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Public Views on the Importance and Expansion of Renewable Electricity Production over the Last 35 Years in Idaho, USA

Robert L. Mahler

Department of Soil and Water Systems, University of Idaho, Boise 83702, USA

Corresponding Author Email: bmahler@uidaho.edu

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ABSTRACT

In 2022, Idaho stood fourth among U.S. states in renewable electricity share, with 74% generated from renewable sources like hydro, solar, wind, and geothermal. The dominant contributor has historically been hydropower. However, due to population growth and limited potential for new dam sites, reliance on solar and wind energy has increased. This paper aims to document the evolution of Idahoan public opinion regarding renewable energy's role in electricity production over 35 years. Public surveys were conducted every five years from 1987 to 2022, each involving at least 500 respondents. The surveys reveal strong public support for enhancing Idaho's renewable energy share. Over 75% of respondents expressed pride in the state's renewable electricity generation. Support for solar and wind energy has grown from 60% in 1987 to over 80% in 2022. Geographical preferences emerged, with south-western and south-central residents favoring solar, south-eastern residents favoring wind, and northern residents divided between hydro, solar, and wind. The surveys disclose that Idahoans: (1) strongly support increased renewable electricity production, (2) endorse solar and wind energy as key contributors, and (3) desire to replace Idaho's remaining non-renewable energy production with renewable sources within the next decade.

1. INTRODUCTION

Climate change presents a formidable challenge to global humanity. Consequently, numerous governments worldwide have committed to preventing global temperatures from rising more than 2°C in the forthcoming decades to avert devastating impacts on human health, water supply, food production, and biodiversity [1]. A crucial step towards mitigating climate change involves reducing CO_2 emissions primarily caused by the extensive use of fossil fuels. The consumption of these carbon-based fuels can be curtailed by shifting towards renewable energy resources such as solar, wind, hydroelectric, and geothermal for electricity production.

Historically, three major energy transitions have been observed. The shift from wood to coal marked the first transition in developed nations, followed by the replacement of coal with oil approximately a century ago. As of 2018, fossil fuels, namely oil, natural gas, and coal, were predominant, accounting for 36%, 31%, and 13% of global energy consumption, respectively [2]. The third and current transition sees the gradual supplanting of fossil fuels with carbon-free renewable energy resources, most notably solar, wind, and geothermal. This ongoing transition, favoring renewable sources, promises transformative impacts on development and the environment, particularly through cleaner electricity [3].

Electricity indeed plays a pivotal role in the economies of both developed and developing nations, and its share of overall energy consumption continues to rise [4]. The electrification of mass transit and motor vehicles is anticipated to further enhance this share [5]. Although hydropower has historically been the largest source of renewable electricity in developed nations, limited opportunities for future expansion due to the exhaustion of major hydropower sites necessitate a swift growth in solar and wind energy. The energy produced by wind increased from 487,000 MWh in 2016 to 824,000 MWh in 2021, while solar energy production experienced even more substantial growth, from 78,000 MWh in 2016 to 850,000 MWh in 2021. This transition to renewable energy resources continues to garner public support [6, 7].

The Pacific Northwest states of Idaho, Oregon, and Washington stand out in the USA due to their heavy reliance on hydropower for electricity. These states contribute 45% of the USA's hydropower generation capacity, resulting in a higher proportion of renewable energy than other regions. As of 2019, the electricity generation in Washington was composed of 60% hydropower, 16% natural gas, 10% nuclear, and 12% other renewables [8]. In Oregon, the respective contributions of hydropower, natural gas, and other renewables were 40%, 36%, and 24% [9], while in Idaho, these percentages were 55%, 16%, and 19% [10]. When hydropower and other renewables (geothermal, biomass, solar, wind) are combined, the renewable proportions of electricity provided were 72%, 64%, and 74% in Washington, Oregon, and Idaho, respectively.

A successful transition to a carbon-free renewable energy system necessitates public support and engagement. In this context, the contiguous Pacific Northwestern states of the USA, where a significant proportion of energy resources are already renewable, serve as an intriguing case study. A repeated measure survey instrument was developed in 1987 to

assess public opinions regarding the value, potential, and sustainability of energy resources in Idaho. The aim of this paper is to track the evolution of public opinion over the past 35 years regarding the importance of renewable energy for electricity production in Idaho. This study seeks to (1) identify the electricity sources that Idahoans consider renewable, (2) determine the most important electricity source in the state, (3) document the percentage of energy considered renewable by Idahoans, (4) ascertain the desired future proportion of renewable electricity in Idaho, (5) gauge the importance of electricity generation in Idaho being renewable, (6) identify the renewable energy source that should be most expanded for electricity production in Idaho over the next 20 years, and (7) predict the future hydropower-solar-wind energy nexus in Idaho based on public surveys. The mail-based survey designed in 1987 was administered to the public every five years from 1987 to 2022. This study summarizes the findings of this survey instrument.

2. METHODOLOGY

A survey instrument was developed to determine public views of the value, potential and sustainability of electricity resources in Idaho in 1987. This survey was sent to over 1,500 residents in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022. The seven survey questions in each of the eight survey years discussed in this paper were as follows:

Q-1. Which of the following electricity sources are renewable (sustainable)? Check all that are renewable: biomass, coal, geothermal, hydroelectricity, natural gas, nuclear, oil, solar, tidal, wind.

Q-2. What is the most important electricity source in Idaho? Choose one: biomass, coal, geothermal, hydroelectricity, natural gas, nuclear, oil (gasoline), solar, tidal, wind.

Q-3. What percent of Idaho's electricity is currently renewable? Choose one: less than 10%, 10 to 25%, 25 to 50%, 50 to 75%, 75 to 90%, greater than 90%.

Q-4. Realistically, what percentage of Idaho's electricity should be renewable? Choose one: less than 10%, 10 to 25%, 25 to 50%, 50 to 75%, 75 to 90%, greater than 90%.

Q-5. How important to you is it that the electricity being used in Idaho is renewable within 20 years? Choose one of the following: very important, important, no opinion, not important.

Q-6. Which of the following energy sources will become more important (viable) in Idaho over the next 20 years? Check all that will become more important: biomass, coal, geothermal, hydroelectricity, natural gas, nuclear, oil, solar, tidal, wind.

Q-7. Assuming that there is no room for further hydroelectricity expansion in Idaho, which ONE of energy sources below should be most relied upon to meet renewable electricity production needs in the next 20 years? Choose one of the following: biomass, coal, geothermal, natural gas, nuclear, oil, solar, tidal, wind.

The survey target audience was a representative sample of the 1,300,000 adult residents of Idaho. In addition, demographic information, including community size, gender, age, educational level and geographical location within Idaho was also collected.

The survey was developed using the Dillman methodology and delivered to clientele via the United States Postal Service [11, 12]. A sufficient number of completed surveys was the goal to result in a sampling error of 3 to 5% [13]. The survey process was also designed to receive a completed survey return rate more than 50%. Addresses were obtained from a professional social sciences survey company (SSI, Norwich, CT). Over 1,500 surveys were sent out in each mailing event. Four mailings were planned to achieve the 50% return rate. The mailing strategy used was identical to other surveys that had been routinely conducted in the region [14, 15]. It only took three mailings to achieve the target return rate of 50% in 1987, 1997, 2002, 2012 and 2017. Conversely, it took four mailings to achieve the 50% return rate in 1992, 2007 and 2022.

Survey answers were coded and entered into Microsoft Excel. Missing data were excluded from the analysis. The data were analyzed at two levels using SAS [13]. The first level of analysis generated frequencies, while the second level evaluated the impacts of demographic factors. Significance ($P<0.05$) to demographic factors was tested using a chi-square distribution [11, 12] since similar response rates were observed in all survey years and data analysis procedures were identical for each sampling.

3. RESULTS AND DISCUSSION

The survey methodology was designed to compare resident responses over time so that useful information about renewable electricity attitudes could be evaluated. Using the mail-based Dillman survey methodology, response rates of 50.9, 52.1, 51.6, 53.4, 50.4, 52.1, 54.4 and 53.3% were achieved for the surveys conducted in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022, respectively. The goal of greater than a 50% response rate was achieved for all surveys, resulting in a sampling error of less than 5%.

When this survey was first initiated in 1987 the population of Idaho was approximately 980,000 [16]. However, by 2022, Idaho's population had grown to over 1,940,000. This 98% population increase resulted in Idaho becoming more urban and more concentrated in communities with more than 40,000 people over the 35-year study period.

There were several instances in this survey study where the demographic factors of gender, age, education level, community size and geographical region in Idaho impacted respondent answers. These instances will be discussed in the following sections.

3.1 Renewable and non-renewable electricity sources

A substantial majority of Idaho residents correctly labeled wind, solar, geothermal and hydroelectric as being renewable electricity sources (Table 1). The percentage of the public that identified wind, solar and geothermal as renewable electricity sources increased between 1987 and 2022. Although a vast majority of Idahoans felt that hydroelectric was a renewable energy source, the percentage agreement fell from 93 to 84% over the 35-year study. This may be the result of publicity about dam removals in the northwestern part of the USA to improve fisheries. Although biomass and tidal energy are widely regarded as renewable energy resources less than a majority of survey respondents recognized these facts. A clear majority of Idahoans recognized that nuclear, natural gas, oil and coal were non-renewable energy resources. Based on the information presented in Table 1 the public had an excellent grasp of renewable and non-renewable energy resources.

The demographic factors of age and education level impacted responses to this survey question. Respondents younger than 40 years old were more likely to recognize nuclear, coal, oil and gas as being non-renewable energy sources than older Idahoans. Residents with two or more years of college were more likely to correctly place energy sources as renewable and non-renewable than residents with less formal education.

Table 1. The Idaho public's understanding of renewable and non-renewable electricity sources based on surveys conducted in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Energy Source	1987	1992	1997	2002	2007	2012	2017	2022	Sign.
	% Calling the Electricity Source Renewable								
Wind	84	81	89	92	91	90	95	96	***
Solar	88	86	85	89	89	93	92	92	**
Geothermal	61	63	60	69	73	77	85	84	***
Hydroelectric	93	90	92	91	87	89	81	80	**
Biomass	47	51	49	48	52	46	48	48	NS
Tidal	18	23	25	23	29	27	24	30	**
Nuclear	23	26	21	23	27	28	21	23	NS
Natural gas	21	19	15	17	18	16	11	10	**
Oil	8	6	7	5	7	4	8	6	NS
Coal	9	6	5	3	4	2	2	1	***
Significance	****	****	****	****	****	****	****	****	

NS = not significant; **, *** and **** = significant at the 95, 99 and 99.9% level of probability, respectively.

3.2 Importance of energy sources in Idaho

Over 70% of survey respondents in all survey years indicated that hydroelectric was the major source of electricity in Idaho (Table 2). The survey respondents were correct in their belief. No other one energy source was listed by more than 9% of survey respondents in any of the eight survey years. The hydroelectric response peaked at 83% in 1992, but declined to 70% by 2022. This recent downward trend may be due to recent media attention to both solar and wind energy. In recent years the percentage of survey respondents identifying solar or wind as the most important source of electricity in the state has significantly increased since 1987; however, responses peaked at 7% for both energy sources in 2022. Survey year had minimal impact on the selection of dominant electricity source in Idaho.

The demographic factors of gender, age, education level and community size impacted answers about Idaho's most important energy source (Table 3). Females were more likely than males to say that hydropower was the major source of electricity in Idaho. Residents older than 60 years old were most likely to choose hydropower as Idaho's main energy source, while residents younger than 35 were least likely to identify hydropower as the major electricity source. Residents with at least two years of college were most likely to choose hydropower while those with less than 12 years of schooling were least likely to choose hydropower. Idaho residents of communities smaller than 7,500 were most likely to choose hydropower, while residents living in communities of greater than 40,000 people were least likely to choose hydropower as Idaho's main electricity source.

Table 2. The public views of the most important electricity sources in Idaho based on surveys conducted in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Energy Source	1987	1992	1997	2002	2007	2012	2017	2022	Sign.
	%								
Hydropower	75	83	80	74	79	74	71	70	**
Natural gas	8	4	6	8	7	9	9	7	**
Oil	1	3	1	1	2	1	2	1	NS
Coal	1	2	2	2	1	1	1	1	NS
Solar	2	2	3	5	4	4	6	7	***
Wind	2	2	3	4	4	3	5	7	***
Geothermal	2	3	2	1	2	1	2	1	NS
Other	8	1	3	5	1	7	4	6	NS
Significance	****	****	****	****	****	****	****	****	

NS = not significant; **, *** and **** = significant at the 95, 99 and 99.9% level of probability, respectively.

Table 3. The impact of demographic factors on Idahoan choice of the most important electricity source based on surveys conducted in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Demographic Factor	Significance	Most Likely to Choose Hydropower	Least Likely to Choose Hydropower
Gender	**	Female	Male
Age	***	> 60 years old	< 35 years old
Education	***	College	12 years or less
Community size	**	< 7,500 people	> 40,000 people

** and *** = significant at the 95, and 99% levels of probability, respectively.

3.3 Reliance on renewable electricity resources

Based on the previous discussion most Idahoans know the difference between renewable and non-renewable electricity resources. When asked about the percentage of electricity that was derived from renewable energy resources, a majority of survey respondents felt that at least 60% of Idaho's electricity was generated by renewable sources (75 to 90% and >90% answers pooled) in every survey year (Table 4). This value exceeded 70% in 1987, 1992 and 1997, but declined to approximately 60% by 2007, 2012, 2017 and 2022. The decline from 70%+ to 60% over the course of the survey period was probably due to power companies indicating that they were buying additional power on the grid due to the large population increase, particularly in southwestern Idaho.

Table 4. The percentage of electricity production in Idaho that the general public considered renewable in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Renewable	1987	1992	1997	2002	2007	2012	2017	2022	Sign.
					%				
< 10%	4	1	1	3	3	3	1	2	NS
10 to 25%	6	5	4	4	3	5	6	7	NS
25 to 50%	4	4	6	10	12	18	20	20	***
50 to 75%	15	14	16	20	21	14	13	11	NS
75 to 90%	60	63	60	54	51	54	50	53	***
>90%	11	13	13	9	10	6	10	7	**
Significance	****	****	****	****	****	****	****	****	

NS = not significant; **, *** and **** = significant at the 95, 99 and 99.9% level of probability, respectively.

Table 5. The general public feels that a realistic share of Idaho's electricity production should be renewable based on survey results in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Renewable	1987	1992	1997	2002	2007	2012	2017	2022	Sign.
					%				
< 10%	0	0	0	0	1	1	0	1	NS
10 to 25%	3	3	2	1	2	4	3	1	NS
25 to 50%	6	6	5	3	2	4	5	5	NS
50 to 75%	23	25	22	20	13	12	9	6	**
75 to 90%	62	61	68	72	77	76	81	84	****
>90%	6	5	3	4	5	3	2	3	NS
Significance	****	****	****	****	****	****	****	****	

NS = not significant; **, *** and **** = significant at the 95, 99 and 99.9% level of probability, respectively.

Table 6. The importance of using renewable electricity in Idaho in the next 20 years based on survey results in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Importance	1987	1992	1997	2002	2007	2012	2017	2022	Sign.
					%				
Very important	34	30	32	28	30	34	35	40	**
Important	39	42	42	44	46	47	47	46	**
Not important	21	24	22	21	19	16	14	11	***
No opinion	6	4	4	7	5	3	4	3	NS
Significance	****	****	****	****	****	****	****	****	

NS = not significant; **, *** and **** = significant at the 95, 99 and 99.9% level of probability, respectively.

Well over 90% of Idahoans felt that a realistic share of Idaho's electricity production should be above 50% renewable (Table 5). This trend was consistent over the 35-year survey period. The percentage of survey respondents that did not think that renewable energy would be important in the next 20-year period declined from 21% in 1987 to 11% in 2022. Conversely, the percentage of Idahoans that thought that renewable electricity would be important (very important + important responses) increased from 73% in 1987 to 86% in 2022 (Table 6).

The demographic factors of gender, age, education level and community size impacted how Idahoans viewed the proportion of renewable electricity over the last 35 years and projected over the next 20 years (data not shown). Females were more likely than males to view renewable electricity sources in Idaho as important over the last 35 years and projecting into the next 20 years. Younger Idaho residents were also more likely to say that renewable energy resources were more important in the past and will be in the future than people older than 50 years of age.

Idahoans with 2+ years of college were more likely to say that using renewable electricity sources 20 years into the future was very important compared to respondents with less formal education. Residents of cities with more than 40,000 people thought that Idaho's share of electricity produced by renewables since 1987 was less than what the more rural residents thought. However, in the next 20 years the more urban residents were more likely to consider renewable electricity more important than rural residents.

3.4 Renewable energy in Idaho's future

Idahoans believe that wind and solar will become more important as electricity sources in the next 20 years (Table 7). Wind energy has become more popular over the duration of the 35-year survey study as 26% of survey respondents in 1987

believed that wind would become a more important source of electricity. However, by 2022, 49% of the public felt that wind had a more important future over the next 20-year period. A similar trend was observed for solar as 21% of Idahoans predicted in 1987 that solar would become important over time. This percentage increased to 43% of respondents in the 2022 survey.

The percentage of respondents that felt that geothermal would become more important in the future increased from 6% in 1992 to 12% in 2012 and 2017 (Table 7). Even though this trend response for geothermal was positive during the survey period, enthusiasm for it was much lower than for solar or wind generated electricity. The potential future expansion of hydroelectric in Idaho was largely ignored by Idahoans because it has low potential for future expansion because new potential dam sites are limited and there is the potential of removing some existing dams for the improvement of fish habitat in Idaho's rivers.

The potential expansion of non-renewable energy sources including natural gas, oil and coal was ignored by Idahoans. There is no future for tidal energy because Idaho does not have a seacoast. Although not currently considered renewable, nuclear energy, because it does not produce carbon emissions, showed some popularity with survey respondents (Table 7). Idaho does have a history of nuclear power research because a large national energy laboratory is located in the state; however, this is unlikely to translate into supplemental nuclear power production in the next 20 years.

Table 7. Electricity sources that will become more important in the next 20 years in Idaho based on surveys conducted in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Energy Source	1987	1992	1997	2002	2007	2012	2017	2022	Sign.
					%				
Wind	26	24	28	31	34	39	43	49	***
Solar	21	26	26	31	33	37	39	43	***
Geothermal	8	6	9	11	10	12	12	11	**
Nuclear	10	10	9	10	13	14	12	12	NS
Hydroelectric	4	3	6	5	4	4	5	3	NS
Biomass	2	4	7	5	3	6	4	4	NS
Significance	****	****	****	****	****	****	****	****	

Non-renewable energy sources that averaged less than 10% are not included in this table. NS = not significant; **, *** and **** = significant at the 95, 99 and 99.9% level of probability, respectively.

Table 8. Electricity source that should be heavily relied upon to become significantly more dominant in Idaho in the next 20 years based on surveys conducted in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Energy Source	1987	1992	1997	2002	2007	2012	2017	2022	Sign.
					%				
Wind	25	27	24	27	33	35	42	46	***
Solar	35	36	37	40	38	39	36	34	NS
Other choice	40	37	39	33	29	26	22	20	***
Sign. W vs. S	***	***	***	***	**	**	**	***	

NS = not significant; **, *** and **** = significant at the 95, 99 and 99.9% level of probability, respectively.

When the data from survey questions 5, 6 and 7 are combined it is obvious that the public thought wind and solar are the most viable long-term solutions for increasing Idaho's share of renewable electricity production (Table 8). This table compares wind, solar and the other potential future sources of energy (hydropower, geothermal, nuclear, coal, oil, gas, biomass, tidal) shown in Tables 1, 2 and 7. The percentage of Idaho respondents that feel that wind should be relied upon to increase renewable electricity in Idaho increased from 25% in 1987 to 46% in 2022 (Table 8). Basically, in 2022 almost half of the survey respondents felt that wind should be the dominant electricity expansion resource in Idaho. The percentage of survey respondents that felt that Idaho should rely on solar energy for the expansion of renewable electricity over the next 20 years ranged from 34 to 40% depending on the survey year as there were no observable year-to-year trends. Survey respondents favored wind over solar in the 2017 and 2022 surveys. Conversely, Idahoans favored solar over wind in the 1987, 1992, 1997, 2002, 2007 and 2012 surveys.

Looking out 20 years into the future, 40% of survey respondents felt that choices other than wind or solar were better options in 1987. However, by 2022 only 20% of survey respondents thought that there were better options than solar or wind. This downward trend over the 35-year survey period indicated that the public is more likely to promote the use of solar or wind 20 years into the future than other electricity sources.

The demographic factors of gender, community size and state of residence impacted survey respondent choices. Males were more likely to view oil as more important than females, while females ranked hydropower and natural gas as more important than males. Residents of communities larger than 40,000 were more likely to consider oil and natural gas more important than respondents in towns with less than 7,000 people. The demographic factors of age and education level did not affect respondents' answers to this survey question.

3.5 Impact of geography on renewable energy in Idaho's future

When the state was divided into three geographic regions, differences in the preferred electricity source of the future were apparent (Table 9). Residents of southeastern Idaho were most likely to support the expansion of wind energy in the next 20 years. This is likely due to high velocity and constant winds that are common in this region. Residents of southwestern Idaho were most likely to support solar energy. This is likely due to the large number sunny days in this region. Solar and

wind energy are not good options for northern Idaho because of low levels of solar radiation and infrequent winds. Consequently, northern Idaho residents felt that hydropower was their best choice for future energy expansion. Although Idahoans did not feel that geothermal would be a major renewable energy source in the next 20 years, residents of the southwestern part of the state were most likely to support this energy resource.

Table 9. The impact of Idaho geography (north Idaho – North; southwestern Idaho – Southwest; southeastern Idaho – Southeast) on the willingness of people to support the use of specific renewable electricity sources based on surveys conducted in 1987, 1992, 1997, 2002, 2007, 2012, 2017 and 2022

Demographic Factor	Significance	Most Pro Region	Least Pro Region
Hydroelectric	**	North	Southwest
Wind	***	Southeast	North
Solar	***	Southwest	North
Geothermal	**	Southwest	North

, and * = significant at the 95 and 99% levels of probability, respectively.

4. CONCLUSIONS AND RECOMMENDATIONS

The major findings of this 35-year survey study were:

- The Idaho public had an excellent grasp of renewable and non-renewable electricity resources during the entire 35-year survey study period.
- Residents younger than 30 years old were more likely to recognize nuclear, coal, oil and natural gas as being non-renewable electricity sources than older Idahoans.
- Idahoans correctly indicated that over 70% of their electricity resources were based on hydropower.
- Residents older than 60 years old were more likely to choose hydropower as Idaho's main electricity source compared to residents younger than 30 years old.
- Well over 90% of Idahoans felt that a realistic share of Idaho's electricity production should be higher than 50% renewable in the future.
- Young Idaho residents were also more likely to say that renewable electricity resources were more important in the past and will be important in the future than people older than 60 years old.
- Idahoans believe that wind and solar will become much more important electricity sources in the next 20 years.
- The future importance of wind as an electricity source increased from 26% of the public in 1987 to 49% by 2022. Likewise, the future importance of solar energy increased from 21% in 1987 to 43% by 2022.

The 35-year survey study showed that Idahoans want renewable electricity. Traditionally, hydropower has provided the large majority of this renewable electricity. However, fast population growth has caused utilities to import additional power, usually non-renewable, from other states. To meet this increased demand for renewable electricity the public wants significant investments in solar and wind energy. With this investment and public acceptance and demand for this type of energy there is good reason to believe that renewable energy sources could provide more than 90% of Idaho's electricity needs by 2030.

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