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The Hydrogen Policy Survey: Descriptive Statistics of the Study Sample and Their Policy Perspectives

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1. Introduction

In the context of a broader study of the policy process related to hydrogen as a fuel, we designed an electronic survey to collect policy beliefs from a wide range of stakeholders. In May, 2005, we sent an email to a sample of about 4,000 individuals, from about 1,450 different organizations in the United States and many other countries. The email contained a description of our study of the policy process related to hydrogen, an invitation to participate from the study, and a link to our online survey. The sample was drawn from several sources, primarily databases of attendees to conferences related to hydrogen.

A total of 502 responses from 323 organizations were obtained, for an approximate 12% individuals' response rate and a 22% organizations' response rate. While we believe these response rates are encouraging taking into account that our survey targeted people with significant time constraints, it may be misleading to assess the quality of the response based on response rates. We prefer to assess this quality by looking at two factors: a) the distribution of responses across organization categories, and b) whether responses were obtained from key stakeholders. Based on these factors, we believe our survey was extremely successful in terms of the quality of response.

This document describes the sample of respondents and presents the descriptive statistics of major policy variables obtained from their responses.

2. Descriptive statistics of the sample

The primary goal of our sampling scheme was to reach all the sectors of the policy process related to hydrogen. An inclusive definition of the policy subsystem (sectors and individuals involved in the process) is a central tenet of the Advocacy Coalition Framework that guides this study. This section describes the sample of respondents and assesses to which extent our objective has been met.

Although invitations to taking the survey were sent to individuals in the many countries, our database of people with potential interest and/or involvement in the hydrogen policy process is dominated by individuals based in the United States. We expect to improve our database in the future to contain more international contacts. Table 1 shows the total number of responses and their distribution across countries where respondents' offices are based.

Table 1. Distribution of countries where respondents are based

Country	Frequency	Country	Frequency
Argentina	1	Mexico	2
Australia	1	Netherlands	1
Belgium	3	Norway	2
Brazil	2	Philippines	1
Canada	31	Portugal	2
Costa Rica	2	Singapore	1
France	5	Sweden	3
Germany	9	Taiwan	1
Greece	2	The Netherlands	1

Country	Frequency	Country	Frequency
India	3	USA	386
Italy	8	United Kingdom	14
Japan	9	**Total**	**490**

The largest concentration of responses is found in the United States, where 79% of our sample is based. The second-largest group is based in Canada, with 31 respondents—a 6% of our sample.

We provided respondents with a list of categories of organizations and asked them to indicate all the categories that fitted their organizations. Table 2 shows the organization categories and the number of respondents falling within each of them, discriminated by the country where the respondents' offices are. For this discrimination, we choose three categories: United States, Canada, and Other.

Table 2. Respondents' organization categories

	USA	Canada	Other
Automobile company	30	2	12
Oil energy company	13	0	9
Electricity energy company	20	1	4
Natural gas provider	9	0	3
Hydrogen production/supply	24	2	10
Hydrogen production/dispensing equipment	14	0	5
Fuel cell developer	24	3	8
Electric battery developer	11	0	4
Government, federal	21	11	6
Government, state	31	0	2
Government, local	16	0	2
Regulatory agency	15	0	1
Permitting official/office	2	0	0
University	63	9	22
National laboratory	27	2	7
NGO, environment	26	0	3
NGO, health	4	0	0
NGO, business	6	0	1
Media	10	1	3
Consulting	59	2	15
Other	79	5	14

The US-based sub-sample is distributed across all the main organization categories we targeted with our sampling scheme. A count lower than expected is found for permitting offices. As described in the Introduction, we take this distribution as a measure of success in terms of response. Regulations on research subjects' confidentiality protection limit our ability to disclose the name of participant organizations to the cases where respondents explicitly give us permission to do so. We can say however that we received responses from essentially all the key organizations in the policy debate. Based on these two parameters, we believe that we have obtained a high-quality response.

The Canada-based sub-sample has no one in a number of organization categories. The respondents were given the option to specify their position within their organization. As many as

245 respondents declined to answer this question. From those who did answer, we find 22 presidents, eight CEOs, seven vice-presidents, 21 directors/executive directors, among others.

To record the respondents' area/s of expertise, we provided them with 19 different options plus an open-ended alternative ("other—please specify"). The distribution of respondents across categories is presented in Table 3.

Table 3. Respondents' areas of expertise

	USA	Canada	Other
Fuel cell technology	96	16	30
Automotive technology	108	4	24
Electric drive technology	63	2	13
Hydrogen production	88	16	23
Hydrogen storage technology	68	12	19
Hydrogen fueling systems	63	9	10
Governmental affairs/lobbying	63	5	7
Policy analysis	148	11	22
Economics	90	8	16
Energy--fossil fuels	94	6	19
Energy—renewables	122	12	23
Energy—other	96	8	14
Policymaking/politics	89	8	19
Environmental analysis	134	13	25
Transportation policy/planning	111	6	22
Public transit	34	1	7
Law	14	0	1
Market research	46	4	5
Codes and standards	35	4	9
Others	81	4	14

Table 3 shows that the areas of expertise are in general more populated than the organization categories. One way we could improve our survey for the next rounds is to measure expertise on a multiple-point scale, instead of a binary scale. The level and distribution of expertise in our sample is important to obtain educated opinions for policy analysis. The effect that respondents may have on the policy behavior of their respective organizations is, however, determined by more than the expertise that they may have in a particular area. To understand this effect, we obtained measures of influence. Table 4 shows the question and statements used to capture respondents' influence in organization behavior, the subsample sizes (N), the means for each of our geographical groups, and the frequencies of responses in each of the categories offered.

Table 4. Descriptive statistics of measures of policy influence

Are you involved in determining the positions that your organization takes on open policy discussions about hydrogen?					
Country where office is based	N	Mean	1="Not involved"	2="Indirectly involved"	3="Directly involved"
USA	343	2.28	162	116	65
Canada	24	2.38	13	7	4
Other	66	2.20	32	22	12

Policymakers seriously consider the opinions of your organization on hydrogen technology/policy							
Country where office is based	N	Mean	1="Strongly disagree"	2="Disagree"	3="Neutral"	4="Agree"	5="Strongly agree"
USA	347	3.54	16	48	78	142	63
Canada	29	4.00	2	1	1	16	9
Other	69	3.35	4	12	14	34	5
Your organization seriously considers your opinions on hydrogen technology/policy							
Country where office is based	N	Mean	1="Strongly disagree"	2="Disagree"	3="Neutral"	4="Agree"	5="Strongly agree"
USA	353	3.88	10	24	69	144	106
Canada	29	4.17	1	0	2	16	10
Other	71	3.86	1	4	18	29	19

About 53% of the non-missing responses in the US-based sample indicate a direct or indirect involvement in determining organization's policy positions. Influence within organizations may materialize however in ways other than this type of involvement. Decisionmakers within organizations are likely influenced by organization members that they consult with. About 71% of the US-based responses indicated either agreement or strong agreement with the statement that their opinions on hydrogen technology/policy are seriously considered by their organizations.

We defined a variable, WEIGHOPINION, as the product of the responses to the last two statements in Table 4, namely:

- Policymakers seriously consider the opinions of your organization on hydrogen technology/policy
- Your organization seriously considers your opinions on hydrogen technology/policy

Responses to these statements were coded on a five-point scale where 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly agree. Therefore, WEIGHOPINION gets values ranging from 1 to 25. The opinion of an individual with WEIGHOPINION=25 is thus expected to be extremely important in formulating the positions related to hydrogen policy of an organization that has direct influence over policymaking. Table 5 shows the frequency distribution for this variable.

Table 5. Frequencies of values of WEIGHOPINION variable

WEIGHOPINION value	USA	Canada	Other
1	3	1	1
2	5	0	0
3	3	0	2
4	12	1	3
5	8	0	0
6	16	0	4
8	21	0	5
9	28	0	4
10	11	0	3
12	47	3	12

WEIGHOPINION value	USA	Canada	Other
15	20	0	4
16	78	11	17
20	47	5	8
25	39	7	4

We also obtained measures of administrative levels of policy activity. We asked our sample "At what levels are you and your organization active in areas of policy related to hydrogen?" Table 6 shows the distribution of responses to this composite question.

Table 6. Administrative areas of policy activity related to hydrogen

		U.S. federal level	U.S. state level	U.S. local level	Country other than the U.S.	International level	None	N/A
US-based	Respondents' organization	207	202	111	58	99	51	35
	Respondents	147	148	89	26	56	90	32
Canada-based	Respondents' organization	5	3	1	25	16	2	2
	Respondents	4	3	0	18	9	7	4
Based in other countries	Respondents' organization	10	7	1	48	36	3	12
	Respondents	5	4	1	40	28	10	12

This table reflects the important fact that policy activities transcend the boundaries of the country where policy actors are based. For example, 7% of the US-based subsample reported being active on hydrogen policy in countries outside of the United States, while 12% of the Canada-based subsample is active in the United States at the federal level.

3. Descriptive statistics of responses

This section presents a description of the distributions of responses for the policy statements in the survey. Since this study is concerned with understanding the map of policy preferences and beliefs in the hydrogen-energy policy subsystem, we weighted some of the statistics presented in the next subsections. For this purpose, we used the variable WEIGHOPINION as a frequency weight for individual responses. Thus, a respondent with say, WEIGHOPINION=20, is counted 20 times when estimating statistical means. This weight intends to capture to some extent the influence of each response in the policy debate.

3.1 General policy-belief statements

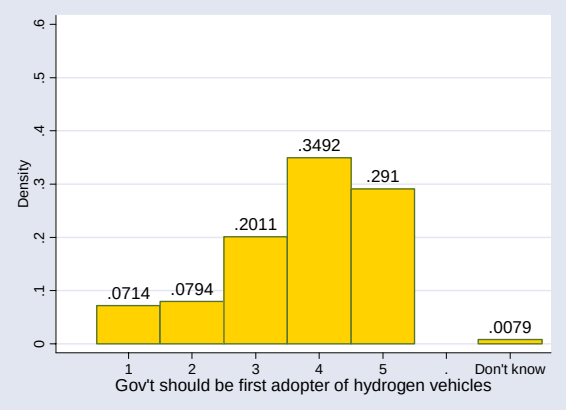
We obtained measures of beliefs on a set of policy areas. A policy belief represents the degree of agreement with a given policy. In this sense, it is a normative belief. We presented respondents with a number of policy statements and asked them to express their degree of agreement on a five-point scale defined as 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly agree. Table 7 shows the means and standard deviations of policy belief statements presented in the survey, for the subsample based in the United States. The weighted statistics indicate that that the variable WEIGHOPINION was used as a frequency weight.

Table 7. Means and standard deviations for responses to policy-belief statements

Statement	Non-weighted mean	Non-weighted std dev	Weighted mean	Weighted std dev
Governments should be first adopters of hydrogen vehicles	3.715	1.177	3.814	1.153
Governments should provide funds or the development of hydrogen fueling infrastructure	3.841	1.259	3.946	1.242
Governments should provide funds for demonstration programs on hydrogen technologies/systems	4.147	1.025	4.202	0.997
Environmental regulations should be standard-based, not technology-based	4.130	1.081	4.204	1.031
Government regulations can accelerate technological innovation	4.176	0.846	4.210	0.836
All policy benefits and costs can be reflected reasonably well in a cost-benefit analysis	2.897	1.138	2.891	1.135
Sequestration is a promising way to deal with CO_2 emissions from hydrogen production.	3.203	1.158	3.248	1.169
The external costs of energy PRODUCTION should be internalized	4.060	0.895	4.057	0.921
The external costs of energy USE should be internalized	4.102	0.883	4.120	0.890
Anthropogenic CO_2 emissions are a significant cause of global warming.	4.031	1.050	4.079	1.018
Governmental policies should be more concerned with helping lower-income groups than helping higher-income groups	3.516	1.117	3.488	1.127
In general, market-based policies are more effective than command-and-control policies	3.953	1.025	3.959	1.033
In general, protecting the economy is more important than protecting the environment	2.388	0.936	2.379	0.889
More international collaboration is desirable on policies related to hydrogen	3.941	0.895	3.972	0.886

The most agreement consensus in our sample is found for government funding of hydrogen-technology/systems demonstration programs, the notions of regulation being capable of spurring technological innovation, and the desirability to internalize the external costs of energy use. The most disagreement consensus is found for the statement that protecting the economy is in general more important than protecting the environment. The notion that cost-benefit analysis captures reasonable well all policy benefits and costs, is generally disagreed upon.

The histograms in Figure 1 show the non-weighted fractions of the responses that chose each of the response categories for the policy-belief statements described above. The reader should note that the names of the horizontal axes are simplified versions of the actual statements, provided only to ease the reading of the document. The reader is also reminded of the characteristics of our sampling scheme. The non-weighted results in this document are presented primarily as descriptive statistics. They may be a representation of the perspectives in the relevant population, but they are likely not to convey faithful representations of the actual political weight of the variables measured. Such information will be better provided in future analyses of our data.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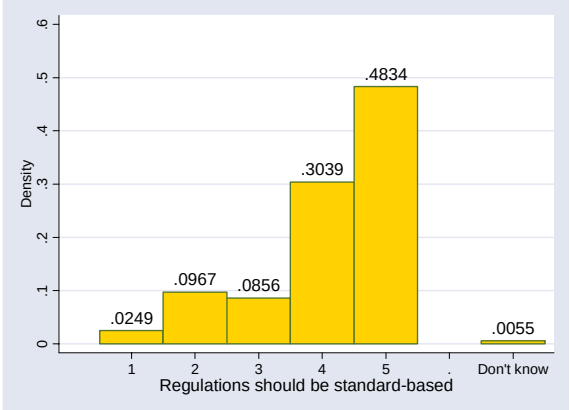
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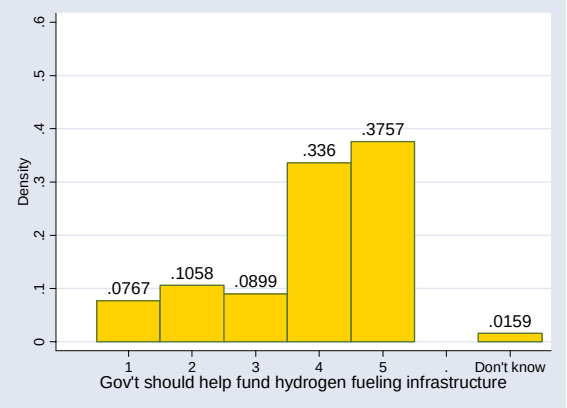
Don't know
Regulations should be standard-based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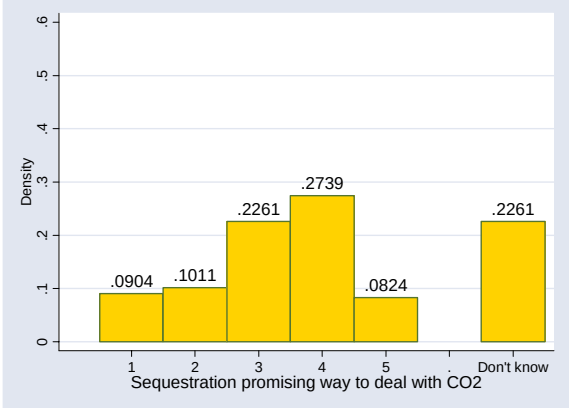
Don't know
Gov't should help fund hydrogen fueling infrastructure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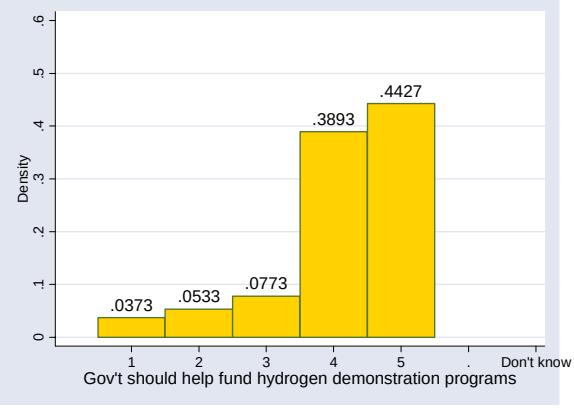
Sequestration promising way to deal with CO2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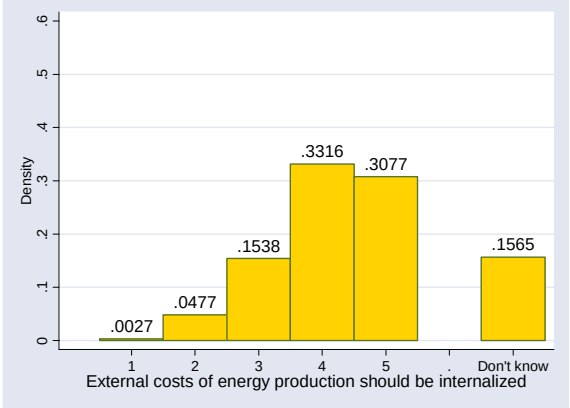
Gov't should help fund hydrogen demonstration programs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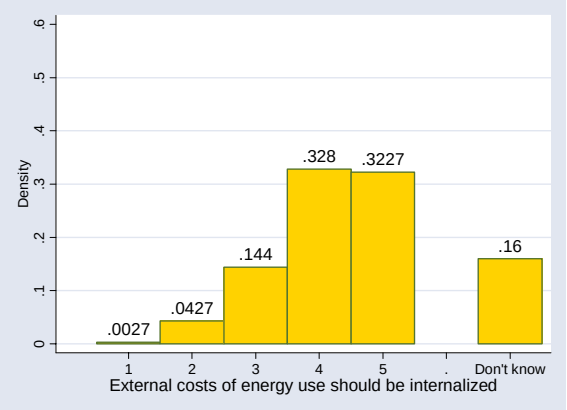
External costs of energy production should be internalized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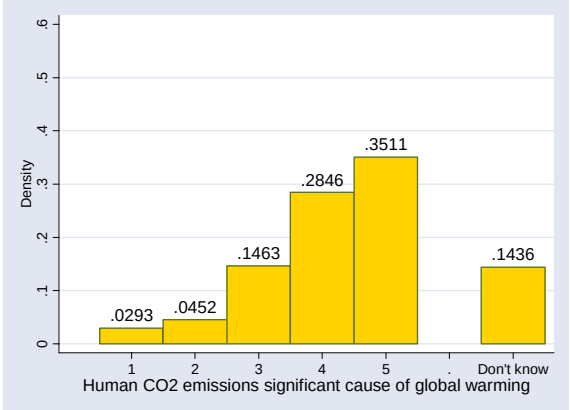
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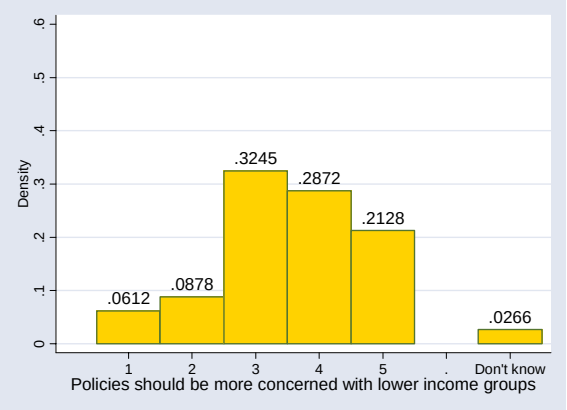
Human CO2 emissions significant cause of global warming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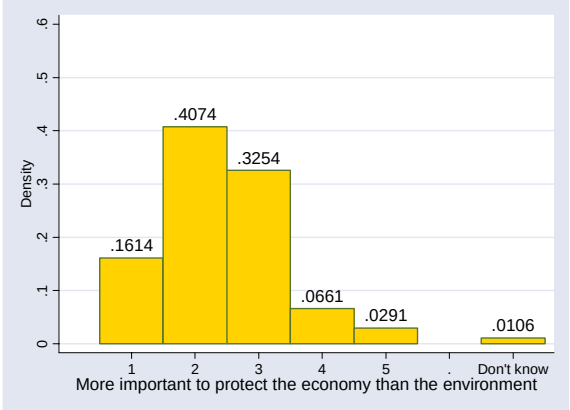
Policies should be more concerned with lower income groups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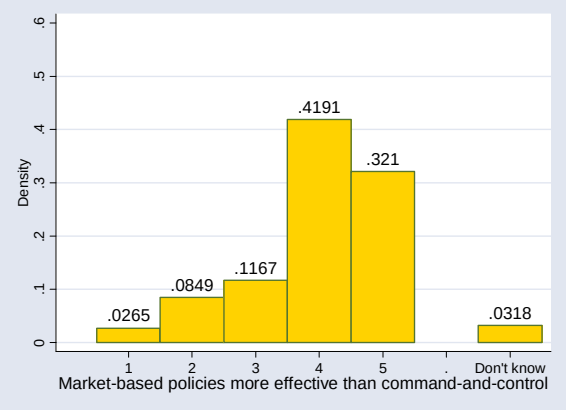
More important to protect the economy than the environment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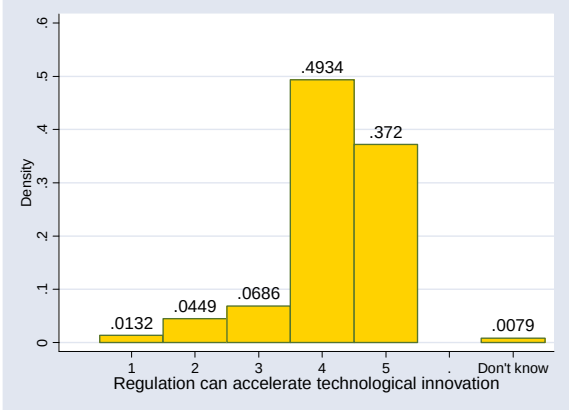
Market-based policies more effective than command-and-control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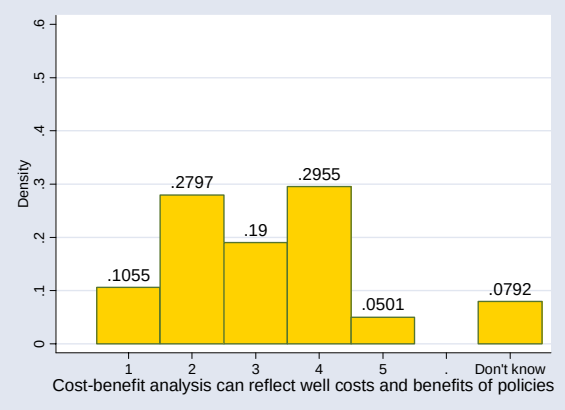
Don't know
Regulation can accelerate technological innovation



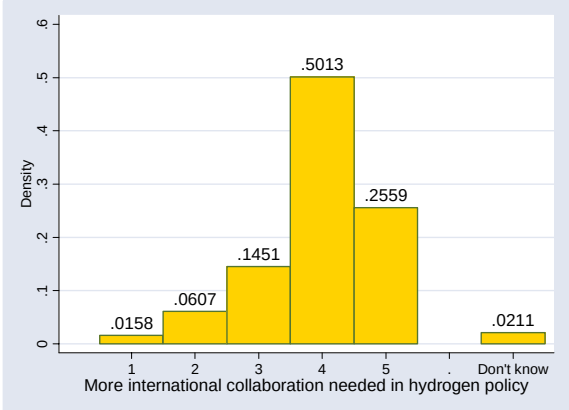


Figure 1. Histograms of responses to general policy-belief statements

3.2 General policy-preference statements

Policy preferences differ from policy beliefs primarily in that they represent the degree of actual support that a respondent would lend to a given policy. They therefore constitute closer measures of latent policy activity than policy beliefs. We presented respondents with a set of policy statements and asked them to express their degree of support on a five-point scale defined as 1=Strongly oppose, 2=Oppose, 3=Neutral, 4=Support, and 5=Strongly support. Table 8 shows weighted and non-weighted descriptive statistics of the responses to policy preference statements for the subsample of respondents based in the United States.

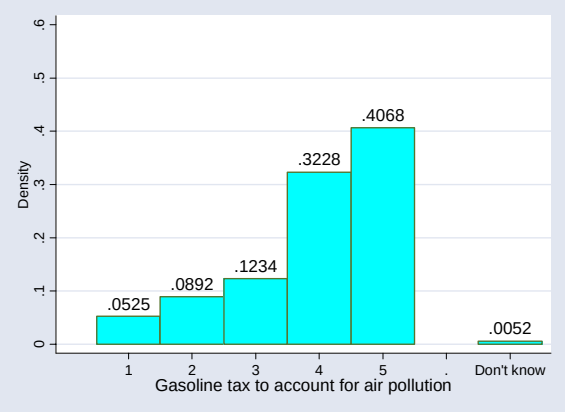
Table 8. Means and standard deviations for responses to policy preference statements

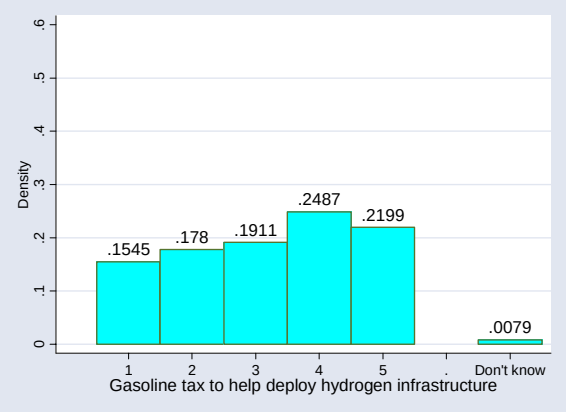
Statement	Non-weighted mean	Non-weighted std dev	Weighted mean	Weighted std dev
A tax on gasoline to account for its air pollution costs	3.947	1.169	3.936	1.187
A tax on gasoline to encourage less driving	3.515	1.336	3.549	1.315
A tax on gasoline as a source of revenue for the development of a hydrogen infrastructure	3.203	1.380	3.260	1.386
Incentives for buyers of vehicles that bring societal benefits relative to standard gasoline vehicles	4.230	0.987	4.278	0.967
A carbon tax	3.849	1.192	3.884	1.211
Promote basic research on hydrogen technologies at universities	4.309	0.838	4.305	0.859
Economic incentives ("carrots") for firms to accelerate the market introduction of fuel-cell vehicles	3.955	1.108	3.985	1.154
A mandate on the quantity/percentage of hydrogen-fueled vehicles produced	2.299	1.208	2.326	1.252
A mandate on the quantity/percentage of zero-emission vehicles produced	2.973	1.381	3.007	1.403
A mandate on the quantity/percentage of fueling stations that offer hydrogen	2.652	1.252	2.630	1.270
Increasing fuel efficiency requirements on new light-duty vehicles	4.456	0.904	4.465	0.913
Regulating the minimum percentage of hydrogen to be produced from renewable sources of energy	3.658	1.129	3.662	1.156

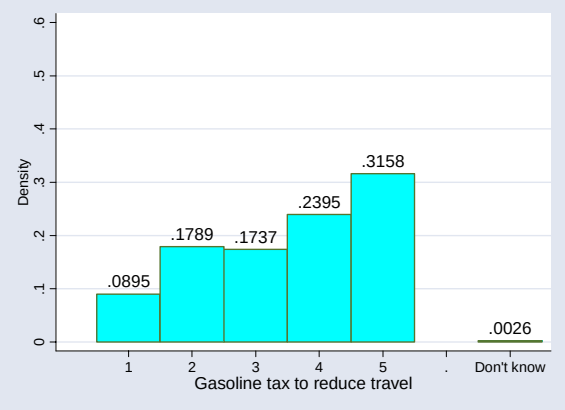
Statement	Non-weighted mean	Non-weighted std dev	Weighted mean	Weighted std dev
Regulation that ensures liability insurance of hydrogen infrastructure at reasonable prices	3.323	1.323	3.319	1.317

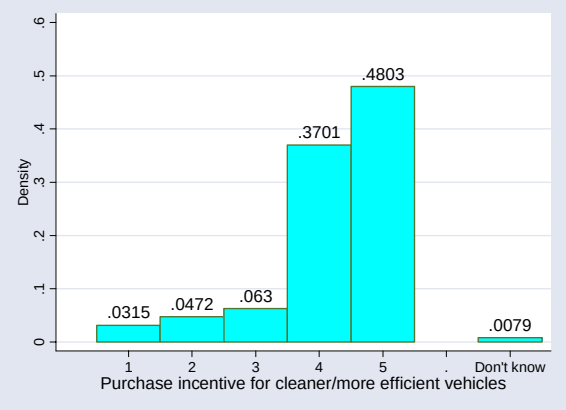
If measured by higher mean values and lower standard deviations, the policies with the greater support are to provide incentives to consumers to buy cleaner or more fuel-efficient vehicles, to promote basic research on hydrogen technologies, and to increase CAFE standards. Respondents show the greatest disagreement on a mandate on zero-emission vehicles.

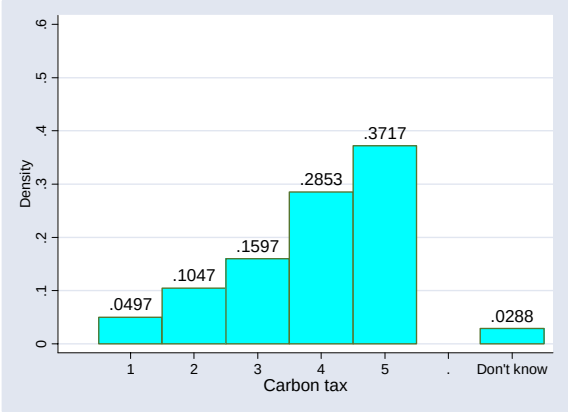
Figure 2 shows the density histograms of the non-weighted responses to the policy-preference statements. The reader is reminded that the names of the horizontal axes are simplified versions of the actual statements, provided only for to ease the reading of the document.







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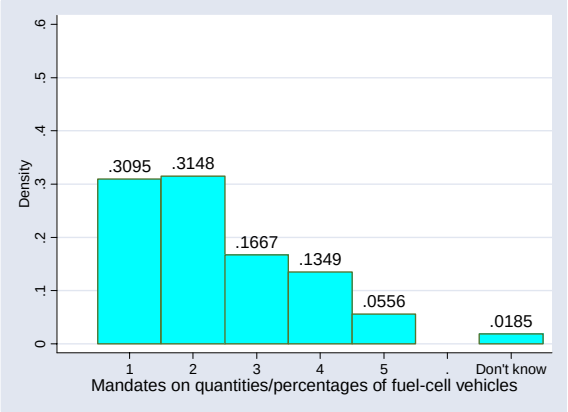
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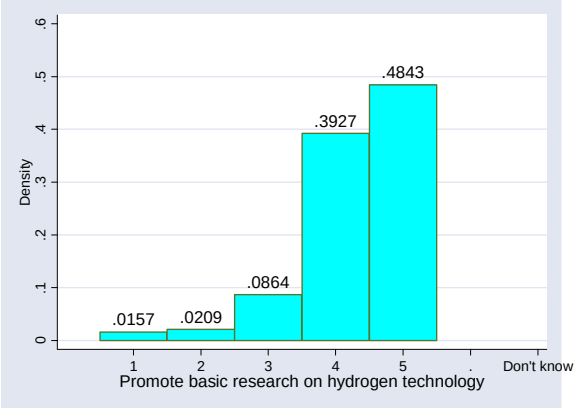
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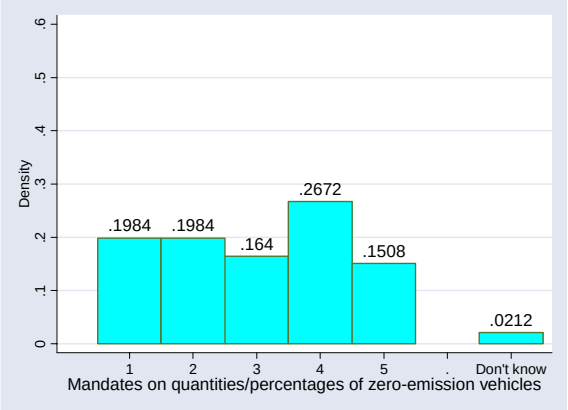
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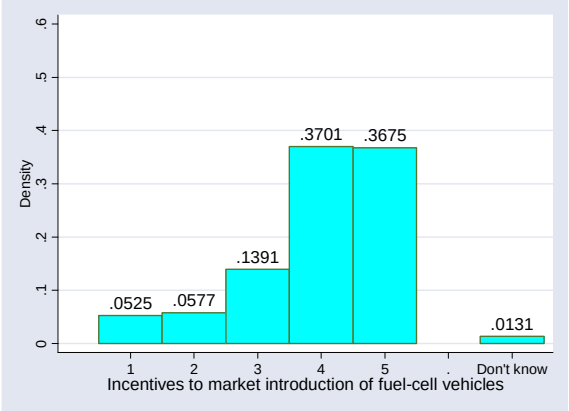
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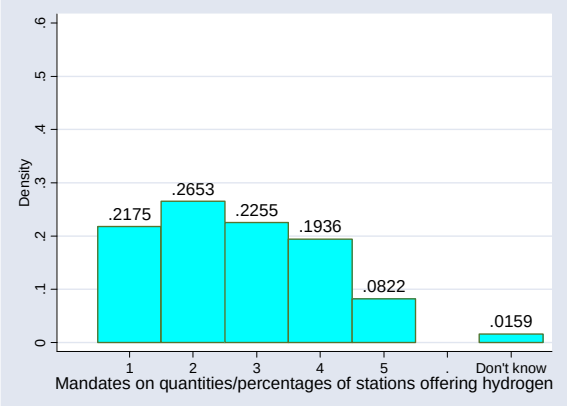
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Mandates on quantities/percentages of stations offering hydrogen

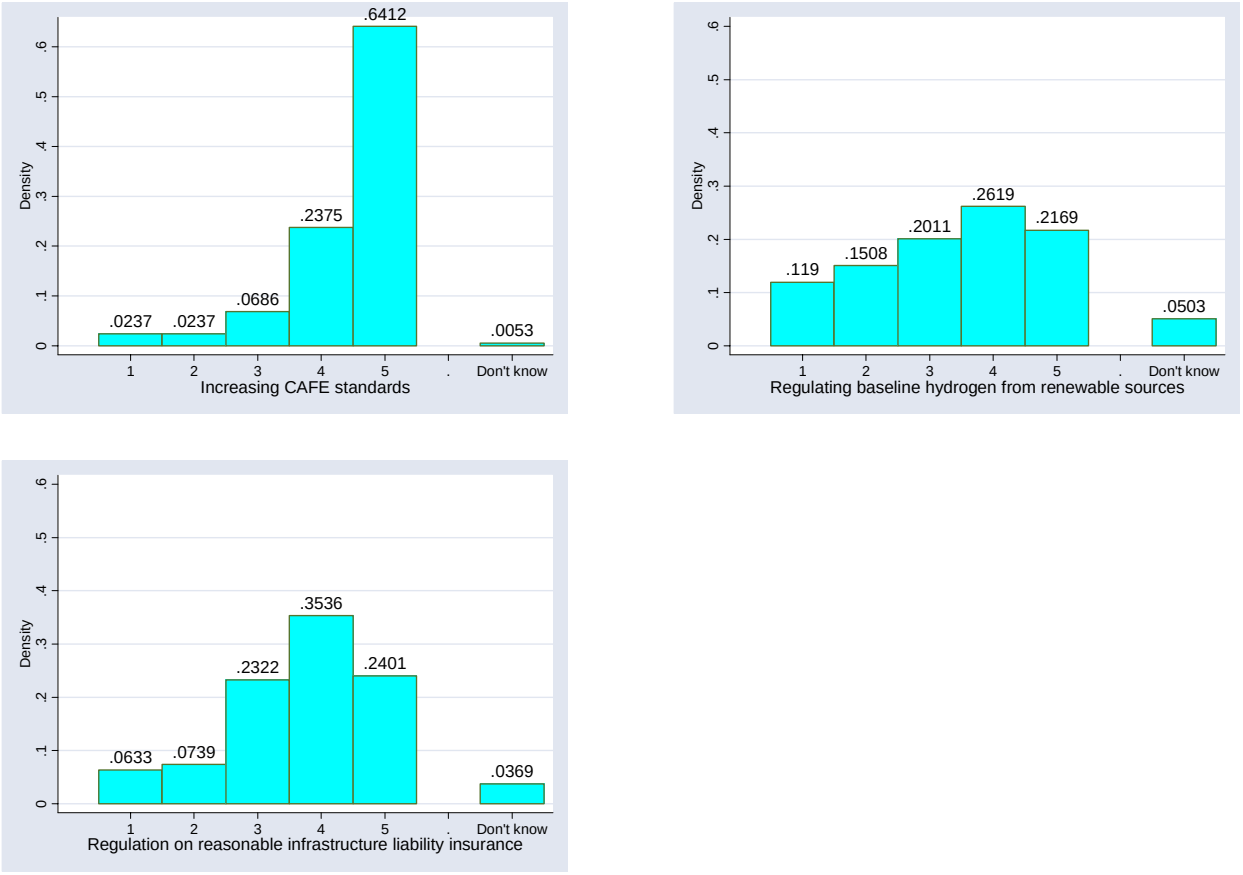


Figure 2. Histograms of responses to general policy-preferences statements

3.3 Policy preferences on hydrogen production pathways

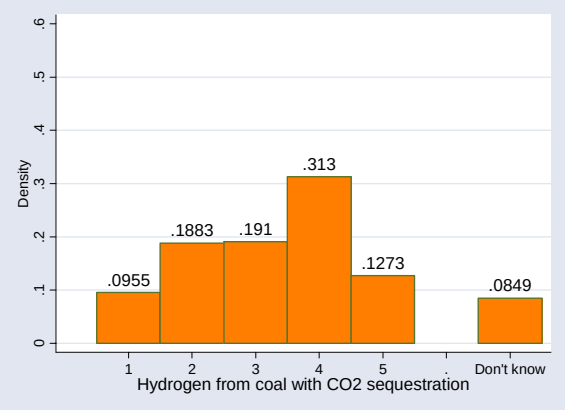
Production pathways refer to the combination of energy feedstock use and technologies involved in the production of hydrogen. The production pathway chosen may have significant impacts on the production costs and societal benefits associated to the use of hydrogen. From a policy standpoint, we expect the debate to center not so much on the particular production technologies employed, but rather on which feedstock should be favored and whether the carbon emitted at the production site should be captured. We presented respondents with a set of hydrogen production pathways and asked them to express their degree of support in the short term for policies that promote each of them. We collected responses on a five-point scale defined as 1=Strongly oppose, 2=Oppose, 3=Neutral, 4=Support, and 5=Strongly support. Table 8 shows weighted and non-weighted descriptive statistics of the responses to production preference statements for the subsample of respondents based in the United States.

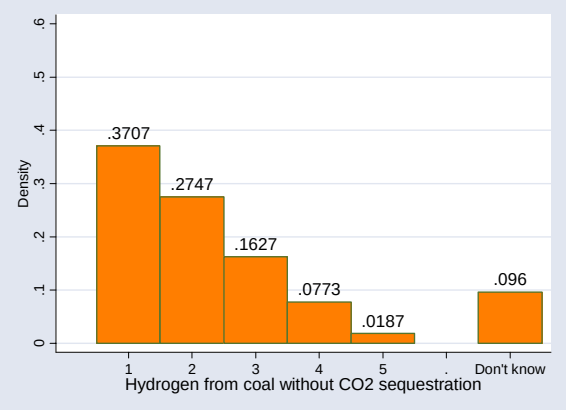
Table 9. Means and standard deviations for responses to hydrogen-production policy preference

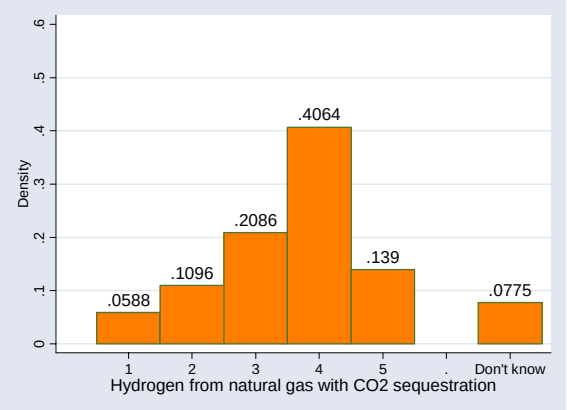
Statement	Non-weighted mean	Non-weighted std dev	Weighted mean	Weighted std dev
Coal with CO_2 sequestration	3.206	1.218	3.250	1.249
Coal without CO_2 sequestration	2.003	1.059	1.987	1.076
Natural gas with CO_2 sequestration	3.496	1.084	3.562	1.130
Natural gas without CO_2 sequestration	2.791	1.137	2.869	1.176
Nuclear	3.354	1.318	3.278	1.378
Geothermal	4.096	0.891	4.095	0.912
Petroleum/Coke	2.340	1.016	2.290	1.027
Wind	4.224	0.960	4.217	0.989
Solar	4.254	0.971	4.252	0.998
Biomass	4.152	0.986	4.144	1.004

Our sample shows a tendency to support policies that promote the use of renewable sources of energy for hydrogen production in the short term. This preference is followed by a preference for pathways that involve low carbon emissions to the atmosphere. This result should be interpreted as reflecting the lower number of responses from sector that support other hydrogen production pathways. Future analyses will look into the question of how this and other policy preferences are distributed in the map of stakeholders.

The histograms in Figure 3 display the non-weighted fractions of the total respondents, who chose each of the response categories as an answer to the hydrogen production policy preferences statements.



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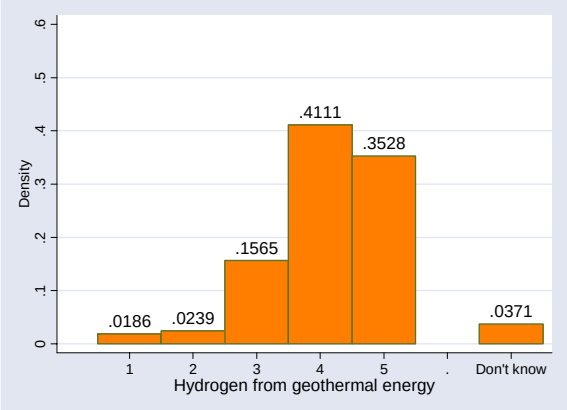
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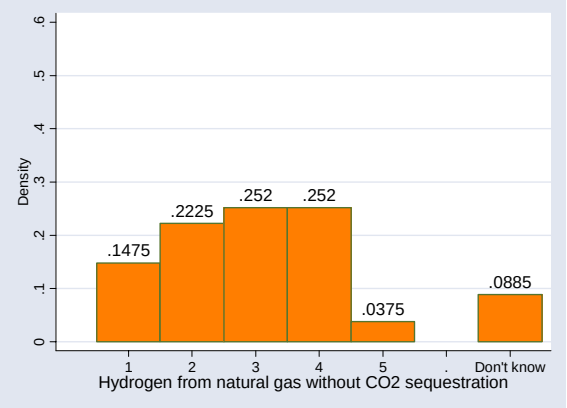
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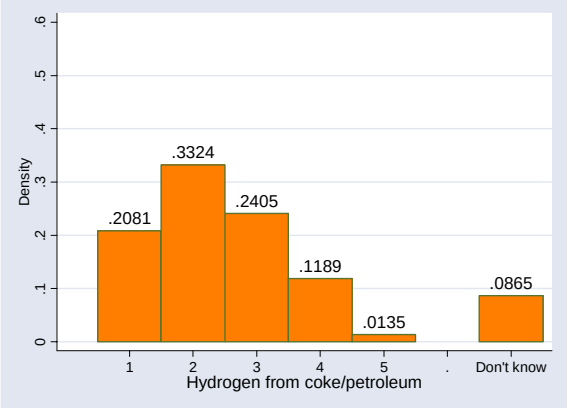
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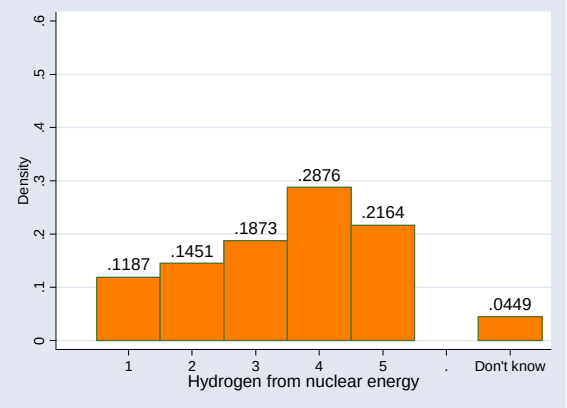
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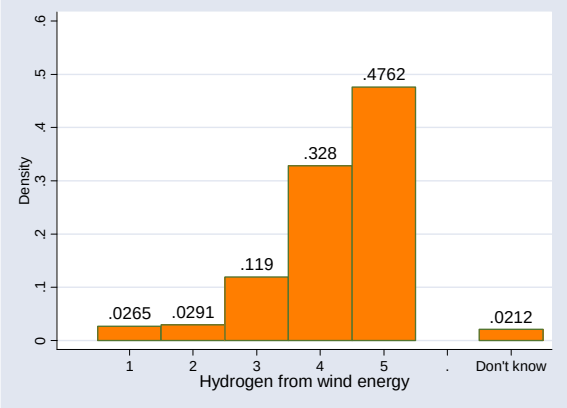
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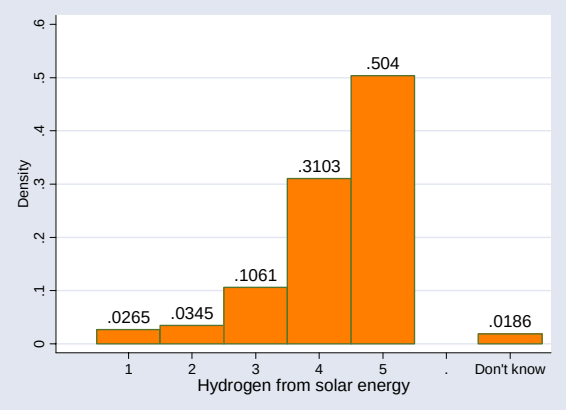


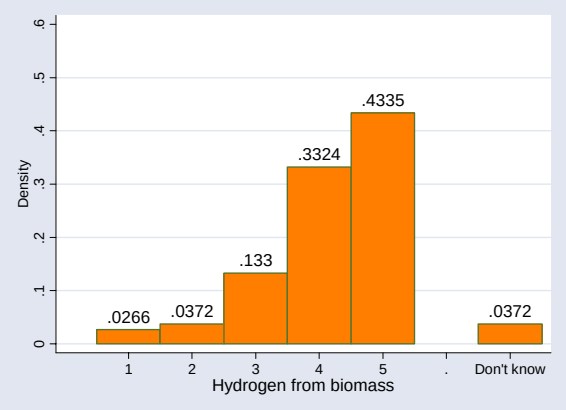


Figure 3. Histograms of responses to questions on hydrogen production pathways preferences

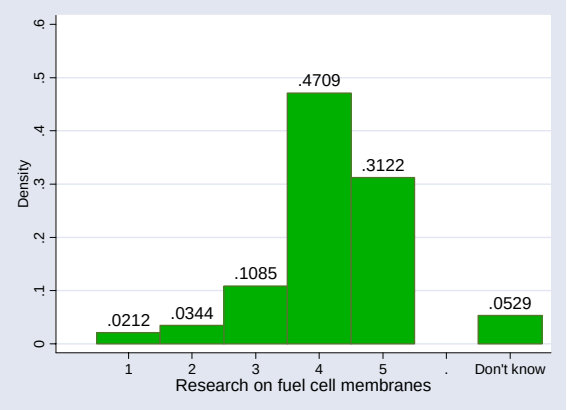
3.4 Research policy preferences

Technological progress is still necessary to attain cost competitiveness of different stages of the hydrogen cycle, from production to consumption. Research policy is therefore a central component of a policy package to assist the market introduction of hydrogen as a transportation fuel. To investigate stakeholders' preferences in terms of research policies, we offered them a list of areas where research is commonly believed to be most necessary. We then asked them to rate how much support they would lend to government programs for research, development, and demonstration of each of these areas. Again, we use a a five-point scale defined as 1=Strongly oppose, 2=Oppose, 3=Neutral, 4=Support, and 5=Strongly support. Table 10 presents weighted and non-weighted descriptive statistics of the responses to these statements for the subsample of respondents based in the United States.

Table 10. Means and standard deviations for responses to research policy preferences

Statement	Non-weighted mean	Non-weighted std dev	Weighted mean	Weighted std dev
Fuel cell membranes	4.075	0.887	4.091	0.894
Fuel cell catalysts	4.092	0.867	4.113	0.879
Fuel cell durability	4.102	0.906	4.107	0.916
Fuel cell efficiency	4.060	0.906	4.040	0.916
Fuel cell sub-freezing operation	3.869	0.984	3.838	1.016
Hydrogen storage	4.309	0.882	4.355	0.879
Hydrogen delivery	4.076	0.928	4.084	0.926
CO_2 sequestration	3.918	1.099	3.925	1.111
Hydrogen production from coal	3.156	1.228	3.193	1.244
Hydrogen production from natural gas	3.352	1.116	3.358	1.155
Hydrogen production from renewable sources of energy	4.371	0.897	4.381	0.874
Hydrogen production from nuclear energy.	3.548	1.294	3.492	1.353

Our sample lends the strongest support (as measured by higher means and lower standard deviations) to programs for research and development of hydrogen storage and hydrogen production from renewable sources of energy. This conclusion can be more clearly observed in the histograms in Figure 4.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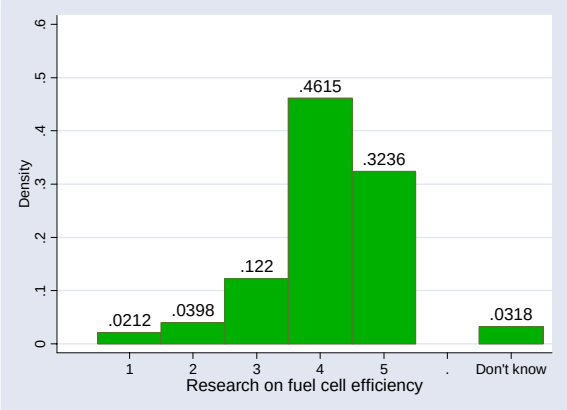
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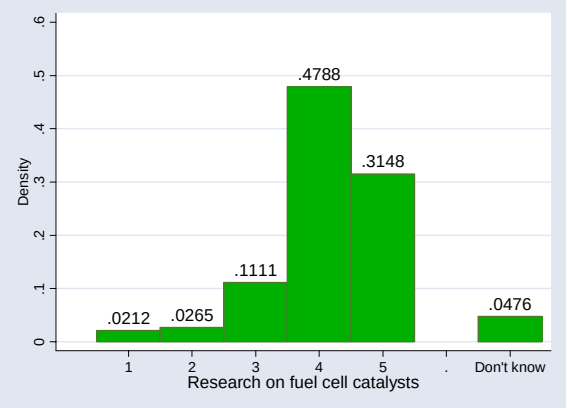
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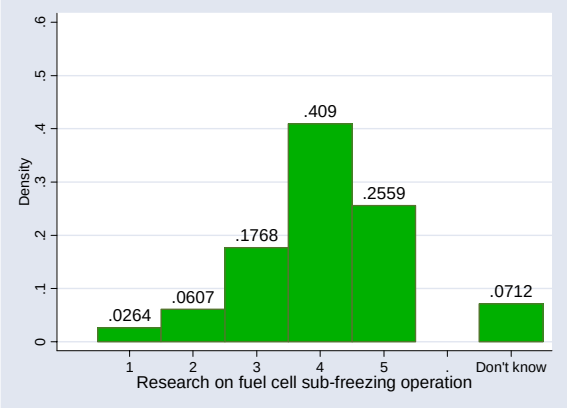
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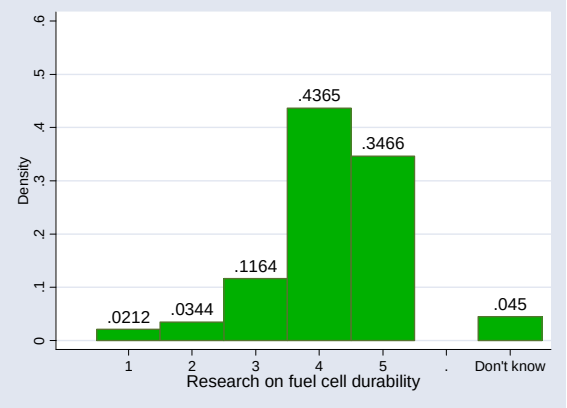
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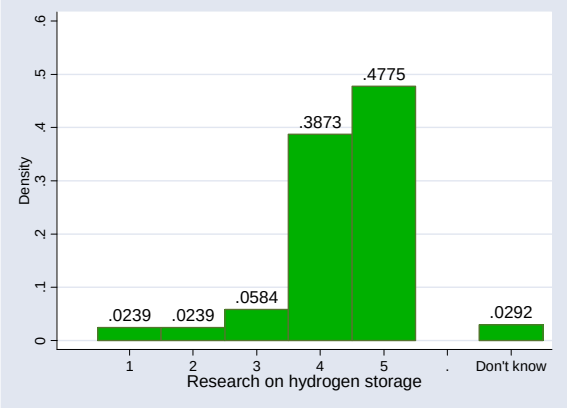
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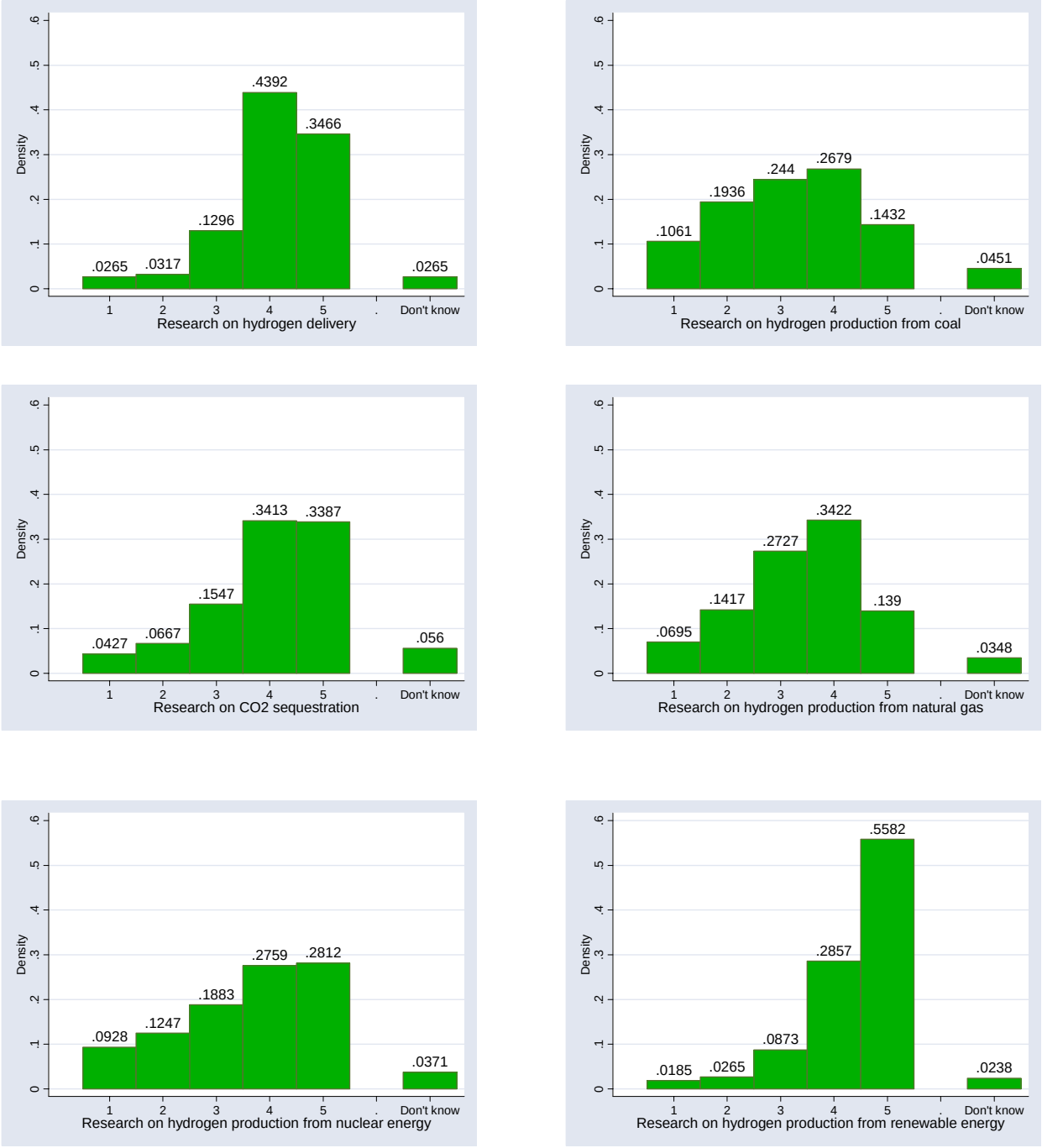

Figure 4. Histograms of responses to questions on research policy preferences

3.5 Organizations' interests

Stakeholders' policy activity is strongly influenced not only by their policy belief systems but also by the interests of the organization that they represent (among many other less stable factors.) The hypothesis here is that stakeholders' policy positions with regard to hydrogen are affected by their organizations' interest in markets for related or competing technologies. We presented respondents with a comprehensive list of technologies directly or indirectly associated or competing with hydrogen, and asked them to rate in a three-point scale how important short-term markets for these technologies are for their organizations. The scale was defined as 1=Not important, 2=Somewhat important, and 3=Very important. Table 11 presents the frequencies of responses falling in each of these categories for each of the technologies, for the subsample based in the United States.

Table 11. Response frequencies for organizations' market interests

	Frequencies			Mean
	Not important	Somewhat important	Very important	
Gasoline internal combustion vehicles	266	115	97	1.648
Gasoline hybrid electric vehicles	80	188	213	2.300
Gasoline plug-in hybrid electric vehicles	167	178	131	1.973
Battery electric vehicles	222	161	96	1.758
Alternative-fuel vehicles	73	221	186	2.245
Hydrogen internal combustion engine vehicles	161	220	99	1.851
Hydrogen hybrid electric vehicles	124	213	145	1.995
Hydrogen plug-in hybrid electric vehicles	185	190	105	1.830
Fuel-cell vehicles	97	182	199	2.198
Hydrogen-fueled buses	117	185	180	2.082
Hydrogen energy stations	116	168	195	2.144
Hydrogen stationary applications	120	198	160	2.051
Hydrogen portable applications	155	197	128	1.918

On average, the strongest interest in our sample of organizations is in gasoline hybrid electric vehicles, followed by alternative-fuel vehicles, fuel-cell vehicles, and hydrogen energy stations, in that order. The lowest interest is found for gasoline internal combustion vehicles. These numbers are presented only to describe our sample's responses and are not to be used to draw policy conclusions. Only further analysis of our data can tell what the relative influence of each of these interests is in the actual policy landscape.

3.6 Education policy beliefs

The adoption of hydrogen as a transportation fuel would be grounded on significant transformations in terms of the technologies involved and the value of their use to society and consumers. Because of this, a successful market introduction of hydrogen and related technologies will necessitate of policies to educate different sectors of society about the implications of this introduction.

We asked our sample about the areas of education that should be given high priority in the short term, and what the target populations of education policies in those areas should be. The question is framed as to retrieve normative responses. In other words, it asks what *should* be done, as

opposed to what the respondent would actually do. Thus, responses fall in the category of policy beliefs. Given the large number of questions in this section, we used check boxes to collect answers, where a check indicates that high priority should be given in the short term to education programs on a given subject to a given target population.

Error! Reference source not found. and **Error! Reference source not found.** show the education subject areas on the rows and the target populations on the columns. The cells indicate the non-weighted and weighted means of the responses for each combination respectively. Responses were coded as binary variables, so that the means are bounded by 0 and 1.

Table 12. Non-weighted means of responses to education policy questions

Target population / Education area	Consumers	Grade schools	High schools	Colleges	Gov't elected officials	Safety/ Permitting officials	Other	None	Don't know
Hydrogen safety issues	0.512	0.179	0.298	0.412	0.612	0.797	0.040	0.053	0.019
Societal benefits of hydrogen	0.623	0.383	0.541	0.580	0.739	0.311	0.045	0.087	0.027
Value of hydrogen vehicles to consumers	0.683	0.179	0.356	0.433	0.586	0.224	0.063	0.137	0.032

Table 13. Weighted means of responses to education policy questions

Target population / Education area	Consumers	Grade schools	High schools	Colleges	Gov't elected officials	Safety/ Permitting officials	Other	None	Don't know
Hydrogen safety issues	0.511	0.199	0.306	0.408	0.612	0.840	0.045	0.050	0.007
Societal benefits of hydrogen	0.635	0.412	0.551	0.605	0.768	0.325	0.046	0.087	0.011
Value of hydrogen vehicles to consumers	0.700	0.196	0.352	0.442	0.622	0.222	0.067	0.134	0.017

To our sample, the education programs should be primarily concerned with informing consumers about the value proposition of hydrogen vehicles, government about the societal benefits that the adoption of hydrogen could bring about, and perhaps most importantly, safety and permitting officials about issues related to hydrogen safety. These results were intuitively expected. On a second layer of priority, with mean values between 0.6 and 0.7, we find education programs on the societal benefits of hydrogen directed consumers and college students, along with education programs on the value proposition of hydrogen vehicles, directed to government officials. It is worthwhile noticing the general decrease in the means as we move from present consumers to younger groups (future consumers.) This may be an indication of the general perception of our sample that hydrogen vehicles will enter the marketplace sooner rather than later.

4. Perspectives on Policy Influence

The influence of policy actors—organizations and individuals—in a policy process is often referred to in the political science literature as *efficacy*. This concept has been measured in different ways in studies. Faithful to our principle that perceptions and beliefs play a central role in policy activity, we chose to measure efficacy as it is perceived by the stakeholders. To do this, we asked respondents to provide the names of up to five organizations that, or individuals who

they perceived as the most influential on policies related to hydrogen. We present the results in separate tables for organizations and individuals. Table 14 shows the organizations that were mentioned more than once by US-based respondents as being among the most influential in the policy process. In a few cases, responses were consolidated because they represented essentially the same groups. These consolidations are indicated by a slash separating the organization names.

Table 14. Organizations perceived as most influential in the hydrogen policy process

Organization	Number of mentions
US Department of Energy	112
California Air Resources Board	50
US National Hydrogen Association	35
California Fuel Cell Partnership	30
University of California at Davis	27
General Motors	25
California Energy Commission	19
US Environmental Protection Agency	16
South Coast Air Quality Management District	15
US Congress	15
US Fuel Cell Council	14
California Environmental Protection Agency	13
OEMs/Alliance of Automobile Manufacturers	12
US Department of Transportation	12
National Renewable Energy Laboratory	10
Shell	10
State of California	9
European Union/European Commission	8
Ballard Power Systems	7
Air Products	6
Honda	6
National Academy of Sciences/Transportation Research Board	6
Nuclear Regulatory Commission	6
The White House	6
California Hydrogen Business Council	5
Ford Motors	5
Oil companies/American Petroleum Institute	5
Society of Automotive Engineers (SAE)	5
Toyota	5
Union of Concerned Scientists	5
Universities	5
US Government	5
British Petroleum	4
California Hydrogen Highway	4
ExxonMobil	4
Natural Resources Defense Council	4
US Department of Defense	4
International Energy Agency	3

International Partnership for a Hydrogen Economy	3
Oak Ridge National Lab	3
Rocky Mountain Institute	3
State Governments	3
University of California	3
US National Labs	3
Argonne National Lab	2
California Department of Transportation	2
CHBritish Columbia	2
ChevronTexaco	2
Energy companies/suppliers	2
FreedomCAR	2
NASA	2
National Science Foundation	2
Office of Science and Technology Policy	2

Arguably, the California Air Resources Board and the California Environmental Protection Agency could have been consolidated, in which case they would have reached 63 mentions. A consolidation of responses was performed also for individuals, whenever their names as well as the specific position they occupied were mentioned. Individuals mentioned more than once by US-based respondents, are presented in decreasing order in Table 15.

Table 15. Individuals perceived as most influential in the hydrogen policy process

Individuals' names/positions	Number of mentions
President Bush/US President	24
Alan Lloyd	20
Gov. Arnold Schwarzenegger/Gov. of California	17
Steve Chalk	9
Joan Ogden	8
Terry Tamminen	6
David Garman	5
Joseph Romm	5
Dan Sperling	4
Spencer Abraham/Secretary of Energy	4
Don Paul	3
Research scientists/University researchers/Leading academics	3
Robert Walker	3
Geoff Ballard	2
Gov. George Pataki	2
Gov. Jeb Bush	2
Scott Samuelsen	2
US Senator Byron Dorgan	2