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Viewpoint

Public understanding of environmental impacts of electricity deregulation

Branden B. Johnson[a,*], Pamela G. Frank[b]

[a]*Department of Environmental Protection, Division of Science, Research and Technology, 401 E. State St., P.O. Box 409, Trenton 086250409, USA*
[b]*Sun Farm Network, 15 Frog Hollow Road, Califon, NJ 07830, USA*

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Abstract

Electricity deregulation has aroused concern that environmental quality might be harmed by consumer preferences for cheap, "dirty" (e.g., coal) electricity products, despite the perhaps stronger influence of supply side policy on environmental impacts. This outcome depends on public understanding of the environmental impacts of their decisions, which this study explored with interviews, focus groups, and surveys in New Jersey. People had thought little about the topic, were unable to articulate how electricity production might affect the environment except in very general terms, and were mostly unwilling to guess whether deregulation's impacts would be negative, neutral or positive. Those who did guess expected negative impacts less than any other kind. Reactions to specific "reasons" for expecting no, positive or negative impacts suggested that consumers had little structure to their mental models in this area; for example, people who thought positive-impact reasons were probably true were not necessarily likely to see negative-impact reasons as probably false. However, in the aggregate, people seemed to have a fairly consistent ranking of energy sources by expected negative environmental impacts. Earlier research found that consumers comparing two electricity products on environmental impacts reached different decisions if they had energy-source-only or energy-source-plus-emissions information. Although regulator-required "environmental labels" for electricity products provide both source and emissions data, it is not clear that they do an adequate job of both alerting consumers to the possibility of negative environmental impacts and identifying the relative life-cycle impacts of different products so as to produce informed consumer decisions.

Keywords: Electricity deregulation; Environmental impacts; Public perceptions

1. Introduction

The rationale for electricity deregulation has been its potential to lower prices and make the industry more efficient. But one fear of some advocates and many opponents of such deregulation is that customer interest in lower prices would lead to choice of electricity products with high negative environmental impacts, thus increasing air pollution, global climate change, water demand and pollution, land use change, and waste generation. Deregulation is an opportunity for firms to offer, and governments to encourage, "green" electricity as a premium product, but the potential demand for such a product has been unclear. While the supply side of such policies (e.g., through regulations requiring that a certain portion of production be from renewable sources) may ultimately outweigh the influence of the demand-side, the latter has had a high profile in rhetoric about deregulation and could in fact influence policy design.

One factor in consumer choice of "green" versus "dirty" electricity is the public's knowledge of environmental impacts of electricity generation and transmission. Greater knowledge does not necessarily lead to more choice of "green" electricity, since that also depends upon such factors as how much environmental impacts are valued relative to differences in price. However, low levels of knowledge are unlikely to

*Tel.: +1 6096332324; fax: +1 6092927340.
E-mail addresses: Branden.Johnson@dep.state.nj.us (B.B. Johnson), pgfrank@comcast.net (P.G. Frank).

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promote "green" demand, since consumers will be unaware that this is a consideration in choice of an electricity supplier. This paper reports a pilot study in New Jersey of residential consumers' understanding of environmental impacts of electricity deregulation, and of their reactions to required environmental-impacts information.

2. Background

The New Jersey Legislature enacted the Electric Discount and Energy Competition Act in 1999 (PL 1999, Chapter 23).[1] Among its many aims was to "Prevent any adverse impacts on environmental quality in this State as a result of the introduction of competition in retail power markets in this State" (C.48:3-50(2)(a)(9)). To aid this goal, the statute had "environmental disclosure requirements" for information for electricity suppliers to give potential customers. This information included the power supply's fuel mix, emissions in pounds per megawatt hour of sulfur dioxide, carbon dioxide and nitrogen oxides, and any "retirement" of emissions. Emissions had to be compared to a benchmark allowing "a meaningful comparison," in a "format that is graphic in nature and easily understandable by consumers" (C.48.3-87(38)(b)(2-3). As well as marketing efforts (including the "environmental label" (EL) for the "disclosure" cited above) by electricity suppliers, the state extensively advertised the program, and used a series of focus groups and telephone surveys to track awareness of the program and intentions to shift suppliers.

No studies have assessed lay knowledge of environmental impacts of electricity deregulation. Occasionally studies of energy use or policy tap environmental attitudes, but these tend to examine the interaction between general concern for environmental quality and general support for particular energy sources, rather than explore which particular environmental impacts people think of in connection with energy use or sources. For example, Brunner and Vivian (1980) found general consensus on resistance to energy price increases, concern for public health, safety and the environment, and distrust of authorities. Studies in 1999 to prepare to educate environmental group members on benefits of renewable energy found that even for these interested people terms like "renewable energy," "clean energy," and "green power" were unfamiliar (Rosoff et al., 2002, p. 10). Green Mountain Energy, a leading marketer of renewable energy, concluded that the prime customer for such energy need not be environmentally oriented. Rather, this person is a risk-taker, and a homeowner better educated and older than average, who responds to messages about positive impacts of clean energy rather than ones on pollution effects of electricity generation (Rosoff et al., 2002, p. 11). A recent study (Clean Energy States Alliance and Gardner Nelson Partners, 2003) found that Americans preferred "clean energy" as a term to describe electricity from wind, solar and water sources, and saw fossil fuels as the basis of a comfortable and familiar life. By contrast, clean energy lacked scale and mainstream acceptance, without proven products and services. Self-sufficiency was seen as more motivating for behavior change than the standard, "nagging" appeal to environmentalism. This study did not explore beliefs about particular electricity sources beyond the taken-for-granted distinction between "clean" and other sources.

In preparation for electricity deregulation in several states, tests explored what EL designs for impact information might be most informative to consumers. For example, the New England Information Disclosure Project concluded that the EL should include four key pieces of information (price, contract terms, fuel mix, air emissions). Emissions of sulfur dioxide, nitrogen oxides and carbon dioxide should be reported in grams per kilowatt-hour and as a percentage of regional average emissions. Consumers consistently chose the supplier using less coal and more gas and renewable sources as "cleaner," unless shown data indicating that the coal-based product had lower emissions (Austin et al., 1998). Focus groups in New Hampshire and Massachusetts rated environmental information as very much secondary to price attributes of electricity products. But they liked fuel mix disclosure and to a lesser extent emissions data (Levy et al., 1997). Nationally, 19 focus groups in six states (not including New Jersey), a national telephone survey of 1600 respondents, and a shopping mall intercept study with 1000 consumers tested sample ELs' performance. Only joint use of fuel mix and air emissions data corrected consumer preferences based on perceived environmental impact of energy sources (Roe and Levy, 1998). This implies consumers had at least a sketchy mental model of which electricity sources were "cleaner," even if it was not entirely accurate.

The aim of the research described here was to examine mental models of energy sources and deregulation's environmental impacts in New Jersey, which might inform policy decisions on communication aspects of deregulation, greenhouse gas reduction, and associated programs.

3. Methods

3.1. Overall approach

The project began with in-depth interviews using a modified "mental models" strategy (Morgan et al.,

[1]This law's concurrent deregulation of the natural gas market is not discussed here.

2002). The interview began with "Have you heard about the deregulation of the electric utilities in New Jersey?" If the answer was no, subjects were told about the timing and nature of the choice they now could make on their electric supplier. They were then asked to "Tell me about the environmental impacts of electricity deregulation." Initial, often halting, responses were probed in a similar non-directive, open-ended manner (e.g., "Tell me more about that" for each earlier topic cited by the interviewee) until the initial response was exhausted. The interview then turned to slightly more directive questions (e.g., "Tell me about the environmental impacts of how electricity is produced"), probing in a similar manner. This continued until all major elements of the topic—the production, transmission, and use of electricity—were profiled, and the interviewee indicated she had no further concepts on the topic. This method seeks a more detailed view of individuals' conceptual models of a topic, such as the causal sequence from energy production to use, than feasible with focus groups, and reduces possible bias due to more directive questioning (e.g., "How does using coal as an energy source for generating electricity damage the environment?").[2] Subjects were asked whether they thought electricity deregulation in New Jersey would have positive, negative or neutral results for environmental quality, and why. They were also asked about desired information on environmental impacts, and any further comments due to viewing a diagram depicting different electricity sources and sample environmental impacts at the interview's end.

The 12 people interviewed in New Jersey were between 18 and 65, and included five men and seven women. All but one were college graduates and whites; ten were homeowners. Interviews averaged 15 min, with a range of 10–20 min.

The Center for Research and Public Policy (CRPP), a consulting firm hired by the New Jersey Board of Public Utilities, conducted three focus groups in New Jersey in November 2000. Group members were recruited by random digit dialing, with ethnicity of members roughly proportional to their share of the total state population. People were asked for reasons for thinking that environmental impacts of deregulation might be positive, neutral, or negative. Members of these three focus groups were sent a copy of the current EL in advance of the meeting; after discussion of that, they were shown an alternative label.

A series of statewide telephone surveys were conducted by CRPP both before and after the research reported here, to track public awareness and intentions with regard to electricity deregulation. Although most such survey questions were not pertinent to the present topic, some resulting data are compared to the current results to help put the latter into context (e.g., their representativeness). Unless otherwise noted, the data come from CRPP's seventh report on its August 2001 survey (conducted 1–2 months before the survey whose results appear here).

These interview and focus group results, plus the results of the CRPP surveys and national studies, and discussions with staff at the New Jersey Department of Environmental Protection (NJDEP), were used to design a survey mailed to a random sample of about 1000 New Jersey households in September 2001.

3.2. Survey instrument

Four versions of a survey instrument began with the same set of questions adapted from the New Jersey CRPP surveys (see Results), to provide a basis of comparison, as well as to control for awareness and action when examining beliefs about deregulation. They also ended with the same set of demographic questions.

The version of the survey instrument that will get the most attention here followed the question about positive, negative, or neutral environmental impacts of deregulation with reasons that one might choose each of those options. Respondents were asked to indicate for each reason whether they thought it was "True," "Maybe True," "Don't Know," "Maybe False," or "False." They then rated pairs of energy sources for electricity production as to which had the worse environmental impact; after short definitions of the more arcane "green" sources, pairs involving these sources were asked again. The specific energy sources used are presented under Results.

Since the main information source customers would have about the environmental impacts of the energy mix of their current or prospective electricity suppliers is the EL, this project also tested the current label against two alternatives. This was the purpose of the other three versions of the survey instrument. Agency disinterest in going beyond legislated requirements for the one-page label limited alternatives for testing, with the result that very few differences were found in public reactions. Results reported here focus only on those with implications for consumer knowledge of such impacts.

3.3. Survey response and respondents

The impacts-focused version of the survey was mailed in September 2001 to 251 randomly selected New Jersey single-family households, with reminders and a second copy of the survey sent in October. A total of 85 surveys were returned, and 229 of the original addresses were

[2]This approach to mental models (Morgan et al., 2002) tends to begin with an "expert" model of the topic, which identifies (1) subtopics to discuss later in the interview and (2) gaps, omissions, trivial truths and other problems in lay knowledge that could be corrected with education. The present study used an informal expert model only for the first purpose.

valid (the rest were undeliverable, or in 12 cases the addressee reported not being billed for electricity use), for a response rate of 37%. Although this was a surprisingly high response, given the World Trade Center attack and anthrax scares concerning New Jersey mail during the same period, it falls below the 40% rate usually acceptable to social scientists. Thus, generalization from these responses should be cautious.

The cover letter asked that the survey be answered by the household member responsible for selecting an electricity supplier or for paying electricity bills. This might explain why 66% of respondents were male (36% in the CRPP August 2001 survey). The mean age was 58 (s.d. = 17), ranging from 27 to 88. Thirty percent had college degrees (27% CRPP), and another 23% graduate degrees (11% CRPP). Some 88% were white (84% for CRPP), with 9% reporting Asian or Pacific Islander ethnicity (4% CRPP); only 4% reported Hispanic background (8% CRPP). An annual household income of at least $100,000 was reported by 34% (8% CRPP).[3] In short, respondents were more male, older, better educated, and wealthier than either CRPP respondents or the population of New Jersey or the United States. The sample was significantly whiter than the population of New Jersey (73% in the 2000 Census), but not the CRPP sample.

4. Results

4.1. Interviews

Most people interviewed had heard of deregulation of the electric utilities, but there was uncertainty about the sources of electricity. Those interviewed often admitted never having thought about sources of electricity before. Sources most mentioned, in no particular order, were nuclear power, coal, hydroelectricity, and oil.

As for deregulation's impacts on the environment, most interviewees were split between negative impacts and no impacts. Several trusted that the market would stabilize so as to prevent the energy industry from destroying the environment. Parallels were made to deregulation in other industries (e.g., telecommunications), in the sense that new companies may emerge but little else will change, including environmental impacts. However, most interviewees had a general notion that "power companies are bad for the environment." (That was about as specific as ideas of environmental impact got, although a few people did link coal with air pollution, or mention water impacts in general. Nuclear power was cited by a few as bad for the environment, but without detail.) Many agreed that if deregulation lowered prices, consumption would increase, which under this general notion could increase environmental degradation.

Most people expressed preference for a bottom-line summary of environmental impacts, such as a number between 1 and 10, with "nothing too technical" because "I don't want to take the time to educate myself." Independent information sources were preferred over government agencies, and both over utilities, because "I don't trust big business."

4.2. Focus groups

Most participants agreed that consumers did not link deregulation and environmental impacts. For example, many believed that deregulation might yield a cleaner environment, but admitted they had not thought much about this, partly due to caring but not thinking about the environment, and partly to a traditional lack of choice of electricity supplier. With that choice, group members thought the environmental impact of a firm's electricity could become a selling point, particularly if enough people chose "green" sources for a bandwagon effect. Many focus group members thought existing pollution standards would reduce the risk of environmental damage as a result of deregulation. Fewer members saw prospects of damage to the environment, on the grounds that clean electricity would cost more to produce and few suppliers would chance losing the competition for customers.

A scale of environmental impacts of currently supplied electricity in New Jersey, from 1 (least impact—in 2001, photovoltaic cells) to 10 (most impact—coal), was created based on estimates of average dollars per kilowatt hour to prevent entirely air pollution, water consumption, wastewater discharge, land use, and solid waste impacts under existing US regulatory and tax frameworks. This comparison omitted impacts pertinent to one or a few sources, such as nuclear waste or mercury pollution, to avoid apples-and-oranges comparisons. Focus group members were shown this background scale compared to the average impact rating for all electricity used in the state, and to that of a hypothetical "current" electricity product received by the customer. They much preferred it to the EL, although there were too many explanatory notes and caveats for many people.

4.3. Survey: background attitudes and behavior

Several questions were repeated from the statewide telephone surveys done by CRPP for the New Jersey Board of Public Utilities. About 39% were very or somewhat aware of electricity deregulation in New Jersey (75% aware, August 2001 CRPP). Six percent had decided to switch to another supplier, 35% had

[3]Similar demographics characterized respondents to the three EL-focused surveys; details available from first author.

decided to stay with their current supplier, 23% had "made a decision not to make a choice yet," and 26% were "waiting for more information"; 11% did not know. Some 39% were very interested, and 20% somewhat interested, in receiving information from energy suppliers. Over 77% had heard of the environmental label under deregulation, and 49% rated such a label as "very important," with 35% saying it was "somewhat important." Only 7% said they had read or used an EL to learn more about an energy supply, but 37% said they were "very likely" (41% "somewhat likely") to use it to help decide future decisions on a new electricity supplier.

Asked how much knowledge they had about environmental impacts of electricity supplies (on a scale from 0, "knowing nothing," to 100, "knowing everything anyone could possibly know about this topic"), the mean response was 37 (s.d. = 28; mode = 40); 14% rated their knowledge as zero. Asked about knowledge needed for "an understanding that is good enough for your purposes," the mean response was 61 (s.d. = 29; mode = 70); 11% needed complete ("100") knowledge. Two-thirds indicated they had less knowledge than they thought needed.

4.4. Survey: impact beliefs

Most survey respondents replied "don't know" when asked about the valence of environmental impacts they expected from deregulation (58 of 85, 68%); 7%, 11%, and 14% expected negative, no or positive impacts, respectively.[4] These figures show that the current sample was less willing to express an opinion despite above-average education and income than were respondents to the December 2000 CRPP state-wide telephone survey (9 months earlier than the current survey, but the closest in time that asked this question). In the CRPP survey, 20% expected no impact, 15% a negative impact, 33% a positive impact, and 32% did not know. A 50% cut in the BPU information budget (Jerry Lindsley, pers. comm., October 17, 2001) might be one explanation of this difference in results.

There were only two significant differences (of 90 tested) for six demographic or nine attitude and behavior measures across these four response groups at the Bonferroni-corrected level of $p<0.0085$ for six contrasts. Interest in information from suppliers was lower for "no impact" respondents than for "positive impact" or "don't know" respondents (and lower than for "negative impact" respondents at $p<0.05$). Women were marginally more likely to say "don't know" than that impacts would be negative ($p<0.10$) and those expecting neutral impacts were much older on average (mean = 65, $p<0.05$) than those expecting positive ones (mean = 51). The importance of the EL was lower for "no impact" respondents than for any of the others (all $p<0.10$). "Don't knows" were less likely to have decided about an energy supplier than neutrals ($p<0.05$) and neutrals wanted less knowledge about environmental impacts of electricity supplies than did "negative impact" respondents ($p<0.10$).

Impact-survey subjects then rated "some possible reasons for thinking that energy deregulation might have no, negative or positive impact on the environment." Possible ratings were True, Maybe True, Don't Know, Maybe False, and False, a format from a mental-models study using expert views as the standard (Bostrom et al., 1994). Responses appear in Table 1.

The results show high uncertainty: four of 18 statements had over half of respondents answering "don't know," and this was the modal response for eight other statements. The lowest "don't know" response was 21%, a high level of reported ignorance. Except for "The production of electricity does not affect the environment positively or negatively" (51% False), no statement was rated as absolutely True or False by more than 20% of respondents. This result was not driven by a response bias toward "don't know": 74% gave no more than nine such responses for the 18 items, and the median response (54%) was six or fewer.

Half (9 of 18) of these statements got at least 40% to say they were at least maybe true or false. Two involved "no impact" claims, with people agreeing that new and existing electricity products will have the same environmental impact (#1 in Table 1) and a majority opposing the notion that electricity production does not affect the environment (#5). Four involved "positive impact" claims, with small majorities believing that the profit motive (#6), New Jersey's environmental rules (#7), and competition and imagination (#10) will enhance environmental quality; almost half rejected the claim that New Jersey consumers would pay a premium for "green" electricity (#9). Three involved "negative impact" claims, with a majority insisting that saving money would drive consumers' electricity-supply decisions (#13). Between 40% and 50% thought that high costs would undercut "green" electricity production (#14) and a price-fueled increase in electricity "consumption is not good for the environment by definition" (#17).

Bivariate correlations were examined for significance at the Bonferroni-corrected level of $p<0.0085$ for six contrasts (no-, negative- and positive-impact statements against each other). Seven of 10 no-impact statement comparisons ($r = 0.30$–0.53), six of 21 positive-impact comparisons ($r = 0.30$–0.53), and three of 15 negative-impact contrasts ($r = 0.31$–0.40) met this threshold. As would be expected, other significant correlations (i.e., across different expected impacts) were fewer and

[4] In the overall sample ($n = 339$), the distribution of responses was similar (available from first author).

Table 1
Beliefs about environmental impacts of electricity deregulation (percentage)

Belief statements	True	Maybe true	Don't know	Maybe false	False	Differing means by expected impacts
No impact						
1. New electricity producers will have the same environmental impact as existing electricity producers.	11	29	33	18	9	*d*, e*
2. Some consumers might choose electricity with lower negative impact on the environment, while others might choose electricity that has higher negative impact on the environment, but the overall environmental impact will average out to what we have now.	8	24	40	20	8	*a*, *c*, *d*, e*
3. New Jersey's environmental regulations will prevent any change in environmental quality.	7	11	56	12	14	
4. No new suppliers are trying to sell electricity supplies in New Jersey anyway, so there won't be any change in environmental impacts.	2	9	52	20	16	
5. The production of electricity does not affect the environment positively or negatively.	2	6	24	18	51	a*, c, d*, e*
Positive impact						
6. Electricity suppliers will see a chance for profit in providing "greener" electricity.	13	44	38	4	2	b, *d*, f*
7. New Jersey's environmental rules will force electricity producers to reduce negative impacts to the environment.	15	41	40	2	1	b, *f*
8. The authorities wouldn't allow electricity deregulation unless they knew they could limit negative environmental impacts.	15	22	42	14	6	
9. New Jersey consumers will choose "greener" electricity supplies even if these supplies cost more.	4	12	38	28	19	d
10. The more suppliers there are in the electricity market, the more likely it is that someone will figure out how to supply electricity with fewer negative environmental impacts.	9	42	34	9	5	*d*, e, *f*
11. "Green" electricity is cheaper to buy.	4	5	60	19	13	
12. As more and more consumers learn about and choose less harmful sources of electricity, a "bandwagon" effect will occur: people will choose cleaner electricity because everyone else is doing it.	6	31	36	19	8	
Negative impact						
13. People will choose the cheapest electricity supply, no matter how "dirty" it is.	12	51	21	9	7	d, *f*
14. "Green" electricity costs more to produce, so suppliers won't have any incentive to provide it.	7	33	40	16	4	*e*
15. Suppliers with "dirtier" electricity will tend to be located outside of New Jersey, and therefore not subject to New Jersey's environmental regulations.	9	28	51	2	9	*b*, f
16. Suppliers will have a financial incentive to produce increasing amounts of electricity; even if each kilowatt of electricity has the same environmental impact as now, the greater amount of electricity overall will increase damage to the environment.	7	29	47	11	6	a*, *b*, *e*, *f*
17. The lower the price, the more electricity consumers will use, and more consumption is not good for the environment by definition.	16	33	24	15	12	a, e
18. Electricity deregulation involves environmental deregulation as well.	4	19	49	8	20	

$n = 85$; for t tests of independent samples across expected impacts, $n = 6$ (negative), 9 (no), 12 (positive), and 58 (don't know). Contrasts are negative versus no impact (a), negative versus positive (b), negative versus don't know (c), no versus positive (d), no versus don't know (e), and positive versus don't know (f). Differences significant at $p < 0.10$ in standard font, at $p < 0.05$ italicized, and at Bonferroni-corrected level of $p < 0.0085$ with an asterisk.

weaker, but unexpectedly positive. Three of 42 correlations between positive- and negative-impact statements ($r = 0.30$–0.35), three of 30 between no-impact and negative-impact responses ($r = 0.30$–0.38), and one of 35 between no-impact and positive-impact statements ($r = 0.36$) were significant at the Bonferroni-corrected level. Thus, people were not consistently agreeing with one set of statements and disagreeing with another.

In case this pattern was due to self-reported ignorance about impacts, the analysis was repeated with only those ($n = 27$) willing to express an expectation on deregulation impacts. Three of 10 no-impact statements ($r = 0.55$–0.63), five of 21 positive-impact comparisons ($r = 0.50$–0.59), and one of 15 negative-impact contrasts ($r = 0.58$) met the Bonferroni threshold. One of 42 correlations of positive- and negative-impact statements ($r = -0.50$), one of 30 no-impact and negative-impact responses ($r = -0.68$), and two of 35 no-impact and positive-impact statements (both $r = -0.52$) also were Bonferroni significant. While the exclusion of those reticent about deregulation impacts did indeed change the sign of significant correlations, the overall pattern of signs was virtually unchanged. About half of those in the no–positive and positive–negative comparisons, and about three-quarters in the no–negative contrasts, had positive correlations.

Independent-sample t tests were run to identify any significant differences in responses to these statements by expectations of environmental impact (Table 1, last column). Twenty-one of 108 contrasts were significant at $p < 0.05$ (30 at $p < 0.10$), far more than expected by chance, but only seven such contrasts were significant at the Bonferroni-corrected level of $p < 0.0085$, implying weak effects.[5] This may be due to only 27 people giving an answer other than "don't know" to the expectations question, and the large don't-know response to the belief statements themselves. Six of the seven Bonferroni-significant contrasts involved the "no impact" group. On average this group gave a "don't know" ($= 0$) response to "The production of electricity does not affect the environment positively or negatively" (Table 1, #5), while all other groups had mean reactions in the "maybe false" ($= -1$) to "false" ($= -2$) range: negative $= -1.83$, positive $= -1.5$, and don't know $= -1.09$. The "no impact" group differed significantly from "don't knows" on whether new and existing producers would have similar impacts (#1) and whether impacts of individual consumer choices would average out (#2), and from "negatives" on whether financial incentive for increased production would increase environmental damage (#16). "Positives" differed from "don't knows" on whether suppliers would see a profit in green electricity (#6).

[5]Similar results were obtained if "don't know" responses to the impact statements were omitted.

A second set of t tests was run to examine whether people who thought these statements about environmental impacts were true or false, or did not know how to answer, differed in their demographic characteristics or attitudes and behaviors about deregulation or the EL. Of the 810 contrasts examined (18 statements $\times$ 3 responses $\times$ 15 predictor variables), 54 were significant at $p < 0.05$ (41 expected), and 104 at $p < 0.10$ (81 expected). Twenty-four were significant at the Bonferroni-corrected significance level of $p < 0.01695$ for three contrasts. The largest number of significant contrasts occurred between those who thought statements were true or false (with the false–don't know distinction least often significant), and more for beliefs about negative impacts than for the other two categories. Education (9 Bonferroni-significant contrasts) and income (6) were the most common predictors of differences. For example, people who disagreed that authorities would not allow damaging deregulation (#8 in Table 1), that "green" electricity is cheaper (#11), or that a bandwagon effect would occur (#12) had more education than those who agreed with each statement. Greater education also led people to dispute rather than agree with the coupling of electricity and environmental deregulation (#18).

4.5. Survey: relative impacts of environmental sources

People were then asked to determine which of the two energy sources for electricity production would have "greatest negative environmental impact." (A ranking of the 11 energy sources involved was not attempted, since prior experience showed it is difficult to get complete rankings from the public on issues for which many feel uninformed.) Table 2 shows the results for 30 pairs presented in the survey, as well as for 10 pairs that were repeated after brief definitions were given for certain sources. For example, one definition was "*Fuel cells*: electrochemical process converts fuel directly to direct-current electricity without burning the fuel; similar to batteries"; other definitions were for landfill methane gas, small hydroelectric, solar, and wood or other biomass.

The ranking of adverse environmental impact implied by majority opinions for each comparison is coal > gas > oil > wood or other biomass [WOB] > landfill methane gas [LMG] (tied with nuclear power in the direct comparison; WOB and nuclear power were not compared directly, so it is clear only that nuclear power ranked lower than coal, gas, and oil, and higher than fuel cells) > fuel cells $\approx$ hydroelectric (small) > solar = wind. Large hydroelectric was rated as more damaging than small hydroelectric, but was not contrasted with any other energy source. The provision of definitions for some of the less-known sources had no or small effect in most cases; its strongest effects consolidated the belief

Table 2
Relative environmental impact of energy sources for electricity generation

Initial Estimate (which is *worse*)						After definition					
Source 1 (%)		Source 2 (%)		Same (%)	DK (%)	Source 1 (%)		Source 2 (%)		Same (%)	DK (%)
Wind	7	FC	60	11	20						
Wind	7	HS	56	16	21						
Wind	8	WOB	70	3	19						
LMG	40	FC	23	7	30	LMG	56	FC	20	6	18
Coal	59	Nuclear	19	7	15						
Gas	43	Nuclear	38	5	14						
Wind	11	LMG	66	8	15						
Coal	75	HS	8	1	15						
Oil	52	LMG	19	8	21						
Oil	57	Nuclear	27	1	15						
Coal	70	FC	7	4	19						
Solar	5	HS	62	12	21	Solar	8	HS	60	16	15
FC	30	HS	29	11	30	FC	32	HS	35	13	21
LMG	52	HS	21	5	21	LMG	58	HS	21	4	17
Wind	9	Gas	75	1	15						
WOB	48	LMG	21	8	23	WOB	54	LMG	13	13	21
WOB	63	HS	11	5	21	WOB	70	HS	13	3	14
Solar	8	FC	59	12	21	Solar	10	FC	58	16	16
Oil	11	Coal	53	18	19						
HL	53	HS	4	7	36						
Solar	7	WOB	78	0	15	Solar	7	WOB	77	0	15
Nuclear	38	FC	20	12	30						
Solar	8	Gas	77	1	14						
Oil	62	Gas	10	10	19						
Coal	63	LMG	11	5	21						
Solar	9	Wind	14	47	30						
WOB	58	FC	12	5	25	WOB	71	FC	9	1	19
Nuclear	34	LMG	34	9	23						
Coal	68	Gas	5	8	19						
Solar	7	LMG	70	3	21	Solar	8	LMG	72	6	14

$n = 73$–76 initial estimates, 70–73 otherwise; includes full ratings only. People indicated "which of the two sources has the greater negative environmental impact." DK = don't know; FC = fuel cells; HS = hydroelectric (small); WOB = wood or other biomass; LMG = landfill methane gas; HL = hydroelectric (large).

that LMG and WOB are worse than fuel cells, but still with substantial reported ignorance.

How does this implied ranking compare with that from the alternative label shown to focus group members? Available state data rated coal as having the most negative impacts of any electricity source used by New Jersey consumers, followed in turn by fuel oil, nuclear power, natural gas, large hydroelectricity, biomass, landfill gas, small hydroelectricity, fuel cells, wind, and photovoltaic cells. The Spearman rank correlation of this ranking with that from citizens was 0.92, indicating that consumers had a remarkably good sense of relative impacts despite their ignorance of details.

Many "don't know" responses occurred (from 14% for the nuclear-gas contrast to 36% for the two hydroelectrics), but relatively few people settled for the same-impact response (all under 12%, except for wind and solar at 47%, oil and coal at 18%, and wind and small hydro at 16%). In other words, in all cases except solar-wind (where people definitely believed that they had the same impact) a majority were willing to rate one or the other choice in a pair as inflicting more harm on the environment. Only three of the 29 other contrasts had less than 60% choosing one or the other energy source.

Despite the considerable consensus overall, some intriguing variability occurred. Twenty-five people (of 85) answered every choice without any "don't knows." While 12 chose nuclear power as more damaging, 10 selected fuel cells and three said they were equally harmful; 12 chose small hydroelectric as more damaging and 10 chose fuel cells; 13 chose landfill methane gas and nine chose small hydroelectric; 13 chose LMG and 10 chose nuclear power; 15 chose LMG and seven chose fuel cells. These divergences, particularly the surprising ones involving nuclear power, might be driven in part by relative ignorance of the source, but if so the definitions provided hardly changed the distribution of responses except in the last case cited. Another possible reason for

the divergence would be different weights placed on different kinds of impacts, but this study did not test for that.

4.6. Environmental labels

After seeing an example of the EL in one of the three other survey versions, people were asked to evaluate it. About a quarter each said they did (22%) or did not (24%) understand "what all the energy sources were"; 54% did not know. Twenty-five percent thought "definitions of the energy sources should be added," 16% disagreed, and 60% did not know. About half each found the label easy or difficult to understand; 51% found it very or moderately helpful in "understanding this electricity supply's environmental impact." Eleven percent thought it provided too much information on environmental impacts, 43% thought it provided too little, and 46% thought the amount of information was "about right."

In response to the section on Air Emissions, about two-thirds of the sample could correctly answer three questions requiring them to extract information from the label. No attempt was made (as in earlier studies) to see if consumers' determinations of which of two products had greater adverse environmental impact would differ given energy-source information only, or energy-source plus emissions data. People wanted several kinds of information added to this section. They wanted definitions of unfamiliar words, effects of emitted substances (carbon dioxide, nitrogen oxides, sulfur dioxide), comparisons of emissions to long-term effect levels or regulatory standards (added to or substituted for the legislated comparison to emissions of the average electricity product sold in New Jersey), and information on other kinds of pollution (solid waste, nuclear waste, thermal pollution).

Some 35% said the "energy source" section was the most useful, 25% thought the "air emissions" section most useful, and 14% thought "energy conservation" most useful. Some 41% felt that all sections of the EL should be retained as helpful in choice of an electricity provider.

Finally, respondents to the EL surveys were given the following statement: "Energy-using appliances, such as refrigerators and stoves, now come with an Energy Efficiency Rating (EER) label, which rates the energy efficiency of the appliance from 1 to 10. Some people think a similar system for rating the environmental impact of an electricity supply would be useful, summarizing a lot of information about environmental impacts. Others are concerned that such a rating would be more subjective than the kind of EL you saw earlier, and thus could be misleading. Which do you think would be more helpful in choosing an electricity supplier, the EL or a rating of 1 to 10?" Some 41% preferred the EL, and 33% the rating system, with 26% undecided.

5. Discussion

This study found that

- Despite general awareness of electricity deregulation in New Jersey, people had given little thought to its environmental impacts and had little experience with materials (i.e., the EL) intended to convey information on this topic. However, such information was desired and deemed important.
- The CRPP survey 9 months before the current survey, and the interviews, were able to get most respondents to hazard a guess as to whether deregulation's impacts would be neutral, positive or negative. In focus groups and the impact survey relatively few people were willing to express an opinion. In all cases, however, people were more likely to expect positive or no impacts than they were to expect negative ones.
- Expectations about environmental impacts were not explained by demographics, or by deregulation attitudes or behavior.
- Faced with specific potential reasons for expecting no, positive or negative impacts of deregulation, the dominant reaction was uncertainty. The main exception was that half of the respondents thought it was absolutely false that deregulation would have no positive or negative environmental impacts.
- Some 40–60% were willing to say that several statements about impacts were either likely to be true or likely to be false. However, these responses did not vary in structured ways across different kinds of reasons. For example, rather than tending to believe reasons for positive impacts were true and reasons for negative impacts false (or vice versa), correlations among these responses were at least as likely to be positive (e.g., agreeing with both positive-impact and negative-impact reasons).
- Demographics and deregulation attitudes and behaviors were most likely to distinguish "true" and "false" (versus "don't know") responses to these impact reasons, and negative-impact reasons more often than positive- or no-impact reasons. Education and income were the most common predictors of responses.
- Aggregate pair-wise comparisons of energy sources implied a mental model of their relative environmental impact, with coal, gas and oil ranked in that order as the worst offenders and solar power and wind tied for the least negative impact. This seems consistent with earlier research finding a coal-including electricity product deemed worse than an alternative without coal, unless information showed that it

produced less air pollution. It also was an implied aggregate ranking remarkably close to that produced by expert analysis of diverse relative environmental impacts of sources of electricity supply in New Jersey, despite citizens' actual and admitted ignorance of both electricity sources and their impacts.

- Consumers are interested in information on environmental impacts of electricity, but their information preferences imply that they find information on energy sources used to generate electricity as more immediately diagnostic of impacts than emissions information. They wanted information on more environmental impacts than provided, but neither as individuals nor in the aggregate did they recognize the full potential scope of such impacts.

CRPP elicited expectations of environmental impacts of electricity deregulation from a larger proportion of its telephone survey respondents. While caution is certainly warranted in generalizing from the current results, it would be premature to assume the CRPP findings are better. The 9-month gap and 50% drop in marketing of the deregulation program between the two surveys may mean the current results are representative of their time. Voting studies find that larger response rates can yield misleading estimates if the larger sample includes many people with unstable, ill-considered or social-desirability-biased responses (Krosnick, 1999, p. 540), but it is unclear whether the CRPP survey elicited similarly unreliable impact expectations.

Whatever caution is warranted in generalizing from either survey's results, in both cases the expectation of negative impacts from deregulation was the smallest response. Elites have been concerned that cost considerations would drive consumers to select dirtier electricity products under deregulation. Whatever the merit of that fear, consumers who do not expect or worry about negative environmental impacts will not pause to consider the tradeoffs involved in electricity-product purchases; at most, those who expect positive impacts might face a tradeoff between cost and *maximizing* environmental benefits. Thus, education of consumers about the potential for impacts, if not specific effects from specific products, might be needed to ensure that at least the opportunity for considering tradeoffs is available.

That, of course, is the aim of the environmental label, which summarizes the mix of energy sources used to produce a given electricity product; its air pollution emissions, and (in New Jersey) associated "conservation" (actually, utility retirement of emission credits). On the positive side, consumers appreciated the label information, including the emissions information, and previous studies found that providing both energy source and emissions data produced more accurate identifications of the "dirtier" electricity product than did energy-source data alone. However, people in this study were far more likely to identify the energy-source data as needed, whether in evaluating the current label and small experimental variations in the survey, or a radically different rating system in focus groups. Asked to compare the relative environmental impact of several pairs of energy sources, without constraint or guidance as to what counts as "impact," in the aggregate they produced a surprisingly consistent interpretation of scientific information on the topic as filtered through their exposures to mass media and education.

It is unclear whether the earlier finding that people will pay attention to emissions data to choose between two products in focus groups or intercept surveys will generalize to real-life consideration of alternative electricity supplies, or whether their implicit ranking of energy sources' relative impacts will dominate such decisions. The fact that the EL focus on air emissions ignores other environmental impacts of electricity supplies is only partly known to consumers. Only some of these highly educated survey respondents mentioned that omission, and even in the aggregate they did not mention some impacts of electricity production (e.g., land or water consumption). Citizens' aggregate implicit rankings of sources' relative impacts were highly correlated with an expert generic ranking that took into account a variety of air, water, land use, and solid waste impacts. However, this need not mean that even in the aggregate consumers would know which electricity products are lower in environmental impact. As noted earlier, research has shown that people can make mistakes based on using only energy-source stereotypes rather than explicit emissions data, and if given electricity products become increasingly mixed in source, making correct inferences will become even more difficult.

A preliminary conclusion would thus be that consumers lack adequate understanding of the potential environmental consequences of their electricity purchase decisions under deregulation, and that the EL required by public utility boards probably will not fill the gap in its current forms. Consumers' implicit mental models of energy sources' relative impact provide a potential basis for both education to meet that need for knowledge and bias in use of any new information that they receive. Designing educational materials that adequately and persuasively inform consumers about the life-cycle environmental impacts of multiple energy sources while keeping cognitive loads low will be a challenge.

But is consumer choice (demand-side) the critical factor in minimizing negative environmental impacts of electricity deregulation? It could be argued that supply side factors are likely to be far more influential. As of February 2003, the US Energy Information Administration identified 25 of the 50 American states as not having "active" electricity industry "restructuring," i.e.,

deregulation, while 18 states did have active programs and the rest had suspended or delayed programs (US Energy Information Administration (USEIA), 2003). The National Renewable Energy Laboratory (2004) reviewed "Green Power Marketing in the United States," concluding that average participation in utility programs is about 1%, although 4–11% in the most successful efforts and 1.8% on average in programs enduring for at least 4 years. Most of this success comes from a dozen utility green pricing programs, so market penetration is still limited (15% of utilities offer such programs). In states with competitive markets, Texas has been most successful, with 14% of residential and 19% of nonresidential customers switching suppliers (the degree to which this was due to switches to cleaner rather than dirtier electricity supplies than the default supply was not discussed). Green-e is a "voluntary certification program to help consumers identify superior renewable energy products" with at least 50% renewable energy content sold in both competitive retail and regulated electricity markets in the United States. By the end of 2003, Green-e had certified 60 electricity products as being "green" in 17 states (Center for Resource Solutions, 2004, p. 3). In many cases (including perhaps most non-US contexts), clean energy might be bundled with fossil fuel sources under renewable portfolio standards imposed by government, so that consumer choice is replaced as a factor by political barriers or opportunities among elites.

Given varying levels of deregulation, limited market penetration to date of explicit "green" electricity products regardless of the regulatory context, and the opportunity for consumers to use Green-e and other certification programs as heuristic cues, accurate consumer knowledge of the relative environmental impacts of different energy sources for electricity production may be unnecessary. However, two arguments suggest that this conclusion may be premature. First, choice among electricity products is indeed growing in the United States, if not elsewhere, and as choice grows full information will be needed for energy markets that are both efficient and effective. Second, ignorance of electricity's environmental impacts among the public at large sets the context for elite choices. Since most decision-making elites are not environmental-impact experts, they are not immune from the knowledge deficits and energy-source stereotypes identified by this study among ordinary citizens. Resultant choices (e.g., never coal; hydroelectricity is always good) might reduce environmental impacts overall, relative to an all-fossil fuel option, but will not be as efficient or effective as possible. Furthermore, successful education of citizens about the full and relative extent of environmental impacts could stimulate a major expansion of institutional purchases of "green" electricity through voter and consumer pressure, even if the choice available to residential customers remains limited.

6. Conclusions

Perfectly informed consumers and citizens are not necessarily needed for good energy decisions by individuals and societies; trust in specific elite groups or bandwagon effects are among cues that can drive useful behavior. But such cues are not infallible, and in general it would be presumed that people who are fully informed about the impacts of electricity deregulation (including environmental impacts) will make better choices of electricity suppliers, whether they weight environmental impacts highly in such decisions or not. Earlier research had found that people given information about energy sources used in producing electricity came to different conclusions about relative damage done by different products than people given both source and emissions data. This finding implied that people had implicit models of energy sources' relative environmental impacts but that these models might be misleading. The present study has confirmed both the existence of an implicit ranking of energy sources' impacts and its potential for biasing electricity purchase decisions, particularly in the absence of any understanding of what those impacts might be. In a world of uncertain energy supplies, in which tradeoffs among cost, environment, and national security seem to be increasing in difficulty, this ignorance is undesirable. The ELs often required under deregulation are only a first, useful but insufficient step toward adequately informing consumers and citizens.

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