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Public Perceptions of Using Woody Biomass as a Renewable Energy Source

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Abstract: Woody biomass is an energy source that may play a significant role in reducing greenhouse gas emissions. One barrier to using wood for energy is public perceptions. This article describes the results of a needs assessment survey that was used to develop a public outreach program. Survey responses from 298 residents of Alachua County, Florida suggest that respondents do not know about using wood for energy, are willing to be engaged in the decision-making process, and are generally in favor of using waste wood as an energy source. Respondents are most concerned about sustaining nearby forests and air quality.

Introduction

While most Americansâ 56 to 87%, depending on the pollâ believe that global warming is occurring, fewer have strong opinions about what to do about it. In a 2005 poll, 21% of Americans believed that the United States should not take any steps to address climate change, and another 42% supported only gradual, low-cost steps to conserve energy (Nisbett & Myers, 2007). Most analysts, however, suggest that dramatic changes in the sources of our energy are required. Pacala and Socolow (2004, p. 968) suggest that humanity "already possesses the fundamental scientific, technical, and industrial know-how to solve the carbon and climate problem for the next half-century."

They present a multi-faceted strategy based on the premise that while no single change would enable the United States to meet its energy needs while reducing greenhouse gas emissions, a host of changes implemented concurrently could enable the United States to stabilize its carbon dioxide (CO_2) emissions by 2050. A number of technological options could increase conservation, boost biological carbon sequestration, and decarbonize electricity and fuels, which collectively would allow the United States to meet its energy needs while stabilizing

CO_2 emissions (Pacala & Socolow, 2004).

One method for stabilizing CO_2 emissions involves using biomass (i.e., trees) to produce electricity (Berndes, Hoogwijk, & van den Broek, 2003). Public perception, however, can be a significant barrier to proposed power generating facilities. Most research looking specifically at public perceptions of biomass-fueled power plants comes from the United Kingdom (U.K.). In one case, the failure of a proposed 20-megawatt (MW) straw-burning plant in the U.K. has been attributed to public opposition that resulted from a poor public relation strategy (Hargreaves, 1996). Three additional proposals for biomass-fueled power plants in the U.K. have been documented where "in each case, it was strong local public opposition which resulted in a negative planning decision" (Van der Horst, Sinclair, & Lofstedt, 2002, p. 123). Because of cases like these, public opposition has been described as "one of the major obstacles to promote biomass energy" in the U.K. (Upreti, 2004, p. 785). Others observe that "promising biomass energy projects with interesting technologies (e.g., biomass gasification) and concepts have been delayed, modified or failed due to various non-technical issues [including] insufficient perception and acceptance" (Rosch & Kaltschmitt, 1999, p. 347).

Studies closer to home suggest that the importance of public perception would hold in American communities as well. For example, a series of polls conducted by utilities companies across the United States has shown that, while the majority of Americans support renewable energy initiatives and express a willingness to pay more per month on their electric bills for power from a renewable resource, biomass energy initiatives receive far less public support than zero-emission sources (e.g., solar and wind). In fact, respondents rank woody biomass no better than fossil fuel energy sources, often deeming it less favorable than natural gas (Farhar, 1999).

The low public support for wood-fueled power production is not entirely surprising. While the technology for producing electricity with wood fuels has been used for decades, the public is generally unfamiliar with this process. A recent national survey reports that only 12% of Americans can pass a basic quiz on energy knowledge (NEETF, 2002). Without better understanding, public opinions are often inconsistent and based on preconceived ideas and emotional responses (Yankelovich, 1991). Thus, a basic lack of awareness of current sources of energy and availability of new sources makes engaging the public in a thoughtful discussion of our energy future a daunting task (Earhart, Weber, & Williams 1990).

A number of federal initiatives are underway to make this daunting task an essential one. The Departments of Energy, Agriculture, and Interior issued a joint memorandum in 2003 pledging cooperation in support of developing woody biomass where appropriate (NACD, 2005). A national strategy to increase energy security calls for a coalition of farm, ranch, and forest managers to provide 25% of our energy supply from local, renewable energy sources by the year 2025 (25x25', 2007). In addition, a new forest-based bioenergy Community of Practice was formed in 2008 to support and facilitate communication among Extension programs (eXtension, 2008).

Extension agents will play an important role in these programs (Fortson 2006). Given the lack of public awareness and the pivotal role that public perception can play in the outcome of a biomass project, Extension programs are critical at an early stage of the project when agents and project planners may be able to dispel misconceptions and to identify and address valid community concerns. Extension programs are more effective if they are designed to build on existing knowledge, overcome misconceptions, and address concerns (Jacobson, McDuff, & Monroe, 2006). The polls cited above lump all biomass energy sources into one category. This article reports efforts to understand public perceptions specifically about using woody biomass in an area where the local government is considering wood-to-energy technology.

Methods

Survey Development

Our primary tool for data collection was a mailed survey. To assist in the development of the survey, 12 interviews were conducted in two counties in Florida and South Carolina identified as having a growing energy demand and enough local forests to supply a wood-fueled power plant. These interviews were conducted using an open-ended version of Conceptual Content Cognitive Mapping (3CM) (Kearney & Kaplan, 1997). The benefit of using 3CM is that the participants define the salient aspects of the issue in question, rather than answering a set of questions focused on the researchers' views of what would be important.

Mail Survey

The 3CM interview results were used, along with available literature on biomass projects to develop the survey. It consisted of 22 questions, which covered five main areas: (1) Awareness and knowledge; (2) General impressions; (3) Misconceptions; (4) Trust; and (5) Community participation. Nine demographic questions were included to compare against census data.

Alachua County, Florida was chosen as the study site for the survey. This area has growing energy demand and local wood resources capable of supporting a wood-fueled power plant. In addition, City Commissioners in Gainesville, the largest city in the county, have included the possibility of a wood-fueled power plant in discussions about meeting future energy needs.

To select the sample, names were chosen randomly from Alachua County's tax roll for single-family and mobile homes. A large proportion of the apartment dwellers and renters in Alachua County are college students whose time in the area will be relatively brief. The exclusion of apartments was deemed necessary in order to increase the likelihood of responses from county residents rather than students. Every 33rd owner was chosen from the list. A total of 1,517 surveys were sent to residents of single-family and mobile homes in Alachua County in early September 2006, with one reminder postcard sent in late September 2006.

Results

Response Population

Of the 1,517 surveys sent, 298 useable surveys were returned, yielding a response rate of 19.6%, with African Americans, lower-income households, and individuals between 18 and 34 being underrepresentedâ a common shortcoming of mailed surveys. As a result of the low response rate, one cannot use these results to draw conclusions about the Alachua County population as a whole. Nevertheless, these data can still be useful for designing Extension programs for a number of reasons. First, using established extrapolation methods to approximate response bias, there is reason to expect that opinions of non-responders would not contradict the general conclusions drawn below. For example, the Spearman correlation between willingness to put a wood-fueled plant in Alachua County and household income and age is negligible (0.005, and 0.07, respectively).

In addition, researchers performed a time-series analysis on the returned surveys. The assumption with these analyses is that late responders are likely to be more similar to non-responders (Armstrong & Overton, 1977). The results from surveys returned before the reminder postcard (n = 160) were compared to those returned after the reminder (n = 34). For most questions, there was no significant difference (at = 0.05) between responses from the two groups. The most notable exception was the knowledge question, in which September responders express significantly more confidence in their knowledge of using wood for electricity. This suggests that perceived lack of knowledge on the part of non-participants explains some of the failure to respond.

Awareness

The possibility for a wood-fueled power plant as part of the plan for meeting Gainesville's future power needs has been a part of public discussion since late 2003, yet only 18% of the respondents were aware of these talks. When asked to assess their own level of knowledge about converting wood to electricity, less than 5% considered themselves "Very knowledgeable," while over half (54.5%) considered themselves to be "Not at all knowledgeable" about the topic.

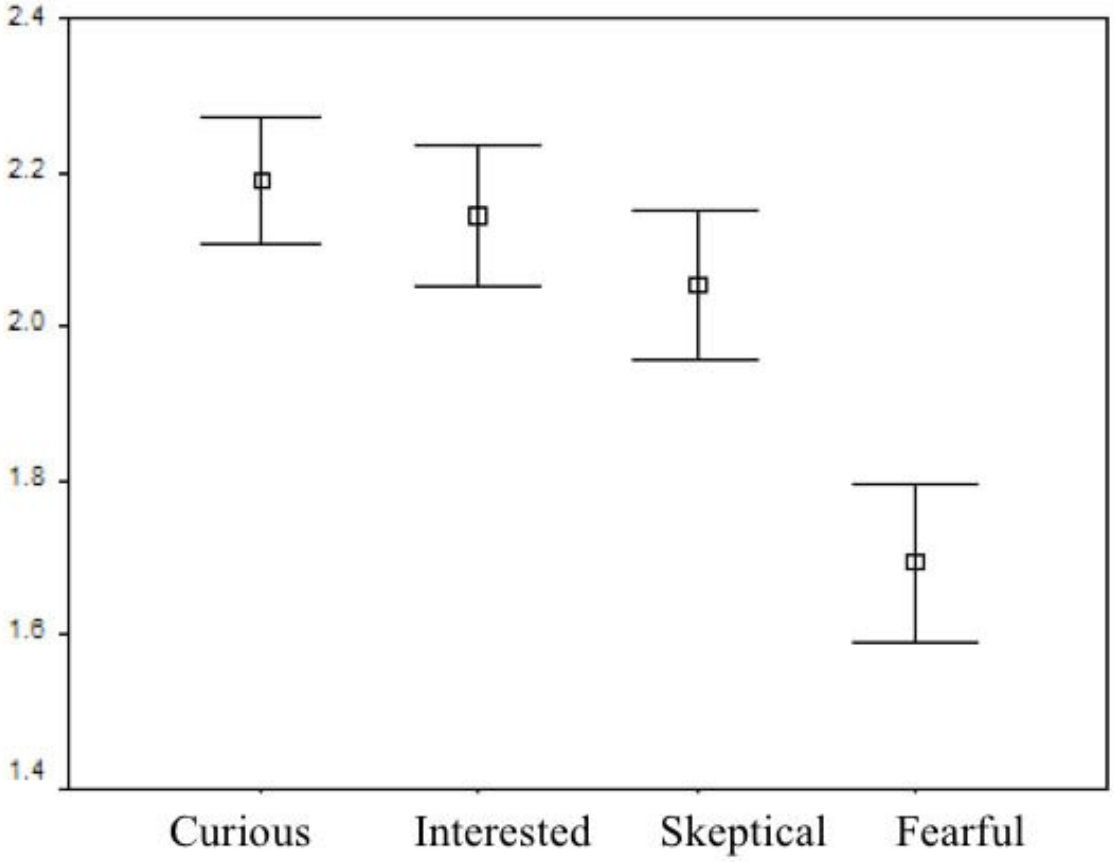
This lack of knowledge also surfaces in questions where respondents compare wood to fossil fuel energy sources in the context of several different characteristics (e.g., air pollution and worker safety). In every specific query, at least a third of the respondents answered that they did not know whether wood would be better or worse than either coal or natural gas. On some characteristics, such as price and local economic benefits, this fraction rose to over half of the respondents.

General Impressions

Respondents were asked to characterize their initial reaction to the idea that their area has been identified as having the necessary conditions for developing a wood-fueled power plant. Assessing the strength of four different possible reactions, respondents appear to be more "Curious" and "Interested," as shown in Figure 1. "Fearful" scored significantly lower than any of the other three reactions included on the survey at $p < 0.05$.

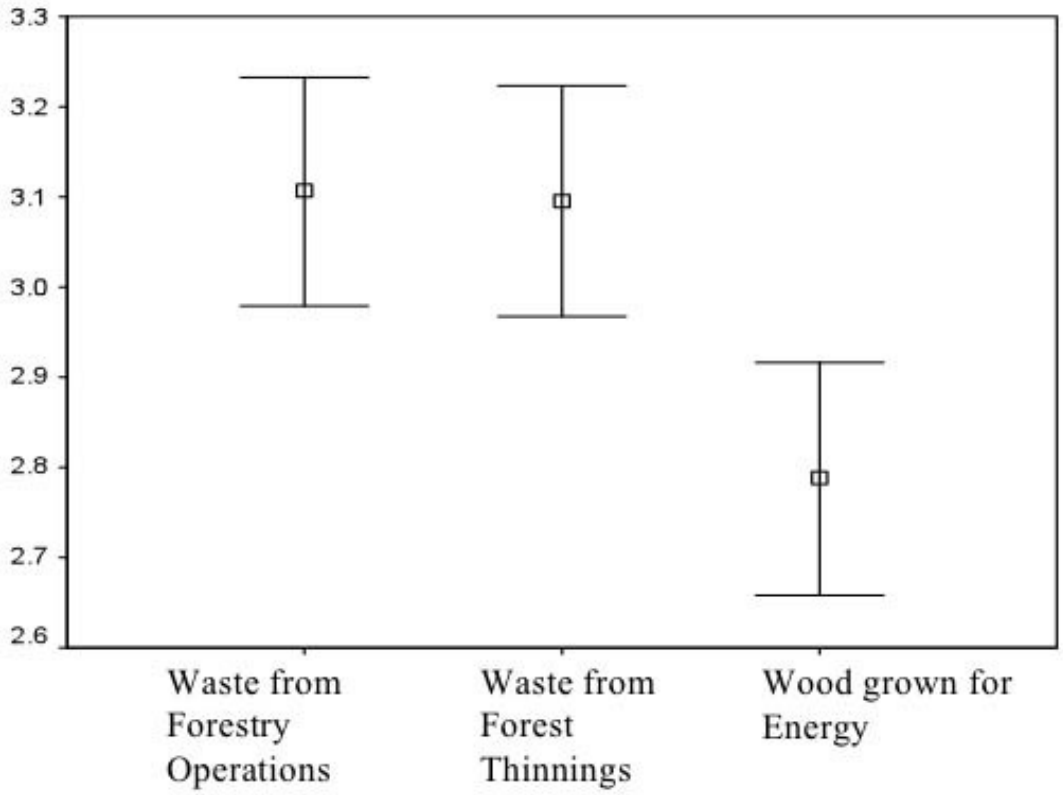
When respondents were asked to characterize their feelings about building a wood-fueled power plant in Alachua County, 31.6% of them expressed "Negative" or "Highly negative" feelings, and 27.1% expressed "Positive" or "Highly positive" feelings. The remainder, 41.2%, answered "Neutral."

Figure 1.
Scores (95% confidence intervals) for Initial Responses to the Idea of Developing a Local Wood-Fueled Power Plant (1 = Not at all; 2 = Somewhat; 3 = Very much)



The survey included questions regarding potential sources of wood fuel. Respondents were asked to assess their support for using wood waste from forestry operations, wood waste collected during forest thinning, and wood grown specifically for energy. Figure 2 shows a clear preference for waste wood over wood grown specifically for energy. In fact, a large majority of respondents (71%) indicated that they were at least "Fairly supportive" of using both sources of waste wood listed here. While the wood grown specifically for energy received relatively less support, even here 61% of respondents indicated that they were at least "Fairly supportive" of this source.

Figure 2.
Scores (95% Confidence Intervals) for Support of Various Sources of Fuel Wood Sources (1 = Not at all supportive; 2 = Slightly supportive; 3 = Fairly supportive; 4 = Highly supportive)



Respondents were also asked to assess the level of importance of a number of concerns and benefits sometimes associated with converting wood to energy. Figure 3 shows that "Air pollution" and "Loss of local forests" are the most important concerns, while "Noise" and "Increased competition for wood" are the least important. Regarding the potential benefits, Figure 4 shows that making use of a potential waste and maintaining local forests are both perceived as extremely important benefits. Conversely, relatively little importance is put on creating new jobs and new markets for local wood.

Figure 3.
Scores (95% confidence intervals) for the Importance of Concerns Associated with Converting Wood to Energy (1 = Not at all; 2 = A little, 3 = Somewhat; 4 = Fairly; 5 = Extremely)

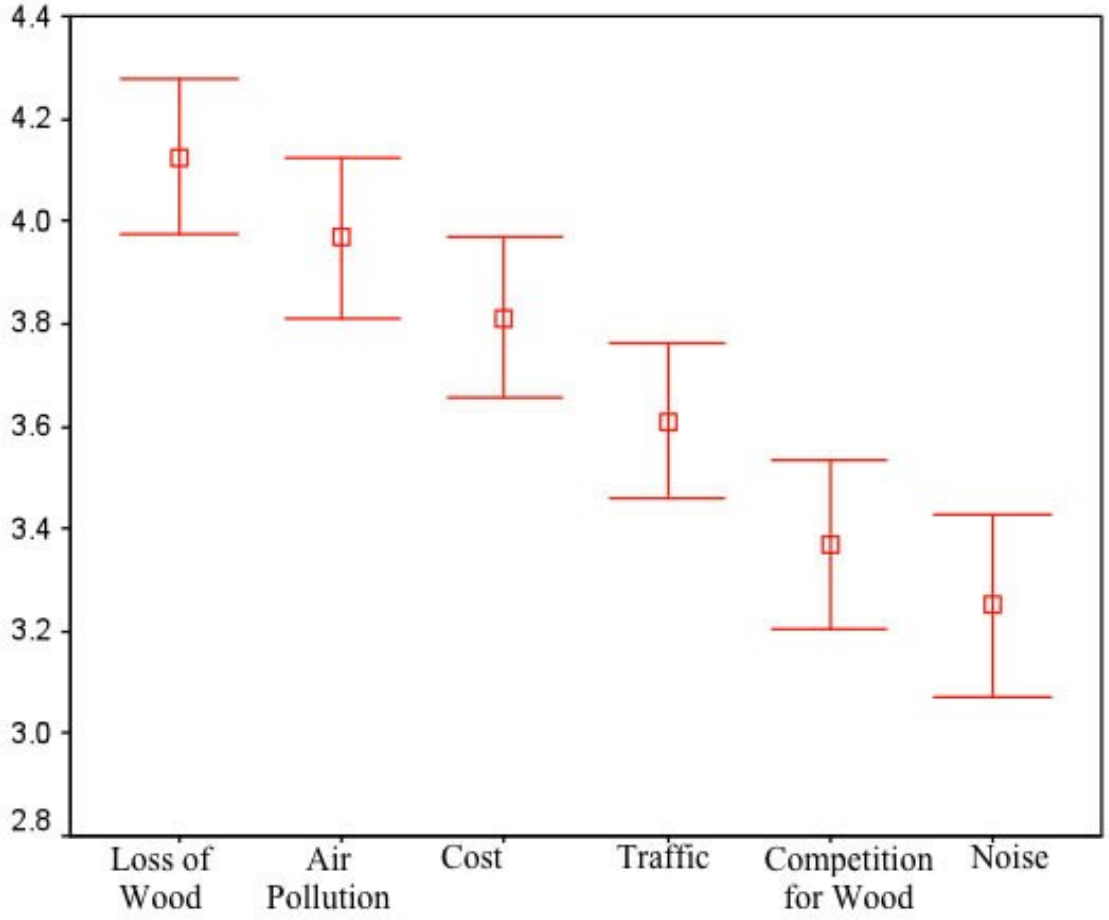
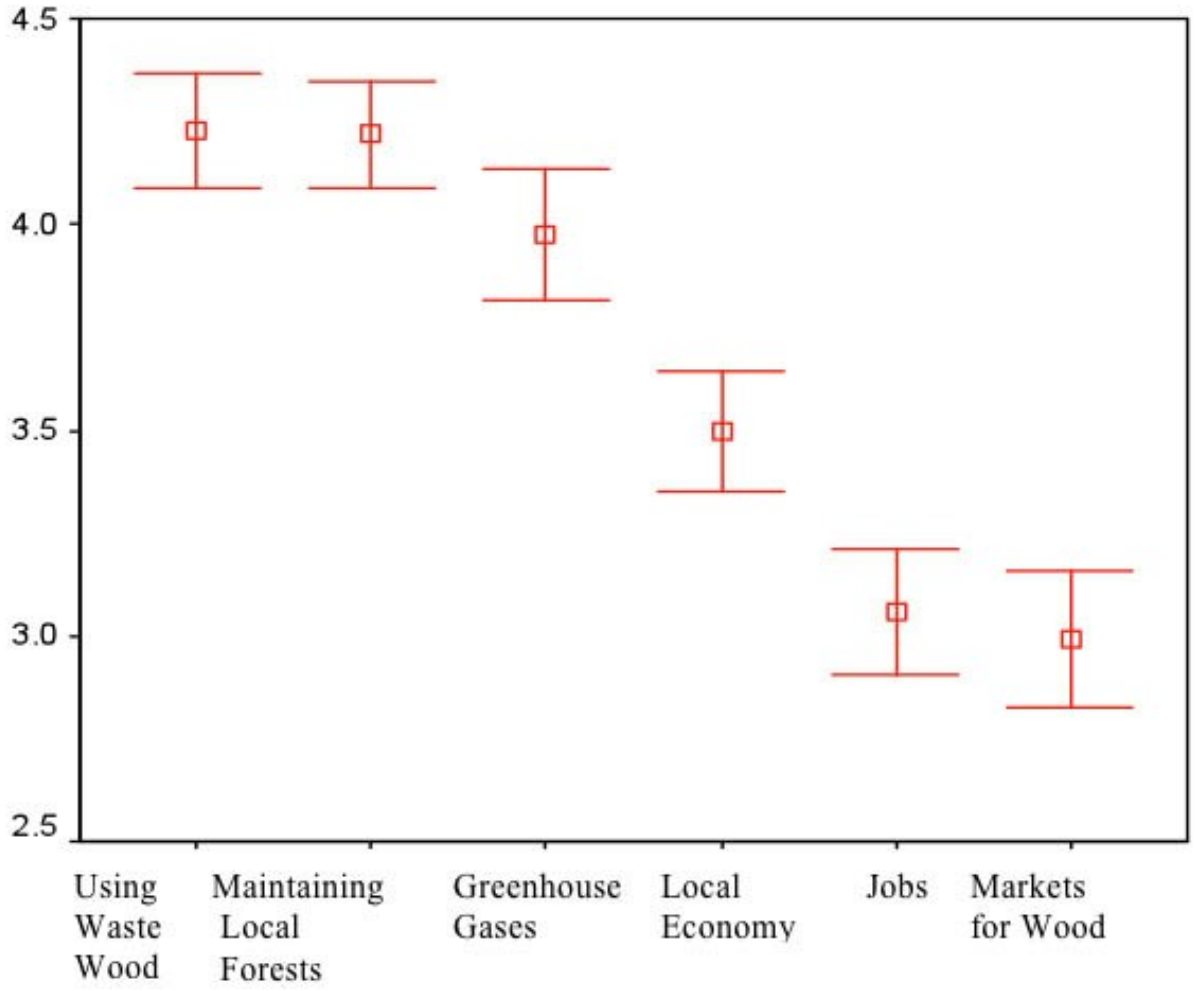


Figure 4.
Scores (95% confidence intervals) for the Importance of Benefits Associated with Converting Wood to Energy (1 = Not at all; 2 = A little, 3 = Somewhat; 4 = Fairly; 5 = Extremely)



The high importance placed on maintaining local forests and using wood that would otherwise go to waste can be seen again where respondents were asked to mark their level of agreement with a series of statements about converting wood to energy. As shown in Table 1, the two highest scoring statements express these ideas.

Table 1.
Level of Agreement to Statements about Converting Wood to Energy

Statement		**Score***	**n**
1	If we are going to use wood for energy, it is most important that we manage the forest sustainably for wildlife, water quality, and wood production.	3.71	290
2	As long as waste wood is being burned, we should collect it and use the energy.	3.27	284

3	Healthy forests are precious ecosystems and should be left to nature.	2.97	282
4	Without a viable market for pine trees, forest owners will sell their land for development and urban sprawl will eventually cover north and central Florida.	2.93	274
5	We should not remove waste wood from forestry operations because that requires the input of more fertilizer.	2.39	251
6	Planted pine trees, like corn, are grown in rows for human consumption. It doesn't matter what we do with them.	2.14	279
*1 = Strongly Disagree; 2 = Disagree; 3 = Agree; 4 = Strongly Agree			

Misconceptions

Some of the opinions expressed by the respondents may be due to a number of common misconceptions regarding the use of wood as a fuel. First, respondents tended to over-estimate the current potential for solar power to meet rising demands in energy. Nearly half of the respondents (44%) consider solar power to be a very feasible solution to meeting additional local power needs, while only 18% have that kind of confidence in wood, despite solar energy's current lack of market competitiveness. Although solar energy is used for home heating, market competitiveness of solar energy for producing electricity on a large scale is still several years away even by the more ambitious estimates (U.S. Department of Energy, 2007a).

Respondents also seem to over-estimate the capacity of future (as yet unidentified) technological advances to meet our energy needs. When asked to rank their level of comfort with possible energy solutions and the feasibility of those solutions in Alachua County, respondents ranked "Look at new technologies" at the top of both categories, as shown in Figure 5 and Figure 6. Since wood-to-energy projects in particular, and biofuels in general, represent for many experts (e.g., Pacala & Socolow, 2004; U.S. Department of Energy, 2007b) the most promising technological prospects for meeting energy needs in the near future, the respondents' faith in something new and better being developed may be seen as overly optimistic, at least in the short term.

Figure 5.
Scores (95% confidence intervals) for the Level of Comfort with Possibilities for Addressing Rising Energy Demands (1 = Not at all comfortable; 2 = Slightly comfortable; 3 = Fairly comfortable; 4 = Very comfortable)

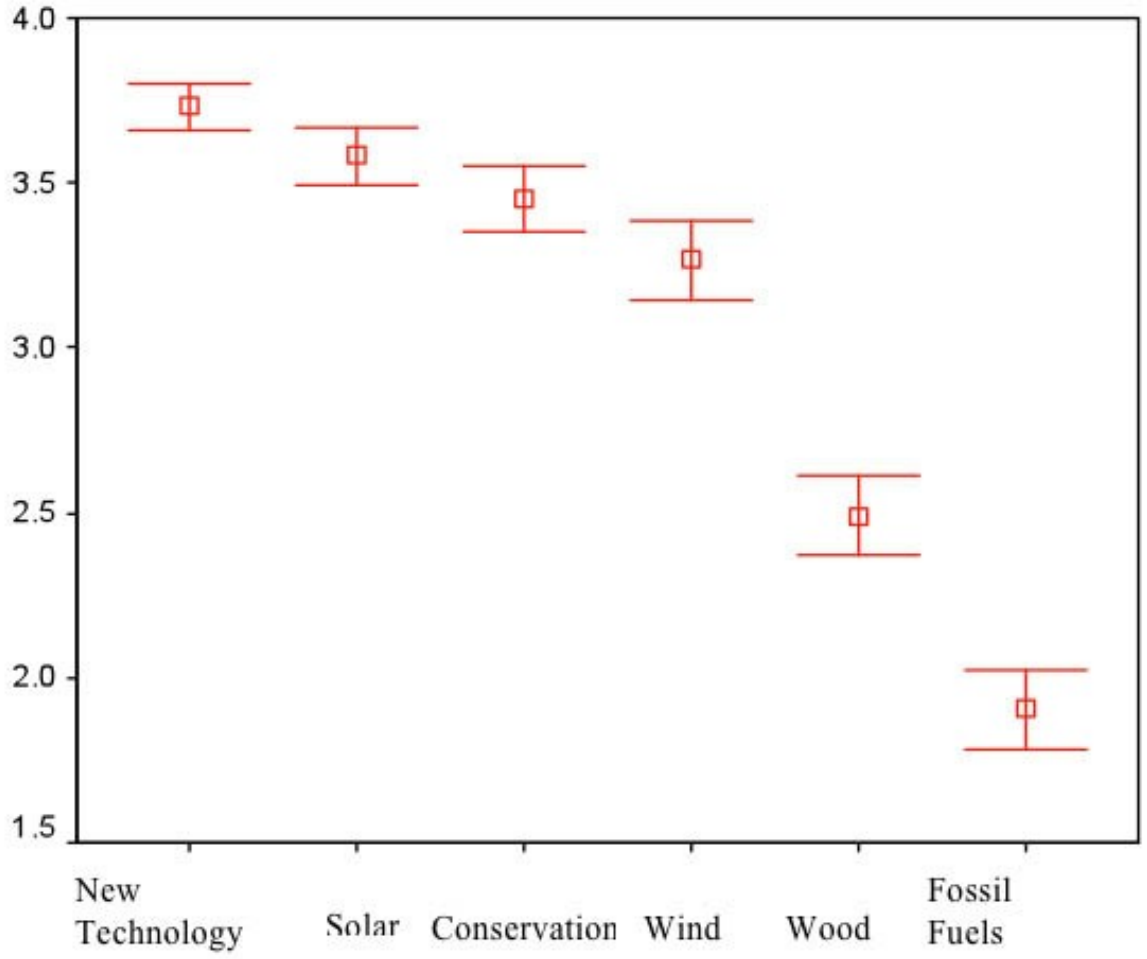
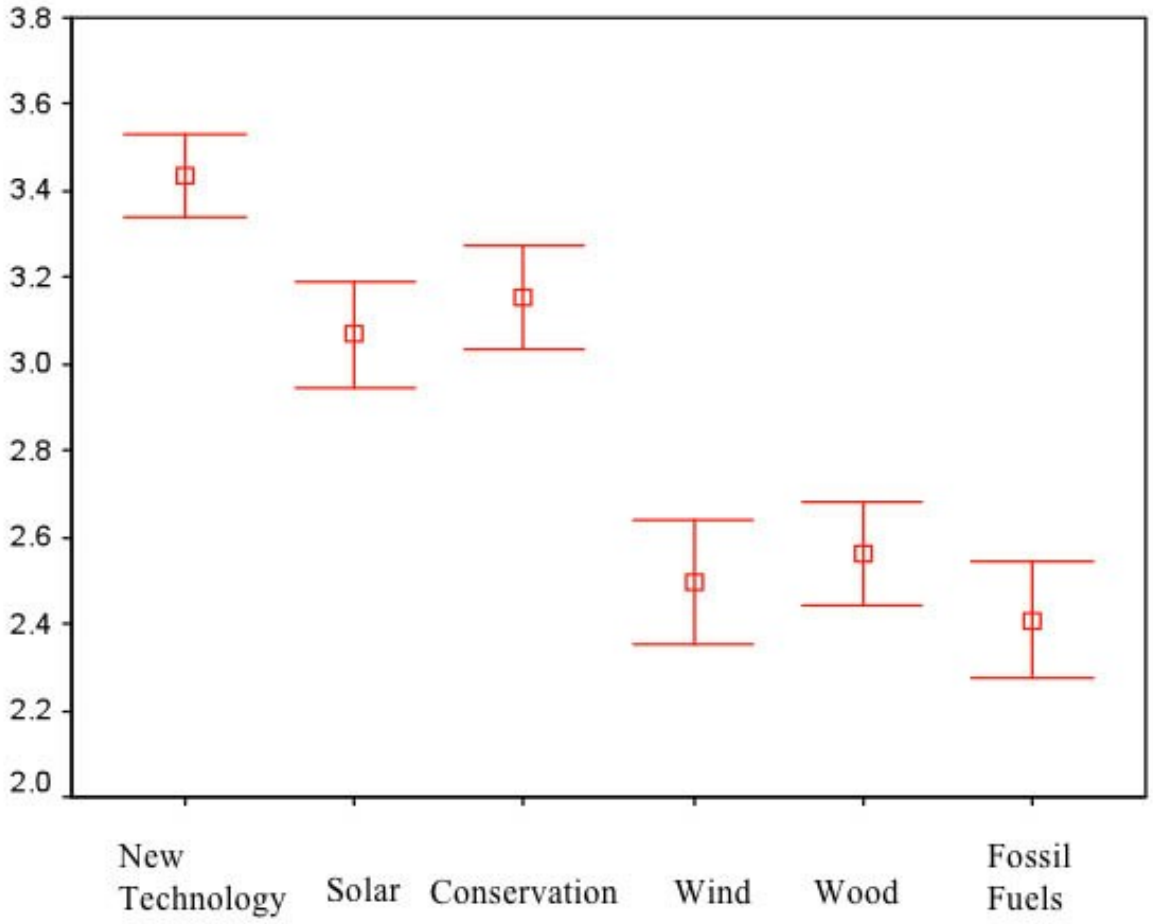


Figure 6.
Scores (95% confidence intervals) for the Perceived Feasibility of Possibilities for Addressing Rising Energy Demands (1 = Not at all feasible; Slightly feasible; Fairly feasible; 4 = Very feasible)



Another misconception comes in the context of global climate change. Burning fossil fuels represents a source of atmospheric carbon with no corresponding sink since new fossil fuels are not being produced on human time scales. Conversely, the carbon dioxide produced by burning wood does have a corresponding sink as long as forest growth rate is high enough to match the harvesting rate. However, respondents do not seem to consider the carbon-neutral nature of wood and the global carbon cycle. When comparing wood to coal and natural gas in the context of global climate change, only a small fraction of respondents seemed to understand the advantages that wood has over fossil fuels (Table 2).

Table 2.
How Does Wood Compare to Other Fuel in Terms of Global Climate Change?

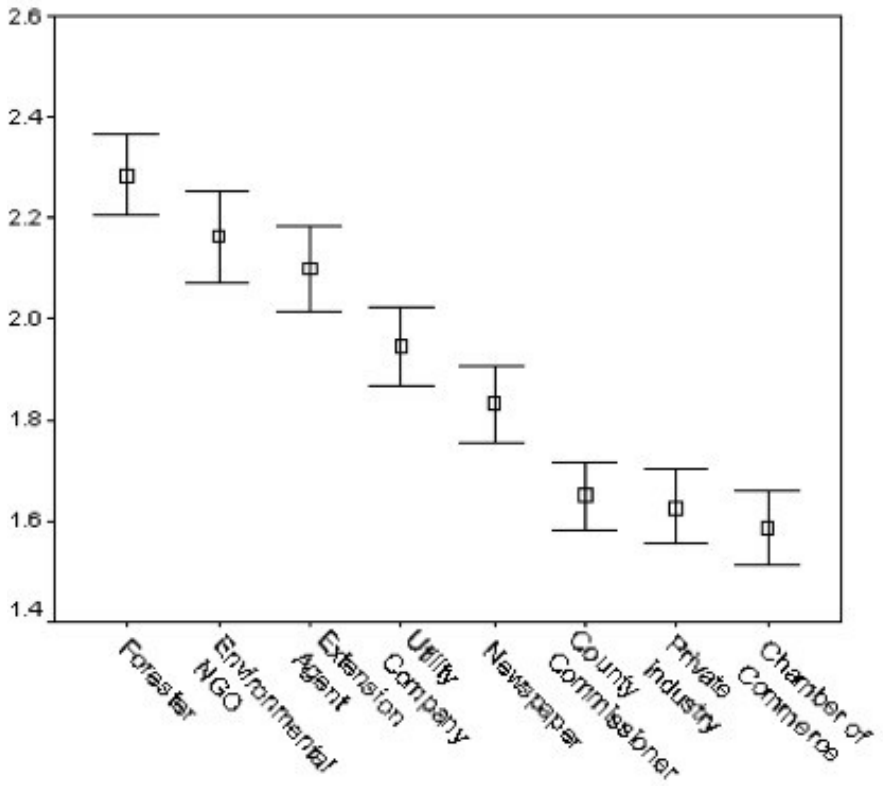
	Coal (n = 155)	**Natural Gas (n = 163)**
Wood is Better	18.8%	11.6%
About the Same	30.7%	24.2%
Wood is Worse	6.5%	23.1%

Don't Know	45.8%	43.0%

Trust

According to the literature, public trust in those who are in charge of developing and managing a wood-fueled power plant has a significant effect on public support (Ibiatayo, 2002; Van der Horst et al., 2002). Figure 7 shows that local foresters are deemed the best source for reliable information on the topic, followed closely by environmental groups and local Extension agents. These results are similar to those from previous studies (Iams & Wilhelm, 1984; Hull, Marvin, & de Cani, 1994; Lofstedt, 1997) that show higher trust for environmental NGOs and Extension agents than for policymakers and private industry. The least reliable sources of information are private industry and the chamber of commerce. These results suggest that those who are likely to hold concerns for forest management and environmental quality are more trustworthy than those who may have a vested interest in economic benefits.

Figure 7.
Score (95% Confidence Interval) Regarding Level of Trust in Various Sources to Provide Accurate Information about a Wood-to-Energy Program. (1 = Not at all; 2 = Somewhat; 3 = Very much)



Community Participation

Respondents showed relatively high interest in participating in any wood-to-energy developments, with 53% expressing a belief that community would be either "Fairly" or "Highly" influential in a proposed project and 54% describing themselves as "Fairly" or "Highly" interested in participating in the decision-making process. Such

high percentages can be at least partially attributed to a response bias of interested residents. Such results provide further evidence of the importance of public engagement in establishing a wood-to-energy project.

Discussion and Conclusions

The concerns expressed by these respondents echo those that we have heard in our discussions across the South of wood-to-energy opportunities. Perhaps the most important results in the context of Extension efforts focused on wood-to-energy outreach programs are that respondents do not know much about the topic and, notably, they are aware that they do not know much. Their initial response to the prospect of a wood-to-energy facility in their area seems to be one of interest and curiosity rather than fear. This combination suggests a general willingness of these respondents to learn more about the potential of wood-to-energy projects. At the same time, however, a larger portion of these respondents oppose than welcome such a facility, even though both are smaller than the "neutral" subgroup.

- Other key factors that inform outreach program development are:
- Deep concern for sustaining local forests and protecting air quality,
- Basic acceptance of using waste wood as a source of fuel,
- Lack of understanding of wood's carbon-neutrality and the impact on climate change,
- Trust in foresters, environmental groups, and Extension agents to provide information about proposed woody biomass facilities, and
- Over-confidence in the ability of solar, wind, or some as yet undiscovered energy source to meet our energy needs in the near future.

Awareness of these factors will likely play a significant role in the success of future Extension efforts regarding wood-to-energy projects. The results of the needs assessment were used to develop the Wood to Energy Outreach Program, which aims to help communities in the South consider using wood for energy <http://www.interfacesouth.org/woodybiomass>.

In closing, it may be helpful to look more specifically at what separates those who are fearful of this technology from those who are interested. The responses seem to show what might be called a "green-eggs-and-ham syndrome." Like the Dr. Seuss character, respondents appear to be wholly supportive of the technology or wholly opposed with little room for middle ground. Those who expressed high levels of fear regarding the prospect of developing a wood-fueled facility locally tended to be opposed to any use of wood as fuel, regardless of the source. In addition, they tended to respond that wood was inferior to both coal and natural gas in every possible way, that importance of potential problems was high, and that importance of potential benefits was low. Conversely, those who expressed interest in a local wood-fueled plant tended to accept all potential sources of wood, considered it superior to both coal and natural gas, and showed a more positive response to the potential benefits of using wood.

This all-or-nothing trend may stem from a general lack of knowledge about using wood to produce electricity. It is feasible that, knowing admittedly little about the topic, the respondents are unable to provide a more nuanced view of the issue, illustrating an understanding of both the benefits and potential problems associated with developing a wood-fueled plant.

The objective for an Extension project should be to address the emotional undertones and raise the level of discussion about converting wood to energy to identify more specifically what makes using wood for fuel an interesting or fearful proposition in the local community. Engaging the public with an outreach program provides the best chance for a community to identify desirable characteristics for a system of local energy supply and to make an informed decision about whether a wood-to-energy program meets those qualifications. Extension agents can play a pivotal role in delivering educational programs to help guide these community discussions, if their materials begin to address the local concerns and fears.

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