A Diffusion of Innovations Approach to Understand Stakeholder Perceptions of Renewable Energy Initiatives

Kami J. Silk¹, Allison Hurley², Kristin Pace¹, Erin K. Maloney³, and Maria Lapinski¹

Abstract
This study uses diffusion of innovations (DOI) as a framework for formative research to understand different stakeholders’ perceptions of renewable energy initiatives (i.e., wind, solar, and biomass). Focus groups (N = 12) were conducted with several different stakeholders in Michigan: farmers (n = 17), rural residents (n = 20), urban residents (n = 30), citizen activists/environmentalists (n = 13), and individuals who live in tourist-based economies (n = 7). Data were analyzed based on DOI constructs. Results suggest that farmers would be considered early adopters, while urban residents would fall in the late majority. Overall, stakeholder groups perceived renewable energy to be relatively advantageous and compatible with their values.

Keywords
diffusion of innovations, renewable energy, stakeholder perceptions, focus groups

¹Michigan State University, East Lansing, MI, USA
²Tufts Medical Center, Boston, MA, USA
³University of Pennsylvania Annenberg School for Communication, Philadelphia, PA, USA

Corresponding Author:
Kristin Pace, 405 Fifth Avenue, Suite 1100, Seattle, WA, USA.
Email: pacekri1@gmail.com
As fossil fuels and other nonrenewable energy sources have become more scarce and controversial, many nations have begun looking toward other natural resources as a strategy to meet the increasing energy needs of consumers. Alternative energy sources are purported as important for our future in a number of different economic, social, legal, and physical realms as new policies affect the use of these resources and the lives of energy consumers. The majority of the lay public is uninformed about the scientific and practical applications of renewable energy sources (Bang, Ellinger, Hadjimarcou, & Triachal, 2000; Sovacool, 2009), despite the fact these innovations have significant social impacts. Because the general population is mostly unaware of these applications, individuals may make decisions about utilizing alternative energy without fully understanding their advantages and disadvantages. Within the population there are distinct segments, or stakeholders, who reflect a range of perspectives on the uptake and impacts of renewable energy initiatives. Michigan provides an interesting context to explore stakeholder perspectives as the state is currently developing the infrastructure to adopt several different types of alternative energy sources as part of the economic recovery (Natural Resources Defense Council, 2014). It is important to understand how stakeholders in Michigan perceive the advantages and disadvantages related to alternative energy sources; they are often the gatekeepers who can choose to erect barriers to, or facilitate the adoption of, new energy sources in their communities.

Framed in diffusion of innovations (DOI), this research uses focus groups in the state of Michigan to examine different stakeholder responses to alternative energy resources. The article discusses alternative energy resources, considers issues related to the adoption of renewable energy initiatives, and provides insight into how different stakeholder groups perceive these initiatives.

Renewable Resources

As our world’s climate continues to change, greenhouse gases, pollution, and overuse of nonrenewable resources have profound effects on our communities. High energy consumption rates in the United States are forcing its residents to face the critical concern of dwindling domestic fossil fuels and nonrenewable energy supplies (Pimentel et al., 1994). After observing the rapid depletion of domestic fossil fuels and the accumulation of the adverse effects associated with the overuse of these energy sources, local and federal governments are moving to slow these threats. One avenue that officials are taking is to invest in energy innovations that harness renewable natural resources (De Gorter & Just, 2009).

There are several potential sources of energy that are considered renewable energy initiatives, including solar power, wind power, and biomass,
which may reduce reliance on fossil fuels and subsequently reduce pollution. Solar power is perhaps the most familiar to the lay public and has been integrated strategically into community structures for decades (U.S. Department of Energy, 2009a). Wind power utilizes wind turbines to generate electricity and can also reduce greenhouse gas emissions, conserve water, lower natural gas prices, expand manufacturing, and generate local revenue (U.S. Department of Energy, 2009b, 2009c). Finally, biomass refers to all renewable organic materials that are used to generate fuels from various natural sources such as ethanol, biodiesel, and switchgrass products.

The use of renewable energy sources may enable our communities to lower their amount of greenhouse gas emissions and aid in reducing our nation’s dependence on nonrenewable energy products, while also improving our communities financially by supporting U.S. agricultural and forest product industries (National Renewable Energy Laboratory, 2010). While renewable energy innovations appear to have many advantages, there are several potential disadvantages. Criticisms of renewable energy initiatives suggest that they are too expensive to implement, are too politically challenging for communities to support, and affect land use in ways that negatively affect the environment and wildlife and drive up food costs (Abbasi & Abbasi, 2000; Rabe, 2007; “Why Is Renewable Energy So Expensive,” 2014). Thus, while potential advantages may be touted by industry and certain stakeholders, potential disadvantages cannot be dismissed.

Given the increased focus on alternative energy options and the myriad possible responses from different stakeholder groups, it is insightful to hear their opinions as a gauge for what information might be necessary for lay individuals to make informed decisions about renewable energy initiatives. The following section introduces the DOI (Rogers, 2003) theory, which provides a framework through which the public’s perceptions about attributes of renewable energy initiatives may be examined to provide insight about their likelihood of adoption.

**Diffusion of Innovations and Renewable Energy**

DOI has its roots in agricultural research and has since been applied in many different contexts to explain and predict how individuals adopt new innovations (Greenhalgh, Robert, MacFalane, Bate, & Kyriakidu, 2004; Rogers, 2003). DOI is a process that individuals in a social system experience when adopting a new innovation or idea (Rogers, 2003). The theory suggests that when new innovations are presented to the public, the public will experience some level of uncertainty when deciding whether or not to adopt the innovation. Given this uncertainty, individuals will engage in information-seeking
behaviors to assess a variety of factors necessary in deciding whether to adopt
the innovation. These factors range from characteristics about the innovation
to ascertaining how others feel about the innovation. DOI also provides a
categorization for describing when individuals choose to adopt an innovation
and the characteristics of these adopters.

Given that the renewable energy innovations are perceived to be “new” to
many stakeholders (Bang et al., 2000; Sovacool, 2009), it is likely there is
uncertainty surrounding the issue. As such, DOI can provide insight into how
stakeholders view the renewable energy initiatives and what aspects of the
innovations may need to be addressed so lay consumers can make informed
decisions. The focus of this study is to determine where certain stakeholder
groups position themselves among the adopter categories and how they eval-
uate the five attributes of renewable energy innovations when making an
adoption decision: relative advantage, compatibility, complexity, trialability,
and observability. Ultimately, these five attributes help inform whether lay
individuals will or will not be in favor of adopting renewable energy sources.

**Adopter Categories**

Not all individuals will adopt an innovation at the same time, and Rogers
(2003) suggests that individuals can be categorized into one of five adopter
categories. **Innovators** are those who are on the forefront of the creation and
adoption of the innovation and generally belong to elite social groups. **Early
adopters** consist of those who are among the first groups to adopt the innova-
tion and are considered to have more “local” social status than innovators.
Early adopters are often looked to as opinions leaders. The **early majority**
consists of those who wait to adopt the innovation until they have had a
chance to observe the early adopters but who adopt the innovation before the
“average” individual. The **late majority** adopts the innovation after the “aver-
ge” individual and tends to take time to carefully evaluate the innovation
before adoption. **Laggards** are the last to adopt the innovation and are often
considered to be on the outskirts of the social system. They tend to have
fewer resources and are the most skeptical of the innovation. The adopter
category into which each person falls depends largely on the individual’s
evaluation of the innovation with regard to the following five attributes:

*Relative advantage:* Relative advantage refers to the extent the innovation
is perceived to be better than other related options and can be deter-
mined by a variety of factors. The relative advantage may be economic
(i.e., innovations that can replace or supplement more expensive items),
or it may be some other advantage, such as relative effectiveness
(Dearing, Meyer, & Kazmierczak, 1994). For example, if stakeholders perceive that it is more costly to pay for electricity generated by windmills, they will not be as likely to support the innovation. Second, if stakeholders view elements of renewable energy to be an efficient way to produce clean energy, then initiatives may have the clear advantage over conventional methods; conversely, if renewable energy is perceived as inefficient or similarly efficient as current strategies, there would be no clear advantage to adopting the initiative. Overall, the higher the relative advantage of the innovation, the more likely it is to be adopted (Dirksen, Ament, & Go, 1996; Meyer, Johnson & Ethington, 1997; Rogers, 2003; Tornatzky & Klein, 1982).

Compatibility: Compatibility refers to the extent an innovation is consistent with the values, beliefs, needs, and experiences of the public. The public is more likely to feel comfortable with an innovation that is congruent with their preexisting values, beliefs, and needs (Atwell, Schulte, & Westphal, 2009; Aubert & Hamel, 2001; Foy et al., 2002; Rogers, 2003; Tornatzky & Klein, 1982). For example, if current farming practices and technology are not compatible with the renewable energy sources, it may be difficult for farmers to adopt the innovation. Furthermore, if stakeholders do not value clean energy or do not believe that the renewable energy source is capable of reducing pollution and reliance of fossil fuels, adoption would be less likely to occur.

Complexity: Complexity refers to the extent an innovation is easy to understand and use. Innovations that are difficult to comprehend or use are not as likely to be adopted (Rogers, 2003; Tornatzky & Klein, 1982). For example, Grilli and Lomas (1994) observed that recommendations that were highly complex resulted in low compliance rates. Given the complexity of renewable energy and its related technologies, stakeholders may not feel comfortable adopting renewable energy innovations.

Trialability: Trialability refers to the extent an innovation can be tested before permanent adoption. Innovations are more likely to be adopted if potential adopters have the ability to test the innovation. The ability to try the innovation before full-blown adoption reduces uncertainty surrounding the innovation, increasing the likelihood that individuals will adopt the innovation (Rogers, 2003). For example, Grilli and Lomas (1994) observed that recommendations that allowed trialability resulted in higher compliance. Trialability at the individual adoption level is difficult to implement based on the financial costs associated with adoption of renewable energy initiatives. This lack of opportunity to test the innovation may decrease the likelihood of adoption.
Observability: Observability refers to the extent the innovation can be examined before it is adopted. Observability is primarily concerned with whether or not the results or outcomes of the innovation can be viewed before a decision to adopt is made. Observing the impact of the innovation can reduce uncertainty and facilitate adoption (Rogers, 2003). In the context of renewable energy, if stakeholders are able to observe a renewable energy innovation being used elsewhere, they may be more comfortable in adopting the innovation. However, if other communities are not providing this observational opportunity, communities may not perceive a need to adopt the renewable energy initiative either.

These five characteristics are critical in assessing the likelihood of innovation adoption. If stakeholders cannot see the relative advantage, cannot see the compatibility of the innovation, or are hindered by the complexity of the innovation, then they will be less likely to accept the innovation. Likelihood of adoption can be increased by reducing the uncertainty about the innovation through offering a “trial” or allowing stakeholders to observe the innovation in action. By understanding how stakeholders view each of these DOI characteristics and under which adopter category stakeholder groups currently fall, a clear picture of concerns, areas of uncertainty, and advantages/disadvantage related to adoption of new initiatives will be revealed:

Research Question 1: What DOI adoption phase (innovators, early adopters, early majority, late majority, and laggards) are different stakeholders currently in regarding renewable energy innovations?
Research Question 2: What do different stakeholders report about renewable energy sources related to the DOI constructs (relative advantage, compatibility, complexity, trialability, and observability)?

Method

Participants and Procedures

Focus groups were utilized (a) to provide an in-depth method for investigating issues of renewable energy sources about which the lay public may know little, (b) to offer an open forum for discussion of ideas that researchers may not anticipate, and (c) to contribute to the development of a statewide survey (Stewart, Shamdasani, & Rook, 2007). Twelve focus groups (N = 87; typically 6-10 participants) were conducted across the state of Michigan during the summer of 2009. Participants were recruited through the Extension offices of a large, midwestern university, and focus groups were conducted in
local community centers by three trained moderators. Multiple stakeholder groups were represented in the focus group research design; farmers, rural residents, urban residents, citizen activists/environmentalists, and individuals from tourist-based economies to gain a range of perspectives (see Table 1 for group descriptions and demographics). Each focus group was comprised of one type of stakeholder. The sample was comprised of 38 females (18-72 years; $M = 42.78, SD = 14.67$) and 50 males (18-79 years; $M = 48.26, SD = 14.79$), with 6 participants not reporting their gender. Participants self-identified as Caucasian ($n = 34, 37.7\%$), African American ($n = 15, 16.6\%$), Latino ($n = 1, 1.1\%$), Native American ($n = 2, 2.2\%$), and “Other” ($n = 8, 8.8\%$), with 30 (33.3\%) not reporting a race/ethnicity. All focus groups were audiotaped for transcription purposes. Focus group participants received a $40$ honorarium.

**Table 1. Demographics Reported by Focus Group Type.**

<table>
<thead>
<tr>
<th></th>
<th>Farmers $,(n = 17)$</th>
<th>Rural residents $,(n = 20)$</th>
<th>Urban residents $,(n = 30)$</th>
<th>Citizen activist $,(n = 13)$</th>
<th>Tourist economy $,(n = 7)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Male</td>
<td>82.4</td>
<td>55</td>
<td>26.7</td>
<td>76.9</td>
<td>57.1</td>
</tr>
<tr>
<td>% Female</td>
<td>17.6</td>
<td>45</td>
<td>76</td>
<td>23.1</td>
<td>42.9</td>
</tr>
<tr>
<td>Age, $M$ $(SD)$, years</td>
<td>52.77 $(9.75)$</td>
<td>48.22 $(16.1)$</td>
<td>35.96 $(9.97)$</td>
<td>55.5 $(16.1)$</td>
<td>a</td>
</tr>
<tr>
<td>Race/ethnicity, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>41.2</td>
<td>60</td>
<td>16.7</td>
<td>69.2</td>
<td>100</td>
</tr>
<tr>
<td>African American</td>
<td>a</td>
<td>a</td>
<td>53.3</td>
<td>a</td>
<td>0</td>
</tr>
<tr>
<td>Latino</td>
<td>a</td>
<td>a</td>
<td>3.3</td>
<td>a</td>
<td>0</td>
</tr>
<tr>
<td>Native American</td>
<td>a</td>
<td>10</td>
<td>a</td>
<td>a</td>
<td>0</td>
</tr>
</tbody>
</table>

Note. Citizen activist = citizen activists/environmentalists.
a. None reported.

**Moderator Guide**

Moderator guide development started with interviews of renewable energy experts to inform the investigators about the prominent research, data, and opinions about renewable energy. Seven interviews were conducted on a midwestern university campus in the fall of 2008. The experts were asked about their definitions of renewable energy, the salient issues about the
renewable energy, important stakeholders, anticipated barriers to adoption, existing programs facilitating the adoption of renewable energy initiatives, best practices for communicating with the public, important initiatives Michigan should pursue, the “products” of renewable energy sources that may be most marketable to Michigan consumers, and the information that lay consumers need to know about renewable energy.

Researchers utilized information gathered from the expert interviews and relevant research literature to inform the development of the moderator guide. The moderator guide asked questions about participants’ awareness of Michigan’s natural resources and knowledge of how these resources are used for energy, participant acceptance or rejection of initiatives, and the positive and negative perceptions associated with biomass, wind, and solar energy. Participants were then shown five pictures of renewable energy products and asked to indicate their thoughts on the major advantages and disadvantages about each innovation on index cards. Participants also completed a brief survey where they rated statements about the attributes of alternative energy sources. For each type of renewable energy initiative examined in this study (wind power, solar power, and biomass), participants were asked to rate, from a single item, if the initiative was advantageous, compatible with their lifestyle, a complex technology, and if the participant would notice if others around him/her used that form of energy (1 = strongly disagree, 5 = strongly agree). All written materials served as a basis for further discussion within the focus group on the perceived advantages and disadvantages of biomass, wind, and solar as renewable energy sources. Finally, the moderator asked questions about information seeking and trusted sources of information about renewable energy innovations. Throughout the focus group the moderator used the guide to seek a balanced discussion and explicitly encouraged participants to provide positive and negative comments.

**Analysis Approach**

The audiotaped content of the 12 focus groups was transcribed verbatim into typed transcripts. Numbers were assigned in place of participants’ names to ensure participant confidentiality. Researchers unitized and coded the transcripts based on a number of pertinent operational and contextual definitions contained in the moderator guide. The coding scheme included codes for knowledge, advantages, disadvantages, perceived priorities, and DOI constructs, as well as source and channel constructs. Two coders were trained and given a portion of one focus group. The coded portion was analyzed for intercoder reliability, the coders were found reliable (k = .852), and the coders continued analyzing the transcripts individually. A subsequent reliability
check revealed that coders were starting to diverge \((k = .561)\); thus coders were retrained and asked to recode a portion of a focus group. Intercoder reliability was sufficiently reliable \((k = .876)\), and coders continued to code the remainder of the focus groups individually. Researchers then analyzed the results and identified quotations that were illustrative of the larger DOI characteristics. The researchers also analyzed the brief DOI survey that participants filled out to rate the attributes of the alternative energy sources. The DOI constructs were analyzed by frequency and distribution across stakeholder type.

**Results**

Qualitative and quantitative results are presented. Qualitative results are presented as they relate to each of the DOI constructs. Quantitative results of the focus group coding are integrated to demonstrate the distribution of DOI constructs across groups and their frequency of occurrence in the focus groups (Table 2). Finally, descriptive results of a brief DOI questionnaire are also included to provide further evidence of the relevance of the DOI to the adoption of renewable energy initiatives (Table 3). Due to the low sample size and the use of single-item measures, the results are reported in a purely descriptive manner.

**Adopter Categories**

The adopter category of participants varied based on stakeholder groups and general placement was determined by an overall look at how the groups viewed the five DOI attributes. Farmers seemed to be eager early adopters, although they did have some skepticism toward renewable energy initiatives. One farmer commented, “If we are going to invest in something like that there needs to be some sort of return to the community” (Focus Group [FG] 1). Rural residents also wanted to move forward with these initiatives but seemed to be more cautious due to the practicality and feasibility of implementing these innovations. The rural residents likely represent an early majority. Urban residents would most likely fall under the late majority category because although they are eager to engage in using these innovations, they often cited needing to see them work in other places first before adopting the behavior. An urban resident stated, “I think seeing other people do the same thing, I think it’s really powerful when you see other people, you say ‘Wow! They’re doing that, I can do that too . . .’” (FG8). Participants from tourist-based economies also most likely fall under the late majority. Although they agreed that initiatives would be safer in the long run, they often adopted
Silk et al.

Table 2. Frequency Distribution of DOI Attributes.

<table>
<thead>
<tr>
<th>Focus group type</th>
<th>Relative advantage units, n (%)</th>
<th>Compatibility units, n (%)</th>
<th>Complexity units, n (%)</th>
<th>Trialability units, n (%)</th>
<th>Observability units, n (%)</th>
<th>Total DOI units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>35 (22)</td>
<td>42 (29)</td>
<td>23 (23)</td>
<td>13 (22)</td>
<td>20 (20)</td>
<td>133</td>
</tr>
<tr>
<td>Rural residents</td>
<td>6 (3)</td>
<td>5 (3)</td>
<td>3 (3)</td>
<td>2 (3)</td>
<td>25 (25)</td>
<td>41</td>
</tr>
<tr>
<td>Urban residents</td>
<td>66 (42)</td>
<td>63 (43)</td>
<td>56 (55)</td>
<td>24 (41)</td>
<td>23 (23)</td>
<td>232</td>
</tr>
<tr>
<td>Tourist economy residents</td>
<td>27 (17)</td>
<td>17 (12)</td>
<td>10 (10)</td>
<td>16 (27)</td>
<td>21 (21)</td>
<td>91</td>
</tr>
<tr>
<td>Citizen activists/ environmentalists</td>
<td>24 (16)</td>
<td>20 (14)</td>
<td>9 (9)</td>
<td>4 (7)</td>
<td>10 (10)</td>
<td>67</td>
</tr>
<tr>
<td>Unit totals</td>
<td>158 (28)</td>
<td>147 (26)</td>
<td>101 (18)</td>
<td>59 (11)</td>
<td>99 (17)</td>
<td>564</td>
</tr>
</tbody>
</table>

Note. DOI = diffusion of innovation. A unit refers to any time an attribute was mentioned in the focus group discussion. The attribute percentages represent the number of times the attribute was mentioned by the specific focus group participants divided by the total number of times the attribute was mentioned by any focus group (i.e., unit total). The total DOI units refer to the number of times each focus group mentioned a DOI attribute.

a “not in my backyard” (NIMBY; van der Horst, 2007) attitude and cited the misuse of natural resources as a major concern. Citizen activists and environmentalists would also most likely fall under the early or late majority category due to their mistrust from past experiences and concern about unforeseen complexities. One activist commented, “There may be new and adverse consequences or impacts that we’re not prepared for as opposed to the ones that we are prepared for” (FG10). These participants noted the impracticality of nonrenewable energy sources and emphasized the importance of energy conservation and a reduction of fossil fuels.

Relative Advantage

Twenty-eight percent of all comments regarding DOI constructs were related to the relative advantage of renewable energy sources (Table 2). Of the mentions of relative advantage, urban residents accounted for the highest percentage of units (42%) followed by farmers (35%), while rural residents had the lowest percentage of units (3%). On average, all of the stakeholder groups considered wind power to be relatively advantageous ($M = 3.85-4.71$). Solar power was also considered to be advantageous ($M = 3.66-4.57$), while biomass was considered to be slightly less advantageous ($M = 2.84-3.82$; Table 3).

When discussing the relative advantage of renewable energy sources over nonrenewable sources, participants tended to focus on the economic benefits of these innovations over the current supply. A farmer commented,
Another major benefit of renewable energy initiatives over current energy sources mentioned by participants across the focus groups was the possibility of job creation. For example, an urban resident stated that these initiatives “should produce more jobs, more money here in the state” (FG12). An environmentalist agreed that the adoption of renewable energy initiatives in Michigan would not only increase jobs but also “transition to a new skilled
labor force” (FG10). A third relative advantage that participants discussed was increased energy independence for the state of Michigan. For example, an environmentalist stated that renewable energy initiatives are advantageous because “[They have] the potential to decrease global strife because we’re not trying to get resources from other people” (FG10). The high importance that participants placed on energy self-sufficiency may be due to the current dependence on foreign oil.

Although participants seemed sure of the benefits associated with using these technologies, they also seemed concerned about the risk of switching to something new and the unknown consequences that may develop. An urban resident questioned,

How much energy am I saving? I mean if I go through all of this and, let’s take solar panels—if I redo my roof and have all of the drainage that comes down to link into things and do all of that and put all of this equipment in, if it saves 30 cents a month on my consumer’s bill, it’s not worth it. But I need some prognosis from that standpoint. (FG8)

Another unknown consequence that was brought up by urban resident stakeholders is the negative health outcomes that may be associated with the utilization of renewable energy initiatives. One urban resident participant stated, “They say some people that are around wind farms it does something to their ears or they get dizzy or nauseous. I’ve heard stuff like that and it worries me a little bit, a little bit” (FG9). In addition to unknown economic and health consequences associated with using renewable energy initiatives over current energy sources, some focus group participants (primarily environmentalists) discussed the possible misuse and mismanagement of resources. For example,

If we covered enough of the southwest in mirrors we could produce enough electricity, all the electricity we wanted. But I mean, there goes our deserts, you know? What an awful idea. And so do we wanna do the same thing to Lake Michigan? (FG10)

**Compatibility**

Twenty-six percent of the comments about DOI constructs were related to the issue of compatibility. Of the mentions of compatibility, urban residents (43%) and farmers (29%) accounted for the highest percentage of units, while rural residents (3%) accounted for the lowest percentage of units (Table 2). Urban residents ($M = 3.50$) and environmentalists ($M = 3.75$) appear to be
slightly more concerned with the compatibility of wind power when compared to the other stakeholder groups ($M = 4.35-4.42$). Solar power was rated as being moderately to highly compatible by all stakeholder groups ($M = 3.43-4.43$), with environmentalists rating compatibility lower than the other groups. Overall, biomass was ranked as moderately compatible ($M = 2.83-4.11$), once again with environmentalists offering the lowest rating (Table 3).

While discussing the compatibility of alternative energy sources, participants often examined how congruent the sources are with both their own lifestyles and the entire state of Michigan. When participants examined the compatibility of these technologies within their own lifestyles, they often alluded to NIMBY issues or spoke about the fact that they, personally, may have to make changes. One rural resident said, “So you need to be able to be open minded enough, to assist in some needs, ya know. But like you say, I don’t want that big windmill in my backyard, even if you get electricity from it” (FG3). Participants from the tourist economy group also agreed, “NIMBY, NIMBY is the thing, I don’t want that damn thing in my backyard” (FG6). Rural residents indicated that these innovations might not be compatible with the state of Michigan due to high transportation costs. One rural resident from the Upper Peninsula stated, “The transportation and infrastructure, we just don’t, we aren’t close enough to the hubs where that stuff gets used” (FG3).

Across focus groups, participants consistently indicated that solar energy is not compatible with resources in the state of Michigan. One urban resident stated, “You have a lot of people thinking about the solar here in Flint but there’s not enough sun in Michigan” (FG11). Participants also voiced concerns about the compatibility of biomass due to the fact that it may be an invasive species. For example, one rural resident stated,

My concern would be if it’s compatible to the area. Because too often, as I said, plants that have been introduced into areas, Louisiana, is a real bad example of it, where they had these plants that were so pretty and all of the sudden, they can’t be stopped. (FG2)

When participants examined the compatibility of these sources within the state, they often discussed the large abundance of resources that are available to aid in the development of green technologies. An urban resident commented,

That’s what we should have been focusing on years ago. Um, back in the 70’s when we first had this so-called gas crisis. They should have started with what Michigan does best, we’ve always done agriculture the best, you know, and we should have started . . . (FG11)
One farmer agreed, “The infrastructure is already in place. You grow corn, you got the corn elevators there, and the farms there, and the combines, and the dealers that support the combines” (FG7).

**Complexity**

Eighteen percent of the comments relating to DOI constructs revolved around the issue of complexity. Of the mentions of complexity, urban residents (55%) and farmers (23%) accounted for the highest percentage of units, while rural residents (3%) accounted for the lowest percentage of units (Table 2). All stakeholder groups considered the complexity of wind power to be a low to moderate level ($M = 2.40-2.83$). Similar results were found for the complexity rating of solar power ($M = 2.47-3.08$). Overall it appears that the farmers, urban residents, environmentalists, and those living in a tourist-based economy rated biomass as more complex ($M = 3.29-3.63$) than rural residents ($M = 2.20$, Table 3).

Participants reported high levels of worry and concern about the complexity of the renewable energy, even those participants who seemed reasonably informed about renewable energy. Several people repeatedly indicated they needed even more information due to the fact that there had not been enough research conducted on these technologies and that the information needed to be explained more clearly. One environmentalist commented,

> I think in essence a lot of these issues are fairly simple and if they’re broken down to the simplest denominator and that’s taught to people, communicated to people. And I think just about everybody will be able to at least make their mind, will understand at a level that they can come to some opinion and be able to grasp the basis of the issues. You know, the technology can get very complicated, a lot of the applications can get complicated, but I think the basic issues are pretty simple. (FG6)

Across stakeholder groups, participants often indicated biomass as the most complex renewable energy innovation. For example, one rural resident stated, “Yea, I think biomass is a little more complex” (FG2). Although these innovations may be somewhat complex, those in the tourism industry noted that the complexities of these innovations have been decreased due to current technologies. For example,

> I’m saying the technology is coming to a point where we can harness that better. I would like to see, you know more done with that, more put into the technology to you know, kind of move us away from “Ok what can we conquer and burn!” (FG6)
Trialability

Eleven percent of the comments relating to DOI constructs revolved around the issue of trialability. Of the mentions of trialability, urban residents accounted for the highest percentage of units (41%), followed by those living in the tourist-based economy (27%) and farmers (22%). Environmentalists (7%) and rural residents (3%) accounts for the lowest percentage of units.

Participants across focus groups seemed eager to try these technologies for themselves. A farmer commented,

I’ll give you a good example; when we got married my wife said, “We should get a windmill” and I laughed at her and said “No way.” Well now, as soon as our Bloomfield Township gets their ordinance in place, I think I am going to look at putting a windmill up. (FG7)

Although eager to try renewable energy innovations, participants across all focus groups indicated that resistance to change hampers the adoption of these technologies. As one urban resident commented, “Yeah I do too, I think the transition would be challenging just because it’s unknown and it’s new” (FG9). Participants also may not have the tools and resources to get started implementing these innovations in their own homes. As one farmer noted,

There’s too much of just sitting, I mean they just sit and they talk about it, but nothing ever goes maybe beyond one or two people that try it, and that’s about it. I don’t think there’s enough opportunity for an individual to get into it unless he has a certain amount of money to put into it himself. (FG5)

Observability

Seventeen percent of the comments about the DOI constructs related to the issue of observability. Of the mentions of observability, rural residents (25%), those living in a tourist-based economy (20%), urban residents (23%), and farmers (20%) accounted for the highest percentage of units, while citizen activists/environmentalists (10%) accounted for the lowest percentage of units. All stakeholder groups indicated that they would be able to notice others using wind power ($M = 4.30-4.71$) and solar power ($M = 4.16-4.62$). Stakeholder groups indicated that they would be slightly less able to notice others using biomass ($M = 3.50-4.00$).

Participants’ comments indicated variable levels of observability. Farmers seemed to be very knowledgeable of innovators in their communities and cited clear examples of these community members utilizing renewable energy initiatives. Rural residents, environmentalists, and those in living in
tourist-based economies also had high levels of observability, although they indicated they would need more concrete examples of the effectiveness of these innovations. For example a rural resident noted, “I’d have to see it work before I agreed to doing something like that. I wouldn’t want something that’s just on paper. And not seeing it being developed somewhere else” (FG3). Participants living in urban areas had low levels of observability and noted a strong desire to see if innovations had worked elsewhere before experimenting with new initiatives themselves. “And I’d like to see if it’s been started anywhere else and how’s it working in that area? And what’s the, you know, conditions? What was you know the whole effect?” (FG11). These urban residents had a hard time listing known initiatives that were occurring in their communities when prompted by the moderator.

Discussion

Michigan provides a unique setting to explore renewable energy initiatives due to its agricultural base and need for economic recovery. The state government is actively promoting the use of solar, wind, and biomass and has passed a law that requires all electric providers to create an energy portfolio that includes at least 10% from renewable energy sources by 2015 (Department of Licensing and Regulatory Affairs, 2014a). Michigan currently has 16 operational wind farms with 5 more under development (Department of Licensing and Regulatory Affairs, 2014b), is encouraging the installation of solar energy systems across the state (Michigan Public Service Commission, 2013), and has 12 biomass facilities (Melow, 2014). The state offers tax incentives for residents and businesses that install energy products and systems (U.S. Department of Energy, 2014), and many of the energy suppliers give residents the opportunity to purchase power from renewable sources. While there is movement in Michigan toward adopting renewable energy initiatives, there is still a lot to learn about how stakeholders view these initiatives.

This research provides insight into different stakeholders’ perceptions of renewable energy as they relate to DOI constructs. Focus group data as well as evidence from the brief survey regarding attribute rankings indicate that DOI has great utility for understanding how stakeholders view the advantages and disadvantages of renewable energy. Our data reveal that participants considered these characteristics in forming their opinions about renewable energy. These characteristics will play a fundamental role in communicating to lay audiences about new renewable energy initiatives. Furthermore, the DOI attributes can create understanding about other constructs that are related to behavior adoption, such as those represented in the
integrative model of behavioral prediction, which is an extension of the theory of planned behavior (Yzer, 2012). The integrative model of behavioral prediction suggests that attitudes, perceived norms, and self-efficacy will affect intentions to engage in a behavior, while skills and environmental constraints moderate the relationship between intentions and actual behavior.

The results suggest that providing clear information that communicates the benefits as superior to current energy options, sharing visible examples of success as well as opportunities to test the innovation, and demonstrating the compatibility of innovations with the stakeholder’s lifestyle will likely increase adoption of alternative energy sources. However, stakeholders also have some very real concerns about renewable energy initiatives. The theoretical and practical implications will be discussed for each DOI attribute.

**Adopter Categories**

This analysis identified which stakeholder groups fall into different adopter categories. This information will be important to consider when making decisions about targeted messaging (Kreuter & Wray, 2003). Each stakeholder group had different perceptions of the five DOI attributes, which likely stem from their past experiences, values, and geographic location within the state. Early adopters and early majority members should be targeted before late majority or laggards (Rogers, 2003). Several of the stakeholder groups examined, such as the farmers, may be considered opinion leaders that other groups will look to for guidance about renewable energy initiatives, and thus it is important to make sure that the concerns of such groups are addressed before targeting other stakeholders. Others groups, such as urban residents, appear to fall into the late majority or laggard categories, likely due to the fact that it is much harder for them to directly observe the effects of renewable energy initiatives. Although all participants were in variable phases of adoption, most seemed to be much more informed about renewable energy initiatives than the current general U.S. population. Reasons for this may include the participants’ occupations, participants’ levels of education, and the agricultural focus in Michigan versus other areas of the country.

**Relative Advantage**

The focus groups revealed that there were many perceived advantages and disadvantages to renewable energy initiatives. These perceptions could help inform general attitudes toward the use of renewable energy initiatives (Bang et al., 2000). As a whole, the stakeholder groups appeared to have positive attitudes toward renewable energy, but stakeholder groups such as farmers
and rural residents tended to focus more on the advantages while citizen activists and those from the tourist-based economy tended to focus more on the disadvantages. The positive and negative attitudes that stem from perceptions of the relative advantages and disadvantages may facilitate or inhibit the adoption of renewable energy initiatives (Yzer, 2012).

One interesting advantage that was discussed in the focus groups was the idea that the long-term benefits of renewable energy initiatives may outweigh the short-term costs. Rogers (2003) stated that one factor stakeholders may be looking for in relation to relative advantage is the immediacy of the reward; thus certain innovations may take longer to adopt because the reward will not occur until sometime in the future. It is possible that for some stakeholder groups, such as the farmers, the threat of climate change and of potential lack of resources is strong enough to offset the short-term costs and speed up adoption. However, other stakeholder groups would hold off on adoption because the rewards are not immediate. Alternatively, there could be a perception that the good of society outweighs the needs of the individual and that it is only when everyone sacrifices a little that society can experience the benefits.

The results reveal that in communicating about renewable energy, it is important to emphasize the clear benefits over current energy sources. By highlighting the economic, employment, self-sufficiency, and environmental advantages of utilizing these innovations, one may be successful in persuading stakeholders to adopt the use of alternative energy sources. It is also important to address the relative disadvantages associated with renewable energy initiatives. By explaining and reducing concerns regarding unknown consequences such as negative health outcomes and the misuse of resources, advocates may attenuate perceived risks associated with adopting these innovations.

Compatibility

Because the public is more likely to feel comfortable with an innovation that is consistent with their values and way of life (Rogers, 2003), it is important to investigate the compatibility of stakeholder resources with the adoption of renewable energy initiatives. Furthermore, perceptions of compatibility may inform the general attitudes stakeholders have toward renewable energy as well as demonstrate perceived norms, which are related to behavior intentions (Yzer, 2012). Stakeholders likely have expectations of what is considered to be acceptable behavior within their community and these expectations may play in role in whether an innovation is considered to be compatible.
The results surrounding compatibility also highlight the importance of targeting and tailoring messages (Kreuter & Wray, 2003). Compatibility had the largest amount of variance across stakeholder groups, indicating that each stakeholder group may need to be addressed differently. For example, it is possible that the low level of compatibility for urban residents was due to the fact that these innovations are difficult to implement in their geographic region. Those in the tourist-based economy, on the other hand, found the renewable energy initiatives to be much more compatible even though it would be difficult to implement the technologies in their geographic region. In this case the compatibility could reflect attitudes toward health, the environment, and the future.

One major barrier to feelings of compatibility is the NIMBY effect. This perception is often observed in situations where necessary services may have negative impacts on a community and commonly occurs in discussions of renewable energy (van der Horst, 2007). In order to address this, one could promote the monetary and environmental values of these innovations and attenuate the negative aesthetics associated with them.

**Complexity**

There is a large amount of concern and worry about renewable energy initiatives due to uncertainty and perceived complexity of these innovations. These initiatives are complex not just in terms of the level of understanding required but also in terms of the consequences of adopting these innovations to the environment, economy, individual budgets, and employment opportunities for future generations. All of these concerns relate back to the complexity of the issue and the technology itself and highlight the importance of understanding how innovations affect the larger social system of which they are a part (Rogers, 2003). Furthermore, these concerns may also contribute to the development of negative attitudes toward renewable energy sources and impede adoption.

Complexity may also be a driving force in how the other attributes are perceived. One of the topics discussed in the focus groups was that there was not enough sun in Michigan to support solar power, even though solar power can be produced on cloudy days (Kelly & Gibson, 2009). While the issue of there not being enough sun to use solar panels is an issue of compatibility, it is the complexity of renewable energy initiatives that is potentially driving the misunderstanding. This issue of complexity may also drive misunderstandings regarding relative advantage and could have overarching impacts on attitudes and perceived norms. Future research should continue to investigate interrelationships between these attributes.
One of the ways complexity can be addressed is by translating scientific research on these innovations into lay terms that are easily understandable, so the general public may make educated and informed decisions. Participants across all focus groups indicated a need for increased education about renewable energy initiatives. For example, one participant stated, “Well and I think the education level on these issues is lacking. If people understood the issues, were aware of the issues more, I think they’d be more willing to listen and to find information and to get involved” (FG6).

**Trialability**

Although it seems that individuals may be willing to try out some of these innovations, there are a number of barriers to their actual adoption. These barriers include a lack of infrastructure, lack of opportunities to test out these alternative energy resources, and resistance to change. Even if there are intentions to adopt or at least a desire to try out new innovations, environmental constraints such as a lack of resources or infrastructure will inhibit the process (Yzer, 2012). One of the major benefits of trying the innovation prior to adoption is a potential boost to one’s sense of self-efficacy and skill level in using the technology, which is related to behavior intentions (Bandura, 1997; Yzer, 2012).

One way to overcome these barriers is to provide the tools to facilitate opportunities to test renewable energy initiatives. Small-scale innovations or “pilot studies” are necessary so that actual tests in communities can be used to demonstrate new initiatives. Working in conjunction with communities, researchers could begin to facilitate partnerships that will allow for small-scale projects that test viability. This is particularly true of farmers who reported that they have switched crops in the past and have not reaped the benefits that were promised.

**Observability**

Examples of instances where renewable energy initiatives have provided energy effectively can be persuasive. Observing others is a key tenant of social cognitive theory and is consistently related to the development of self-efficacy (Bandura, 1997). Additionally, observing others may help develop perceived norms, particularly if those who are being observed are opinion leaders (Rogers, 2003). Both self-efficacy and perceived norms in favor of the behavior are related to behavior intentions.

Finding success stories and communicating them and allowing direct observability may influence people to adopt these initiatives. When
communicating to key publics about renewable energy initiatives, concrete examples where renewable energy sources have worked effectively may be effective. More specifically, communication to key publics about examples in the nearby communities may positively influence public opinion about adopting these innovations.

**Limitations and Future Research**

One of the major limitations of this research is that the data that we collected are descriptive in nature. These data are preliminary and are meant to provide a context for understanding the perceptions of stakeholders about renewable energy initiatives. Additionally, the results are not generalizable to the larger population due to the nature of focus groups. Although these data may not have large external validity, they will be used to guide and inform a future quantitative research about the adoption of renewable energy initiatives.

Further research about perceptions of renewable energy initiatives should take a more quantitative approach to examining the lay population’s perspective. Future research should also examine the influence that social norms and values have on a person’s likelihood to adopt a renewable energy innovation. Also, future research should examine how the effect of individuals’ perceived susceptibility and severity regarding climate change in tandem with their efficacy levels of using alternative energy sources will facilitate this adoption.

**Conclusion**

The Pew Center on Global Climate Change (2010) suggests that by failing to actively embrace renewable energy sources, particularly in the United States and other developed countries, there could be significant consequences affecting both the political and social structure of the nation. Regardless of the policies, agreements, and initiatives that are taking place at a national and global level, if stakeholders do not perceive renewable energy initiatives to be useful or compatible there will be resistance in the adoption of such innovations. The information gathered from these focus groups about the DOI attributes is a step in that direction and provides insight into what needs to be done in order for various stakeholder groups to accept and adopt renewable energy initiatives. By incorporating this information, campaigners and policy makers will be able to move toward a cleaner energy economy.

**Declaration of Conflicting Interests**

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.
Funding
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was funded through a Bioeconomy Initiatives and Science Literacy grant from the Michigan Agricultural Experiment Station.

References


Author Biographies

**Kami J. Silk**, PhD, is the associate dean of graduate studies and director of the master’s in health and risk communication program at Michigan State University. She earned her PhD from the University of Georgia.

**Allison Hurley**, MA, works at Tufts Medical Center in Boston as a marketing and communication specialist. She received her undergraduate and master’s degrees from Michigan State University.

**Kristin Pace**, PhD, is a social research scientist with Seattle & King County Public Health’s Local Hazardous Waste Management Program. She earned her PhD in communication from Michigan State University.

**Erin K. Maloney**, PhD, is currently a research director in the Center for Excellence in Cancer Communication in the Annenberg School for Communication at the University of Pennsylvania. She earned a PhD in communication from Michigan State University and completed a postdoctoral fellowship in the Department of Psychiatry and Behavioral Sciences at Memorial Sloan Kettering Cancer Center.

**Maria Lapinski**, PhD, is joint appointed as a professor in the Department of Communication and Michigan AgBio Research at Michigan State University. She is currently serving as the associate dean for research for the College of Communication Arts and Sciences. She received her doctorate from Michigan State University.