieve a relatively small probability of committing a Type II error and thus increase the analysis power [38].

3. Results

Results showed that males were more likely to see science as a driver of nuclear policy than females (B = -.36, p = .059). Years of experiences, educational attainment, and disciplinary field did not significantly relate to the dependent variable.

The main effect of institutional affiliation on perception of science-driven policy was significant, F (3, 133) = 3.74, p = .013. Post hoc analyses showed that compared to employees of government agencies, advocacy groups and industry stakeholders were less likely to perceive that scientific evidence had played a strong role in driving nuclear policy (Mean Difference = .59, p < .01). Hypothesis 1a is therefore supported. Similarly, respondents of the non-profits/non-

advocacy category were more likely to perceive science-driven policy important than respondents of the advocacy/industry category (Mean Difference = .55, $p < .01$). Hypothesis 1b is therefore supported. No statistically significant difference existed for the other contrast groups (e.g. academics vs. government agencies; nonprofits/non-advocacy groups vs. government agencies) (see Table 1).

[Insert Table 1. about here]

In addition, two issue concerns, including environmental health and safety, $F (3, 129) = 4.57$, $p = .004$, and nuclear waste management, $F (3, 130) = 3.3$, $p = .023$ significantly varied across respondents from different institutions. Hypothesis 2 received partial support as policymakers and stakeholders of different responsibilities showed different levels of concerns with respect to all but two areas. Post hoc comparisons showed that industry and advocacy groups were less likely to think that environmental health and safety is important to the development of advanced fuel cycles than government agencies (Mean Difference = -.72, $p = .001$) and academics (Mean Difference = -.48, $p = .05$). Additionally, compared to those affiliated with government agencies, respondents from academia (Mean Difference = -.47, $p = .016$) and nonprofits/non-advocacy groups (Mean Difference = -.45, $p = .009$) were significantly less likely to think that nuclear waste management is important to the development of advanced fuel cycles. In addition, industry and advocacy groups maintained significantly lower level of concern regarding the issue of nuclear nonproliferation compared to the other three groups; however, the F test was not significant.

Given the significant relationship between institutional affiliation and the two issue concern variables, we performed a set of mediation analysis to examine to role of issue concern in mediating the relationship between institutional affiliation and perception of science-driven

policy (see Figure 1). First, the direct relationship between the dependent variable and environmental health and safety was significant (B = .64, p = .008), indicating that the more people were concerned about the environmental health and safety implications of advanced fuel cycles, the more likely they were to perceive scientific evidence as a strong driver of nuclear policy. In addition, respondents who attached more importance to nuclear waste management tended to perceive science as a stronger driver of nuclear policy (B = .43, p = .07).

Additionally, the $Z_{mediation}$ parameter was significant for environmental health and safety ($Z_{mediation}$ = -1.81, p = .07) but not for nuclear waste management, suggesting that the attitudinal difference between government agencies and industry/advocacy groups can be attributed to the fact that they attached different levels of importance to the environmental health and safety concern. Hypothesis 3 therefore received partial support as we established the mediating role of issue concern only for the area of environmental health and safety.

[Insert Fig 1. about here]

4. Discussion

The notion of science-driven policy aims to reduce uncertainty in policy decisions by basing them on empirical scientific evidence. However, a purely science-driven approach to nuclear energy policymaking is challenging. While technical arguments are required for making most nuclear-related decisions, they rarely have a determinant impact on the policy outcome. Especially when it comes to difficult policy problems that encounter scientific uncertainty (e.g., nuclear waste management), policymakers tend to base their decisions on political considerations rather than independent scientific evidence.

This study investigated how policymakers and stakeholders with distinct institutional responsibilities and interests perceive the role of science in driving nuclear policy. Although

credible science may provide a valuable counterbalance to heterogeneous policy actors with competing agendas, their attitudes toward science-driven policy are not uniform. Industry stakeholders and advocacy groups, for example, were more apathetic to the notion of science-driven policy compared to people from government agencies, nonprofit organizations, and non-advocacy groups. Indeed, the long-term impact of energy sources on environment and public health has played a central role in determining their use. Nuclear analysts and specialists' positive view on nuclear energy can be largely attributable to their concerns about the environmental and public health impacts from the continuing large-scale use of fossil fuels for energy, which are quantitatively much larger than the impacts from nuclear energy. Policy decisions need to base on scientific assessments of the environmental footprints and public health implications of different energy options.

Before discussing the findings in detail, we would first note a number of limitations. First, based on a thorough analysis of official directories and public meeting records, our sample constituted a wide range of federal, state policymakers, and other key actors involved in nuclear policymaking. However, given the relatively low response rate (27.4%), the sample might not represent the overall population of policy decision-makers, especially those with leadership roles. Since 68% of valid responses were from people with more than 15 years of experience in the field, we might not adequately understand how inexperienced staffers would interpret the use of scientific evidence. Yet such an understanding is critical, as they are usually the ones who perform research and reference in response to higher-ranks' requests. In addition, although respondents from the category of advocacy groups/industry were generally pessimistic about the use of scientific evidence in policy decisions, their views might vary. For example, while some energy companies were reluctant to base their decisions solely on science, they had used

scientific evidence to justify the profitability of nuclear power in policy debates [39]. It is important for future researchers to examine the opinions of different companies and advocacy groups in various policy contexts.

Second, our key variables were measured with single-item questions, constraining the overall reliability of the model [38]. Especially for the dependent variable – perceived importance of science-driven policy – a multidimensional construct capturing respondents' emotional, perceptual, and behavioral responses to science-driven nuclear policy is desirable. In addition, the use of categorical variables limited the choice of statistical techniques used to analyze the proposed mediating relationships [37]. To overcome the constraints posed by categorical variables, we performed a two-step analysis incorporating ANCOVA tests and mediation analysis to obtain parameter estimates. Future studies should use continuous variables with a higher inter-item reliability and implement alternative analysis techniques to establish a more powerful model.

In addition, we only looked at the role of issue concern in shaping individuals' perceived importance of science-driven policy without taking other factors, such as interests, motivations, and institutional responsibilities into account. Previous literature has documented that an institution's responsibilities, interests and research resources significantly influence its employees' perception and use of scientific evidence [5,6]. Further research should incorporate these factors into the current model and examine their interactive effects on the attitudinal outcome.

Despite these limitations, this study filled a gap in the literature by demonstrating the importance of psychological factors (e.g., issue concern) in determining policymakers' perception and use of scientific evidence in decision-making. Previous studies on policymakers'

evidence uptake and perceptions exclusively focused on the implications of structural and cultural factors while paying limited attention to the psychological foundation of such processes. Nonetheless, an analysis of Negelkerke's Pseudo R-square change showed that while structural factors, including institutional affiliation, educational background, and years of professional experience explained 13.4% of the variance in the dependent variable, cognitive factors (i.e., the five issue concern variables) explained 9.6%. The psychological mechanism underpinning the documented gap between scientists and policymakers is worth further exploration.

In addition, conceptualizing policy elites as bounded rational decision-makers, we highlighted their reliance on cognitive shortcuts when perceiving the role of science in driving nuclear policy. Specifically, when prioritizing a policy area wherein science had played a pivotal role in guiding past decisions, such as the environmental, health, and safety aspects of nuclear technologies, policymakers and stakeholders were more likely to value the use of scientific evidence in decision-making. In contrast, when considering an area where politics often trumped science, such as the management of high-level waste, people might not necessarily think science-based decision-making is important.

Nonetheless, there might be alternative reasons why certain policymakers and stakeholders reject scientific evidence for nuclear energy policy prescriptions. For instance, some policy decision-makers might reject scientific method in favor of other frameworks (e.g., faith and anecdotes) and hence develop a strong negative perception of scientific evidence. In addition, while most decision-makers are willing to embrace scientific evidence to back up their claims, they tend to discount equivalently valid evidence if it conflicts their existing attitudes or opinions. This phenomenon, known as "motivated reasoning," has received considerable attention in past research [40].

Considering these possibilities, one intriguing question that remains unanswered is what drives nuclear policy decision-makers to defer to scientific evidence in spite of perceived usability of such evidence in certain areas (e.g., public health and safety). Survey results have shown that Americans' attitudes toward evidence use in public policy hinge on party affiliation, political ideology and religiosity [40]. Presumably, policy decision-makers' willingness to uptake scientific evidence should also be influenced by their party members' collective preferences. Due to the sensitivity of the nuclear issue, we chose not to solicit respondents' political identity to secure a reasonable response rate.

However, value predispositions, such as political preference and moral beliefs, can help explain policy decision-makers' areas of concerns and the resulted attitude toward science and evidence-based policymaking [40,41]. An absence of such confounding variables in the current model might result in an overestimate of the pure effects of issue concerns on the dependent variable. Future research should incorporate these factors to examine how value predispositions interact with individuals' occupational interests and issue concerns to influence their attitudes toward science-driven policy.

Previous research has documented that the communication between scientific and policymaking communities is not always effective, as if "each side marches to very different drummers, speak distinctive languages, and sees the world through unique lens" [5]. As a result, meaningful engagement is unlikely to happen among those working for institutions that share no common responsibilities, interests or goals [42]. Scientists are just one of many competing actors that seek to insert informational input into the energy policymaking process. As policy decision-makers can easily feel overwhelmed by the large amount of information available to them, it is important for scientists to tailor their messages to the needs of different audiences.

According to our results, policymakers and stakeholders with different social responsibilities usually have distinct agendas and concerns when it comes to nuclear energy polices. These specific concerns have largely influenced policymakers and stakeholders' perceptions and use of scientific evidence in decision-making. Therefore, when conveying decision-aiding evidence, scientists should highlight the relevancy of their evidence to the specific policy context that concerns the target audiences. In addition, as policy advances to a different stage, policy actors might adjust their proposed agendas and hence change their positions on evidence use. Scientists should be sensitive to changes in the overall landscape of policy agenda and develop communication strategies that accommodate such changes.

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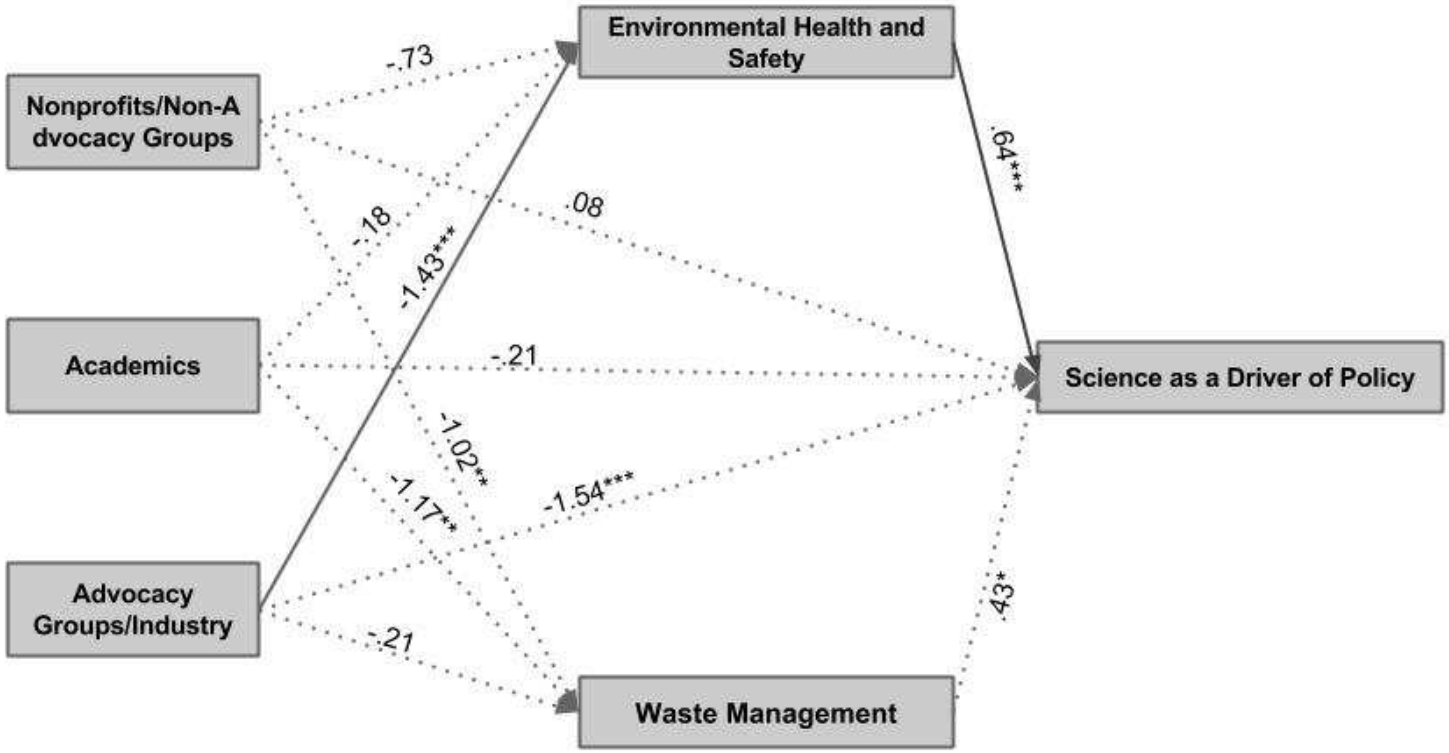
Table 1. Mean differences between categories in perceived importance of science-driven policy.

	Mean Difference	95% Confidence Interval	p-value
Government - Nonprofits/Non-advocacy	.04	-.26 to .34	.793
Government - Academics	.23	-.11 to .58	.182
Government - Advocacy/Industry	.59**	.22 to .96	.002
Nonprofits/Non-advocacy - Academics	.19	-.17 to .56	.298
Nonprofits/Non-advocacy - Advocacy/Industry	.55**	.16 to .94	.006
Academics - Advocacy/Industry	.36*	-.07 to .79	.096

Note: **p < .05, *p < .1

Fig 1. Mediation analysis examining the role of issue concerns in explaining the relationship between insituitonal identity and perception of science-driven policy



Note: Unstandardized coefficients are reported for each relationship; significance levels are indicated by the number of stars (i.e., *p < .1, **p < .05, ***p < .01). Solid lines indicate the $Z_{mediation}$ parameter is significant for the mediating relationship.