# ADOPTION OF SMART GRID TECHNOLOGIES BY COOPERATIVE UTILITIES

Report on findings from an online survey conducted by researchers from the School of Information Studies at Syracuse University

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## Adoption of Smart Grid Technologies by Cooperative Utilities

This report summarizes findings of an online survey of adoption of smart grid technologies by cooperative electric utilities. Researchers at Syracuse University, with the assistance of the National Rural Electric Cooperative Association (NRECA), conducted a 25-item survey-based assessment in 2014. Responses were elicited from individuals most qualified to provide opinions and reflections about the utility's perception and actions with regard to smart grid technologies. These are the responses received from 94 participants representing US electric cooperatives.[1]

### Key Findings

- Among respondents, the majority have deployed automated metering infrastructure (AMI) to most of their customers.
- The most widely deployed grid-side technologies are outage management systems (OMS), SCADA, meter data management systems (MDMS) and substation automation.
- The most widely deployed customer-side technologies are web portals, distributed generation support, pre-pay plans and dynamic pricing.
- Integration of technologies is generally low, except for integration of AMI with OMS and MDMS. Greater integration of AMI, MDMS and OMS with other technologies is planned.
- The main motivations for smart grid deployment are related to service quality, cost and operational efficiency.
- The leading obstacles to deployment are lack of funds and the belief that technologies are not sufficiently mature.

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[1] The sample is not necessarily representative of all US electric cooperatives.

- Top management and boards of directors are seen as generally supportive.
- The biggest organizational impacts of adoption are the need to acquire new skills and knowledge, the need for system integration efforts, and the need for process change.
- Cooperatives mostly look to develop new skills and expertise and learn about new technologies internally, but are more likely to use outside experts to decide how to implement new technologies.
- Cooperatives carefully review likely effects of technology change, but usually wait for technologies to mature before adopting. They are responsive to customer demands, but are less willing to take risks.

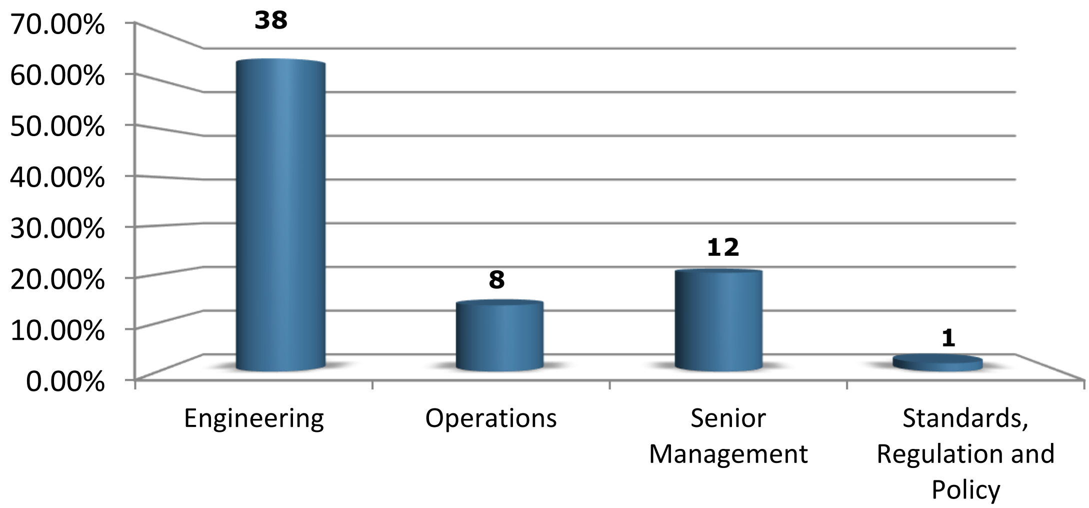
## 1.0 Participants Demographics

Cooperatives from 38 states were represented (see Appendix 1). States with the most respondents were Texas (n=7), followed by Georgia, Indiana, Missouri, and North Carolina (n=6 for these states), Colorado and Iowa (n=5 for both states). Represented states were grouped based on retail competition. Most of the respondents were from states without retail competition (n=28). There were respondents from 9 retail competition states and 1 state under suspended retail competition regulation.

Most respondents were either lower-level managers or group leaders from cooperative utilities. From the representatives, 61 of 94 participants answered the survey question about their position level in relation to the highest executive. Only 1 respondent was from the highest level. Most of respondents, 51% (n=31) were two levels below the highest position at the utility. The remainder of the participants 34.4% (n=21) were three levels below the highest executive in the utility.

Respondents also were asked to identify which department best described their location in the organizational structure. Only 63% (n=59) responded to this question. From these responses, over 60% of the participants (n=38) were part of the engineering department, followed by 20% (n=12) from senior management and 13% (n=12) from operations.

**Figure 1: Respondent departments**



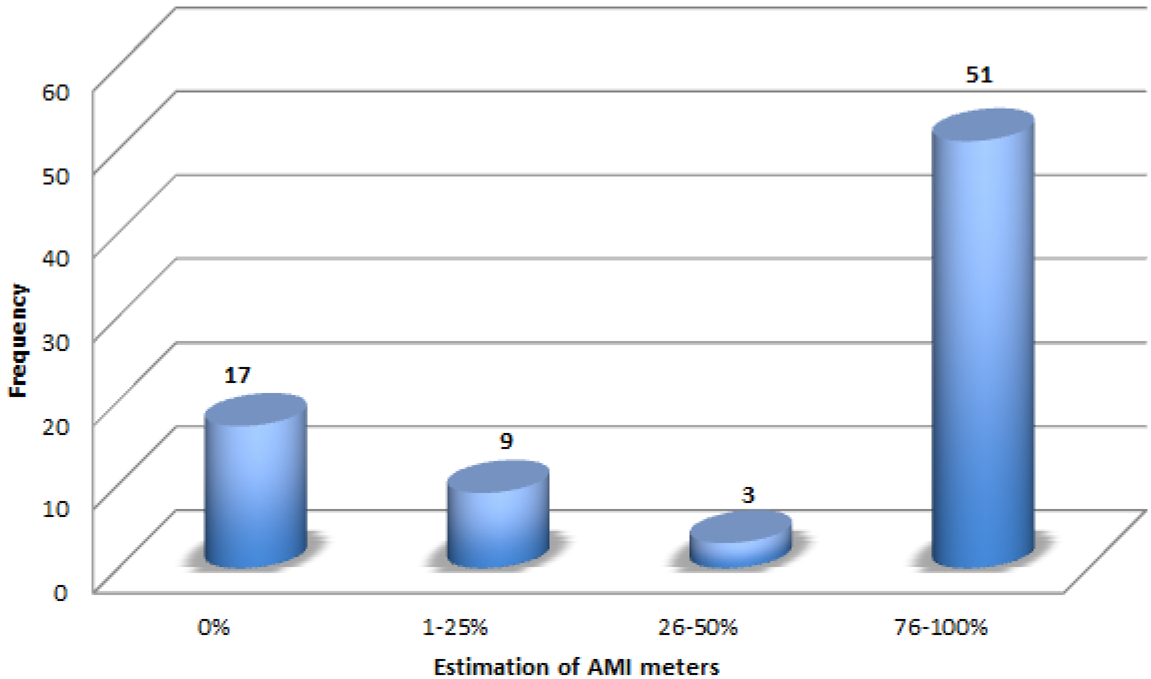

## 2.0 Deployment Status of Smart Grid Technologies

Approximately 80% (n=73) of the participants responded to the extent of deployment of smart grid technologies by their respective utilities.

### Advanced Metering Infrastructure Deployment

The majority of the respondents (n=51) indicated that their utilities had fully deployed or were in the final stages of advanced metering infrastructure (AMI) deployment (See Figure 2). However, there were 17.5% (n=14) who had not initiated AMI deployment.

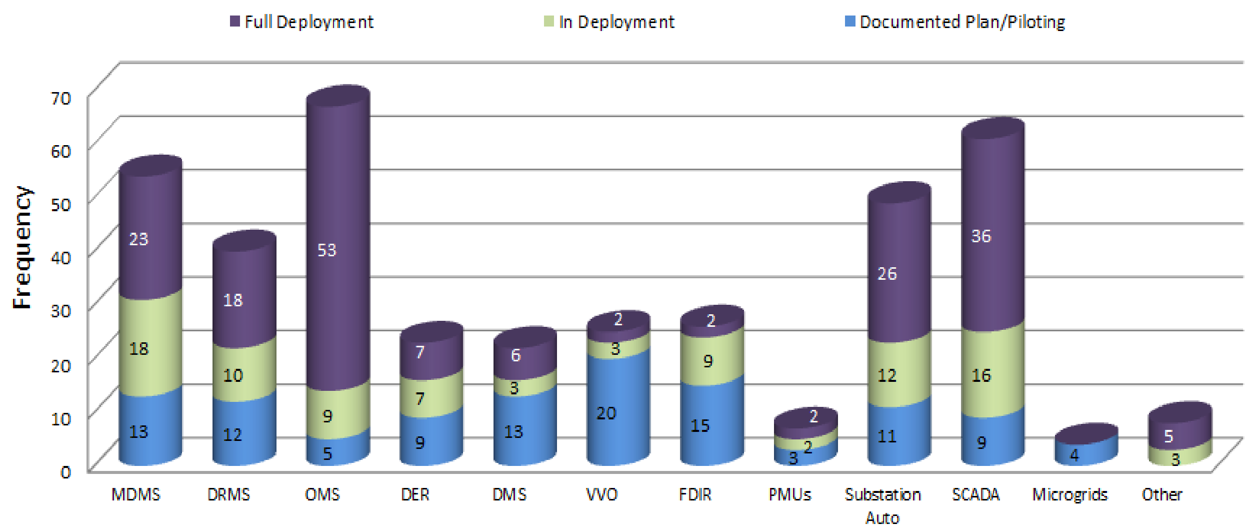
**Figure 2: Estimation of AMI Deployment**




## Deployment of Grid-Side Technologies

Most cooperatives in this sample have not begun deploying many grid-side technologies. Deployment of outage management systems (OMS) was most advanced compared to other technologies. About 74% (n=53) of the cooperatives had fully deployed OMS; 12.5% (n= 9) indicated deployment was in progress, and approximately 7% (n=5) had a documented plan or were piloting. Other noteworthy deployment by cooperatives are two-way SCADA control systems, substation automation and meter data management system (MDMS). See figure 3.

**Figure 3: Deployment Status of Grid Side Technologies**

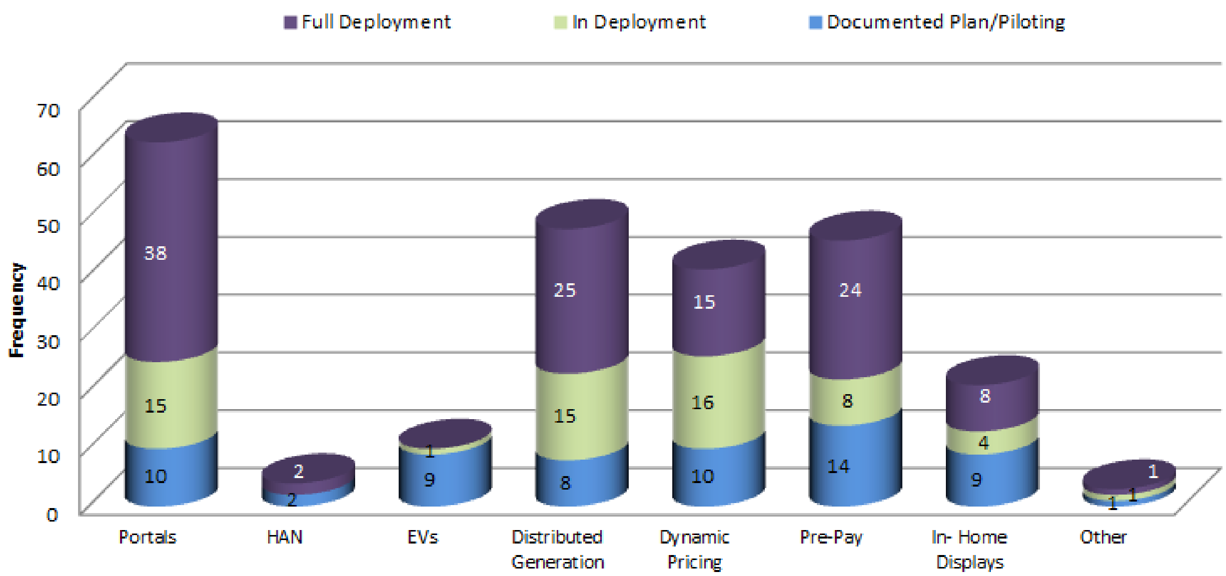



## Deployment of Customer-Side Technologies

From the 73 participants who responded on deployment level of customer-side technologies, only few had plans in place (see Fig 4). Most of the respondents indicated deployment plans for customer web-based portals, distributed generation, dynamic pricing and pre-paid service plans. Customer web-based portals was the most widespread technology in use, with 52% (n=38) of utilities having fully deployed and 20% (n=15) in deployment. About a third of utilities had fully deployed distributed generation programs (n=25) and pre-paid programs (n=24). About 20% (n=15) have deployed dynamic pricing and 21% (n=16) indicated that this was in deployment. Technologies such as home area network (HAN), electric vehicles (EV), and in-home displays were apparently still in the pre-planning stages, and most respondents indicated that there were no deployment plans of these technologies. About 95% (n=69), 86% (n=63) and 71%

(n=52) indicated that there were no deployment plans for HAN, EV or in-home displays respectively. Three respondents listed other technologies such as A/C load control, remote service disconnect and outage entry via text/web deployed or in deployment.

**Figure 4: Deployment Status of Customer Side Technologies**

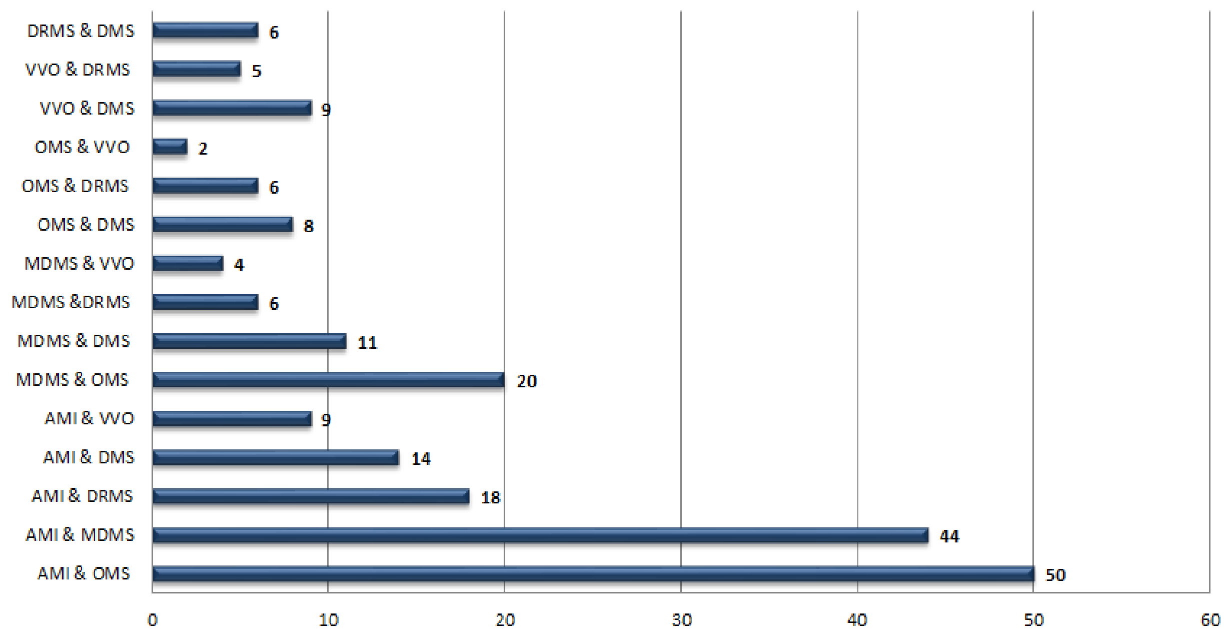



## Current System Integration

Respondent were asked to indicate which of the current systems were integrated (Figure 5). There was a 74% (n=70) response rate to this question. From the responses, it was evident that most of technologies were yet to be integrated. AMI had experienced the highest level of integration. The highest occurrences were between AMI and OMS at 71% (n=50) and AMI and MDMS 62% (n=44). Integration of AMI and other systems were less prominent; demand response management system (DRMS) 26% (n=18), distribution management system DMS 20% (n=14) and volt-var optimization (VVO) 13% (n=9). MDMS was the other system that was substantially integrated. Besides AMI, this system was integrated with OMS 29% (n=20), DMS 16% (n=11), DRMS 9% (n=6) and VVO 6% (n=4). Besides AMI and

MDMS pairing, in some cases OMS was also paired with DMS 11%(n=8), DRMS 8% (n=6) and VVO 3% (n=2).

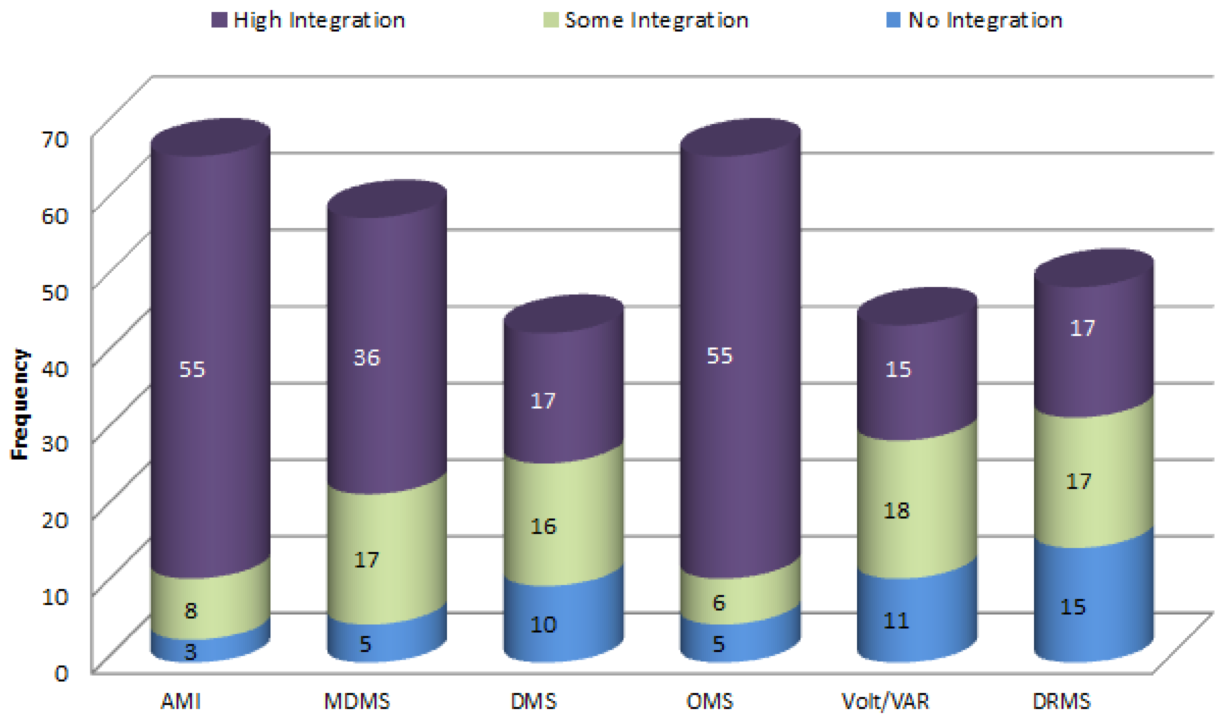
**Figure 5: Paired Integration of SG Technologies (number of respondents)**




## Integration Plans for each SG Technology

As seen above, many existing technologies are not yet integrated. In anticipation of this, the researchers wanted to get a better sense of future integration plans. See Figure 6. Participants were asked to determine their future integration plans on a scale from 1 to 5. Only 73% (n=69) of the participants responded to this question. Most respondents, (80%) saw the need for high integration of both AMI and OMS. These integration efforts were part of their current plans. MDMS was the other technology where 52% (n=36) expressed the need for high integration and 24% (n=17) saw the need for some integration. Most respondents indicated that the integration of technologies such as DMS, VVO and DRMS was not a high priority compared to other technologies.

**Figure 6: Integration plans of each SG Technologies**




## 3.0 Motivations and Obstacles Influencing Smart Grid Adoption

Participants were asked to share their motivations and obstacles that lead toward the adoption of smart grid technologies. The response rate for these questions were approximately 71% (n=67).

### Motivations for adopting SGTs

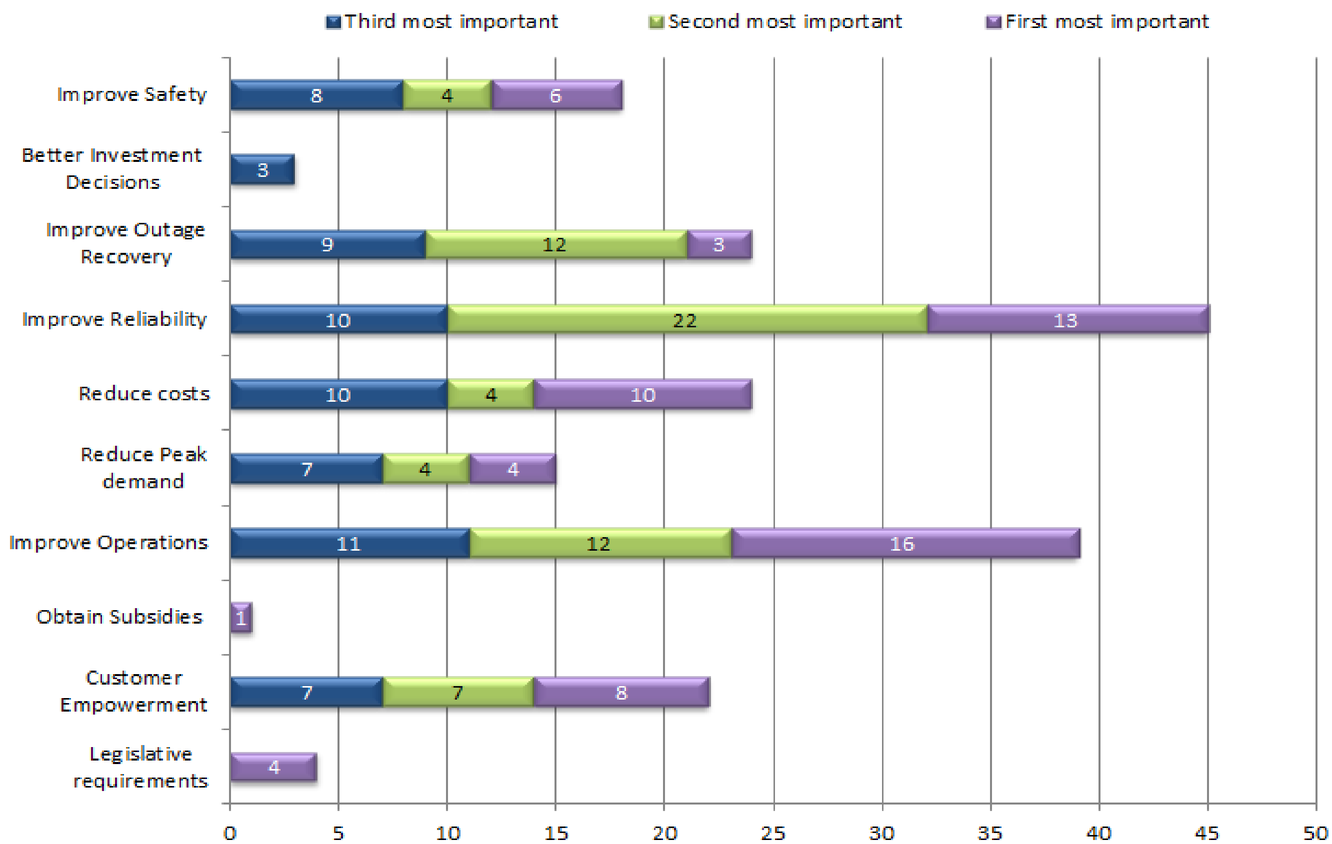
The main motivations (see Table 1) that respondents labelled as most important were linked to improving service and operational efficiency. Specific motivational goals that were labelled as very important were improving outage recovery (n=64), reliability (n=62), operational efficiency (n=56), and communication and safety for field workers (n=56), and reducing operational costs (n=54) and peak demand (n=51).

**Table 1: Organizational Motivations for SG Technologies Adoption (number of respondents)**

| Motivations | Some Importance | Important | Very Important |
|---|---|---|---|
| Meet legislative and regulatory requirements | 35 | 17 | 15 |
| Keep up with industry peers | 29 | 23 | 5 |
| Empower customers to control their energy use | 2 | 29 | 35 |
| Obtain government subsidies and grants | 49 | 11 | 6 |
| Improve operation efficiency | 2 | 9 | 56 |
| Reduce peak demand | 9 | 7 | 51 |
| Reduce costs | 3 | 10 | 54 |
| Improve reliability | 1 | 4 | 62 |
| Improve outage recovery | 0 | 3 | 64 |
| Integrate centralized renewables | 44 | 23 | 0 |
| Accommodate distributed generation | 38 | 25 | 4 |
| Accommodate electric vehicles | 59 | 6 | 2 |
| Make better capital investment decision | 8 | 28 | 31 |
| Improve safety and communication for field workers | 3 | 8 | 56 |

Respondents were asked to rank three of their motivations based on importance (see Fig. 7). Reliability was the top motivator, ranked by 29% (n=13) as the first most important, 49% (n=22) as the second most important and 22% (n=10) as the third most important. This was followed by improvements in operational efficiency where 41% (n=16) ranked this motivator as the most important followed by 31% (n=12) and 28% (n=11) viewing this as second and third most important respectively.

**Figure 7: Rankings of Organizational Motivations for SG Adoption (number of respondents)**




## Obstacles to adoption of SGTs

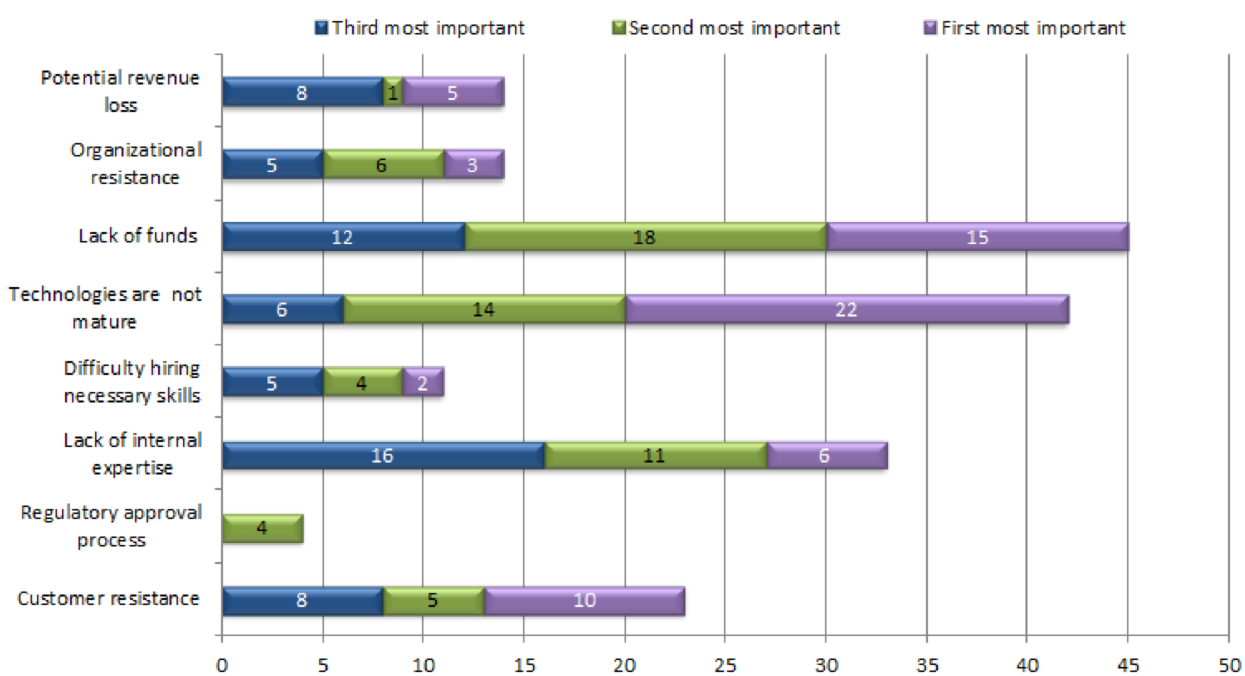
Participants were asked to rate the importance of a selection of obstacles that affected the adoption of smart grid technologies (Table 2). Most respondents indicated that technology immaturity (n=29 and lack of funds (n=30) were very important in hindering adoption.

When asked to rank the top three obstacles (Figure 8); lack of funds to implement was chosen the most times with 33% (n=15) ranking as the most important, 40% (n=18) as the second most important and 27% (n=12) as third most important. Technologies not being mature enough was seen as the most important by 52% (n=22) of the respondents to this question.

**Table 2: Organizational Motivations for SG Technologies Adoption (number of respondents)**

| Obstacles | Some Importance | Important | Very Important |
|---|---|---|---|
| Customer resistance | 31 | 25 | 9 |
| Regulatory approval process | 45 | 11 | 10 |
| Lack of internal expertise | 25 | 27 | 14 |
| Difficulty hiring with necessary skills | 31 | 19 | 16 |
| Technologies are not mature | 18 | 19 | 29 |
| Lack of funds to implement | 13 | 23 | 30 |
| Organizational resistance | 33 | 25 | 8 |
| Potential revenue loss | 31 | 20 | 15 |

**Figure 8: Rankings of Organizational Motivations for SG Technologies Adoption (number of respondents)**




## 4.0 Operating Environment

Respondents were asked to answer questions on competition they faced and their views about their board of directors. Approximately 69% (n=65) participants responded to these questions.

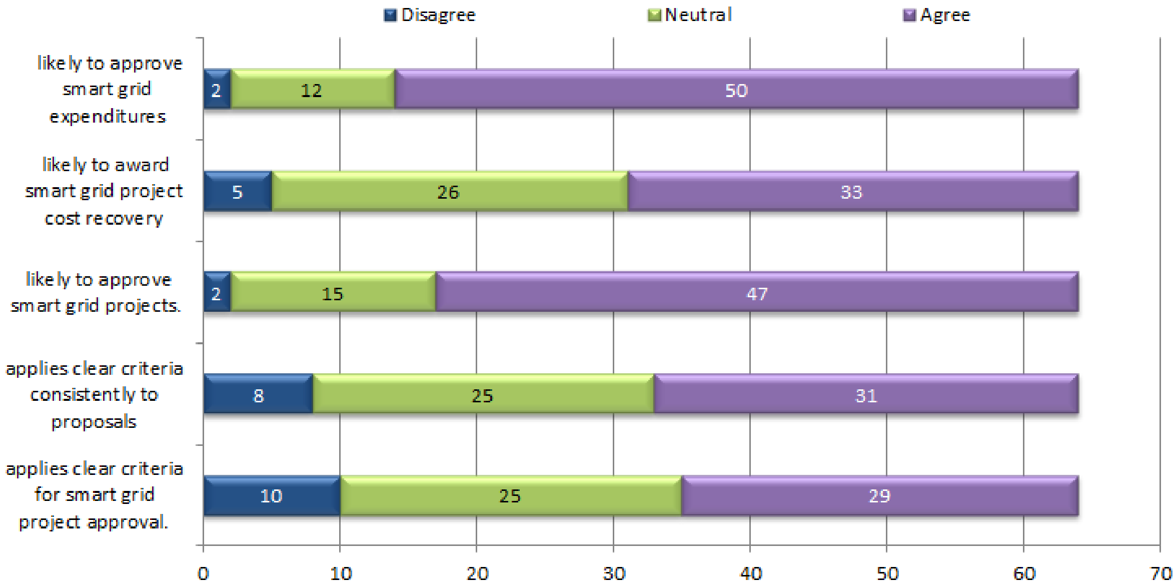
## Competition

About 23% (n-15) of the participants stated that they faced direct competition. Eight of the respondents indicated that they had one competitor, five cooperative utilities had two competitors and two encountered four competitors. Of those who indicated facing direct competition they estimated that competitors deployment of smart grids was 26-50% (n=6) and 76-100% (n=5) completed.

## Board of Directors Attitude to SGTs

Electric cooperatives are not usually state regulated and provide services solely to their members. Major decisions need approval by the membership, which is represented by an elected board of directors. Respondents were asked to specify their level of agreement or disagreement about their board of directors' attitudes to SG technologies (Figure 9). About 78% (n=50) of the participants agree that their boards of directors are likely to approve smart grid expenditures and 52% (n=33) agree that they are likely to award smart grid project cost recovery.

**Figure 9: Board of Directors Attitudes Towards SG Technologies Adoption (number of respondents)**



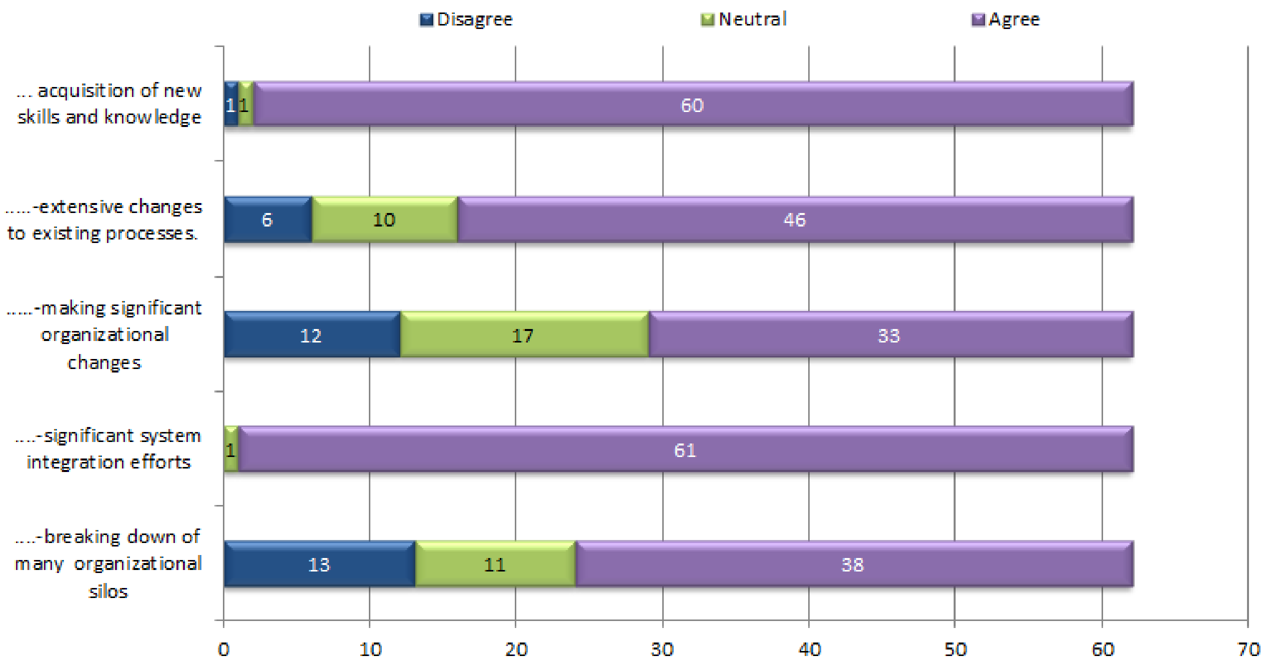

## 5.0 Organizational Perspectives

This section of the survey addressed questions about organizational characteristics such as the nature of top management, level of existing expertise, organization culture that fosters innovation and flexibility to adaptation. Approximately 66% (n=62) of participants responded to this section of questions

### Organizational Impacts of Smart Grid Adoption

Respondents were asked about the varied impacts of SG technologies adoption. Most agreed that adopting and implementing smart grid technologies requires significant integration efforts (98%) as well as the acquisition of new skills, and knowledge (97%) (Figure 10). Approximately 68% (n=38) saw the need for the breaking down of organizational silos. Interestingly about 74% (n=46) of the respondents saw the need for extensive changes to existing processes but only 53% (n=33) saw the need for significant organizational changes.

**Figure 10: Organizational Impacts of SG Technologies Adoption (number of respondents)**




Respondents were asked about how their organization acquires knowledge and skills. To elicit the information the respondents were given two scenarios, and asked to choose the option their company were most likely to elect (Table 3). When there was a need for new skills and expertise 77% (n=48) indicated that their preference was to train current staff as opposed to using temporary or contract workers. When there was a need to implement new technologies, 75% (n=47) participants said that their preference was to reach out to outside expertise as opposed to conducting R&D internally. However, when there was a need to learn about new technologies and the impact it can have on the business 79% (n=49) indicated that they were more likely to send their staff to conferences as opposed to hiring consultants or outside expertise.

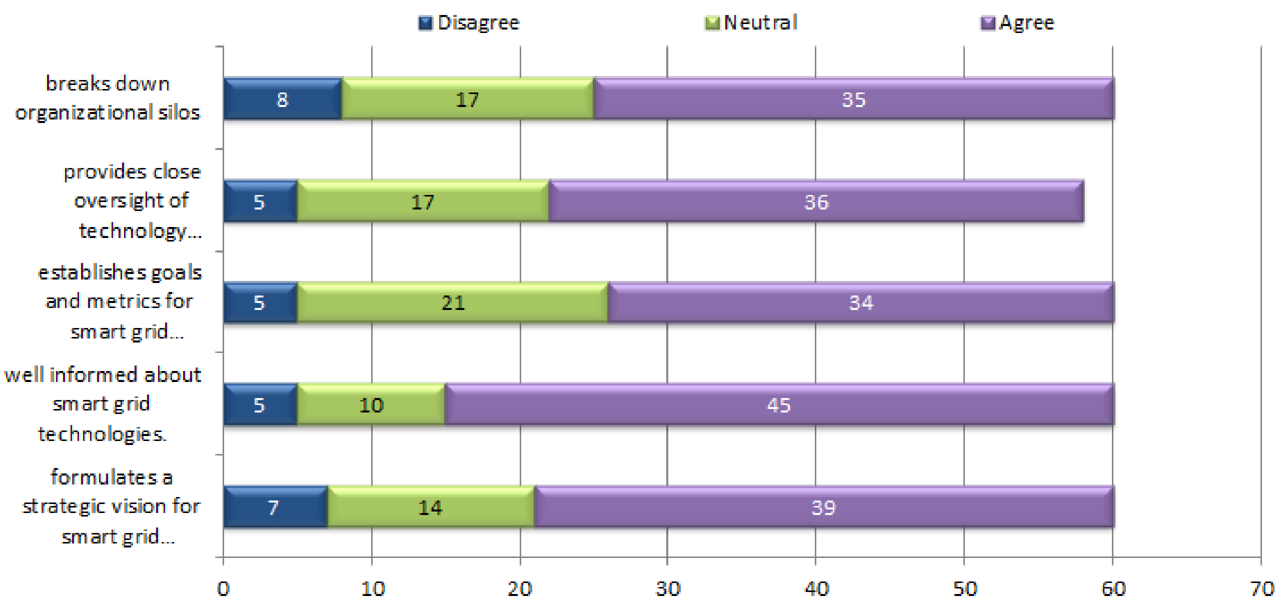
**Table 3: Organization Choices to Acquire Knowledge and Skills**

| When new skills or expertise is needed to complete an important project, we a likely to …. | | When we decide how to implement new technologies, we are more likely to… | | When we need to learn about new technologies and their implications for our business, we are more likely to | |
|---|---|---|---|---|---|
| Train our current staff | Use temporary contract workers or consultants | Conduct R&D ourselves. | Reach out to outside expert | Send our own staff to conferences | Hire a consultant or other outside expert |
| **48** | 14 | 15 | **47** | **49** | 13 |

## Top Management Attitudes

Participants were asked to respond by indicating their level of agreement towards statements about top management or board of directors. Most participants indicated that top management had a positive attitude towards smart grid technologies (Figure 11). Most 75% (n=45) felt that the board of directors were well informed about smart grid technologies and 65% (n=39) indicated that they formulated a clear strategic vision for smart grid deployment. To a lesser degree, 60% (n=36) agreed that their board provides close oversight of technology deployment, 58% (n=35) assisted in breaking down organizational siloes and 56% (n=34) establishes goals and metrics for SG technology deployment.

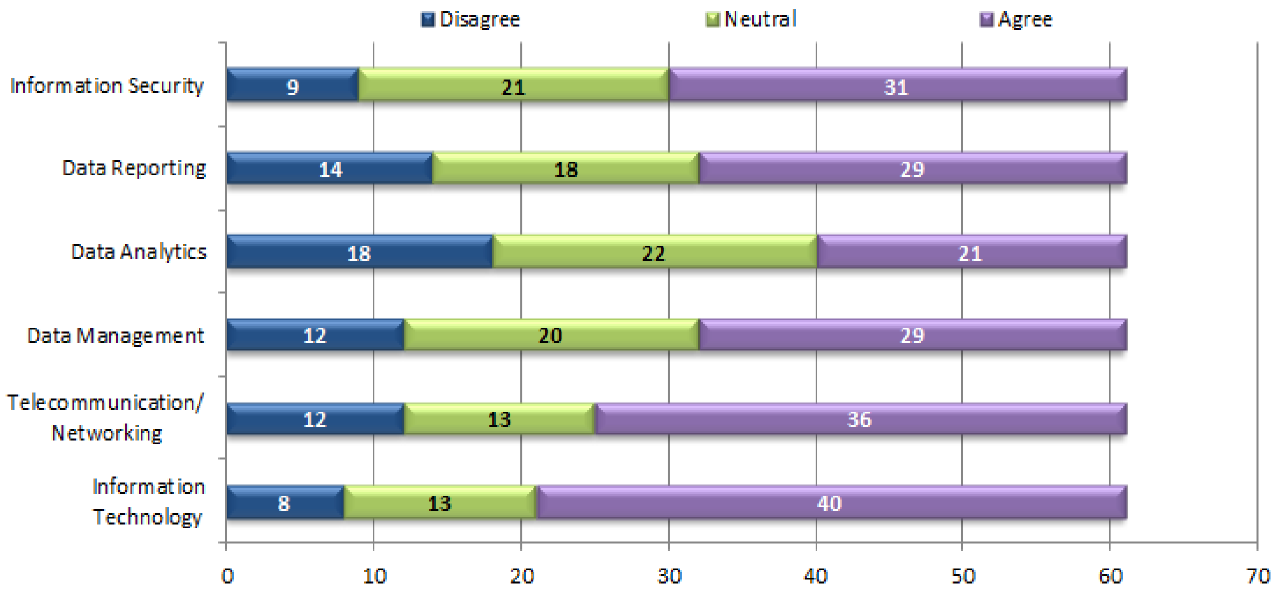
**Figure 11: Top Management Attitude Towards SG Technologies (number of respondents)**




## Organizational Expertise

Participants were asked to respond to statement about their organization level of expertise in the areas shown in Figure 12. Most participants, 65% (n=40) were confident in their expertise in information technologies and 58% (n=36) on telecommunications and networking. About 50 % (n=31) were assured in their expertise in information security. Expertise in data related technologies and skills were lower compared to others proficiencies. Only 33% (n=21) indicted that they had expertise in data analytics, and 46% (n=29) in data reporting and management.

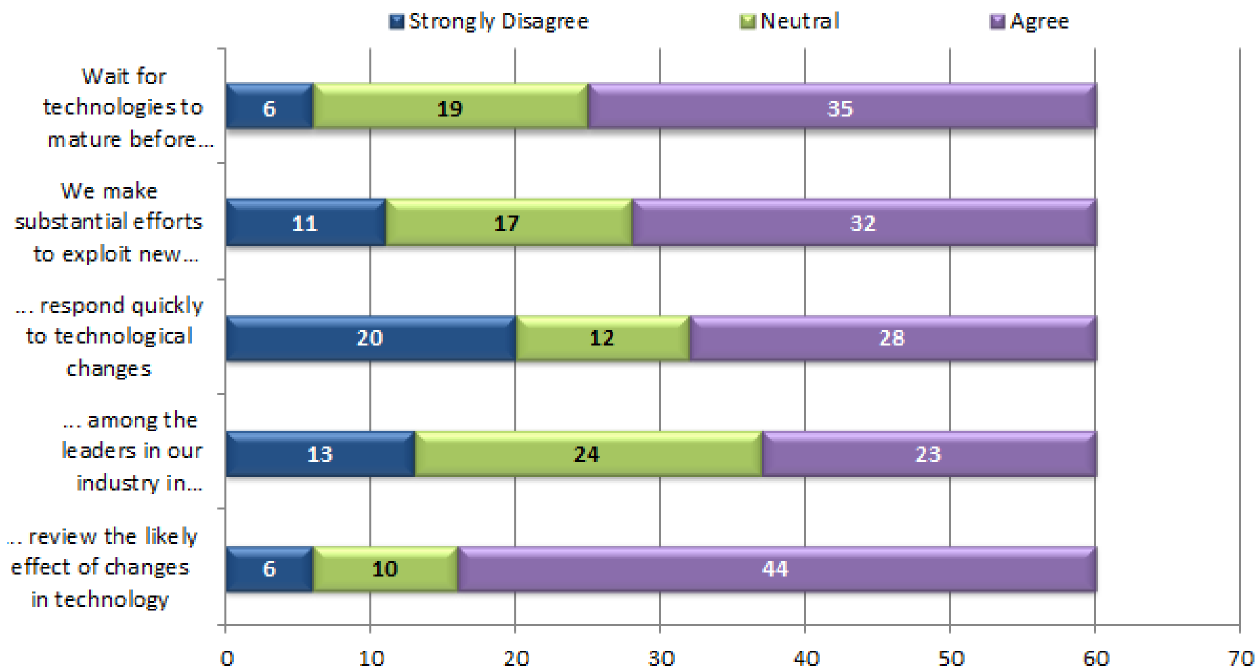
**Figure 12: Organizational Expertise (number of companies)**




## Organization Culture and Practices

Organizational culture is regarded as the collective programming of the mind that influences practices. Participants were asked to respond to statements that reflect their culture (Figure 13). Most participants 73% (n=44) indicated that their organization are periodically review the possible effects of changes in technologies in the business. However, about 68% (n=35) stated that their organization prefers to wait for technologies to mature before adoption while 53% (n=32) indicated that they make substantial efforts to exploit new technologies. Only 47% (n=28) indicated that they generally respond quickly to technological changes and 38% (n=23) saw themselves as leaders in the industry especially when it came to detecting technological changes that may affect the business.

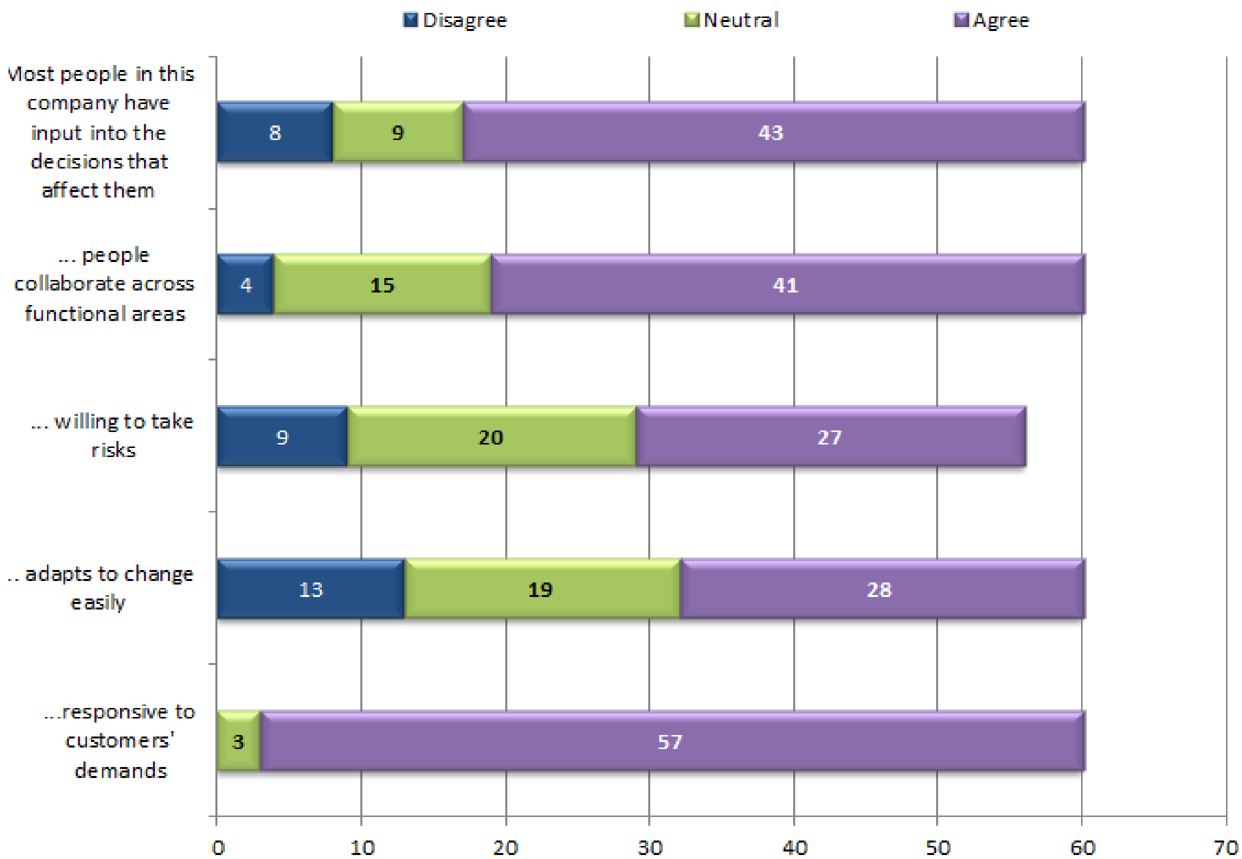
**Figure 13: Organizational Culture and Practices (number of companies)**




## Organization Adaptability

Participants were asked to respond to statements about adaptability of their organization to change (Figure 14). Most respondents 95% (n=57) felt that their organization was responsive to customer's demands. It was noteworthy that participants felt that most people in the company had input in the decision making process (72%) and people collaborated across functional areas (68%). A smaller percentage 46% (n=28) agreed that their organization as adapted to changes easily and when it came to taking risks only 45% (n=27).

**Figure 14: Organizational Adaptability (number of companies)**




## 6.0 Future Directions

The importance of smart grid and understanding all aforementioned issues around adoption drives this study. The researchers aim to explore the factors that play a key role in smart grid technologies adoption and resulting policy settings. The move to a smarter electricity network affects the industry in numerous ways as communication and data management play a more important role. Only through continued research activities can foundations be laid to better understand implications and resulting changes. This is the first report from our efforts to understand smart grid adoption.

The findings documented in this report are limited to responses received from a sample of U.S. electrical cooperatives. Other reports will follow that will focus on municipals and investor owned utilities.

## Appendix 1

### States Represented in Survey

| States | Number of Respondents |
|---|---|
| **No Retail Competition States** | |
| AL, FL, HI, LA, MN, NE, OK, SD, UT, WY | 1 |
| AZ, AR, KS, KY, MT, NM, NY, SC | 2 |
| MS, WA, WI | 3 |
| TN | 4 |
| CO, IA | 5 |
| GA, IN, MO, NC | 6 |
| **Retail Competition States** | |
| DE, IL, MD, MI, NH, PA | 1 |
| OH | 2 |
| OR | 3 |
| TX | 7 |
| **Suspended Retail Competition States** | |
| VA | 3 |

# Appendix 2

## Glossary