ADOPTION OF SMART GRID TECHNOLOGIES BY MUNICIPAL 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 Municipal Utilities

This report summarizes findings of an online survey of adoption of smart grid technologies by municipal electric utilities. Researchers at Syracuse University, with the assistance of the American Public Power Association (APPA), 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 64 participants representing US municipal electric utilities[1]

Key Findings

- Among respondents, the majority have deployed automated metering infrastructure (AMI) to their customers and about two thirds of them are at an advanced stage.
- The most widely deployed grid-side technologies are two-way SCADA, substation automation, outage management systems (OMS), and meter data management systems (MDMS).
- The most widely deployed customer-side technologies are web portals and distributed generation support.
- Integration of technologies is generally low, except for integration of AMI with MDMS and OMS. Greater integration of AMI, MDMS and OMS with other technologies is planned.
- The main motivations for smart grid deployment are to reduce cost, empower customers, and improve operational efficiency.
- The main obstacles to deployment are lack of funds and the belief that technologies are not sufficiently mature.
- City councils and top management are seen as generally supportive.

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

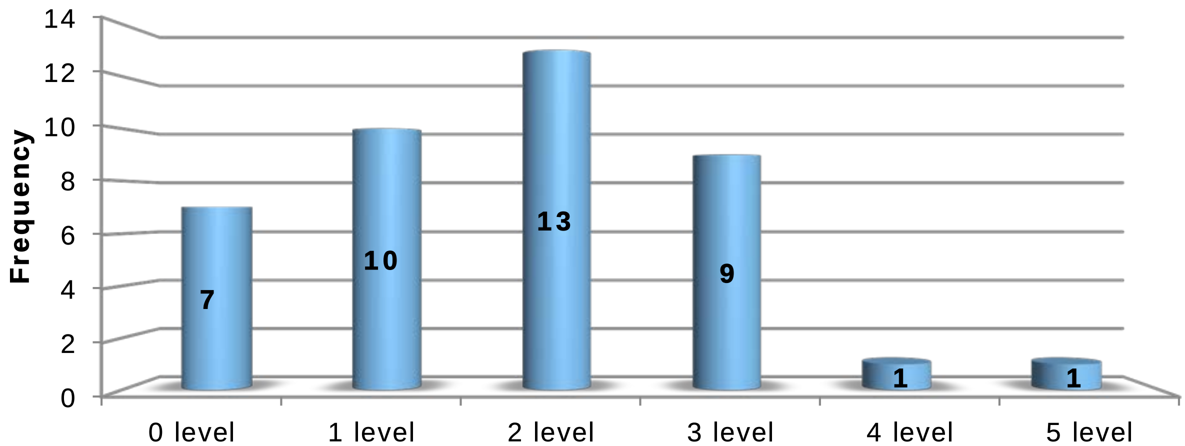
- The biggest organizational impact of adoption is the need for significant system integration efforts.
- Municipals have strong expertise in IT and telecommunications; however, they need new skills in data analytics, data management and data reporting.
- Municipals mostly look to develop new skills and expertise and learn about new technologies internally, but are more likely to use outside experts to decide how to implement new technologies.
- Municipals 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

Municipals from 28 states were represented (see Appendix 1). States with the most respondents were Tennessee and Massachusetts (n=6), followed by California (n=5). Represented states were grouped based on retail competition. Most of the respondents were from states without retail competition (n=37). There were respondents from 8 retail competition states and 2 states under suspended retail competition regulation.

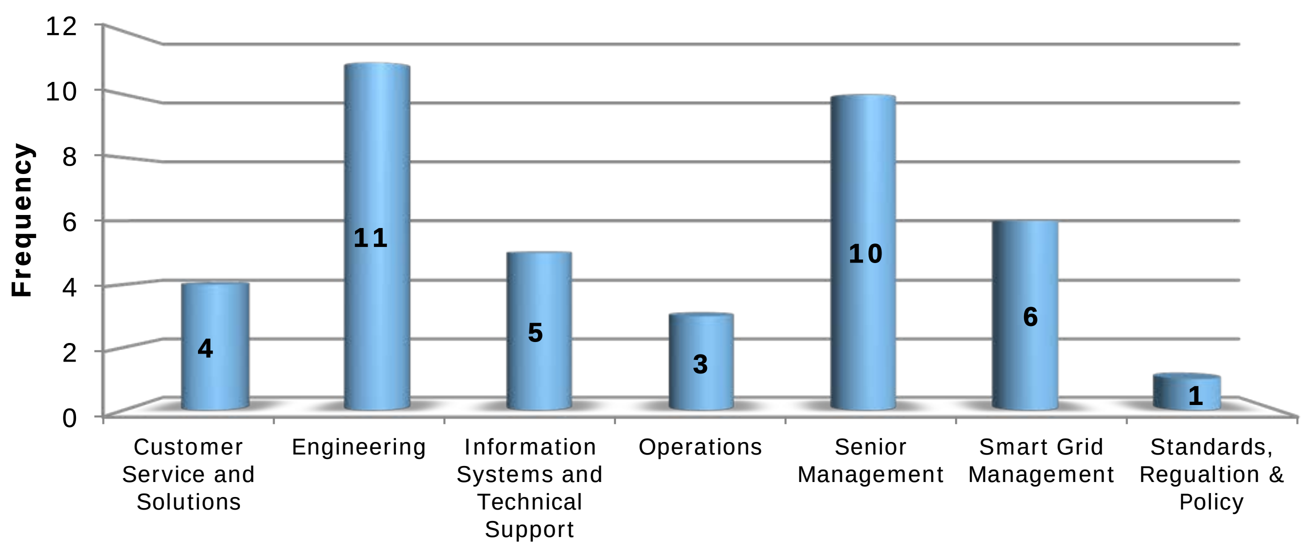
Most respondents were either middle-level managers or group leaders (see figure 1). From the representatives, 63% (n=41) answered the survey question about their position level in relation to the highest executive. 7 respondents were from the highest level. Most of respondents, 56% (n=23) were one or two levels below the highest position at the utility. 9 respondents were three levels below the highest executive in the utility. Only two participants were four and five levels below the highest executive in the utility, respectively.

Figure 1: Participants' level to the highest executive



Respondents also were asked to identify which department best described their location in the organizational structure (see figure 2). 63% (n=40) responded to this question and there was a great variety from these responses. 28% (n=11) and 25% (n=10) of the participants were from engineering department and senior management, followed by 15% (n=6) from smart grid management, 12% (n=5) from IT, 10% (n=4) from customer service, 8% (n=3) from operations and 2% (n=1) from regulation and policy department.

Figure 2: Respondent departments



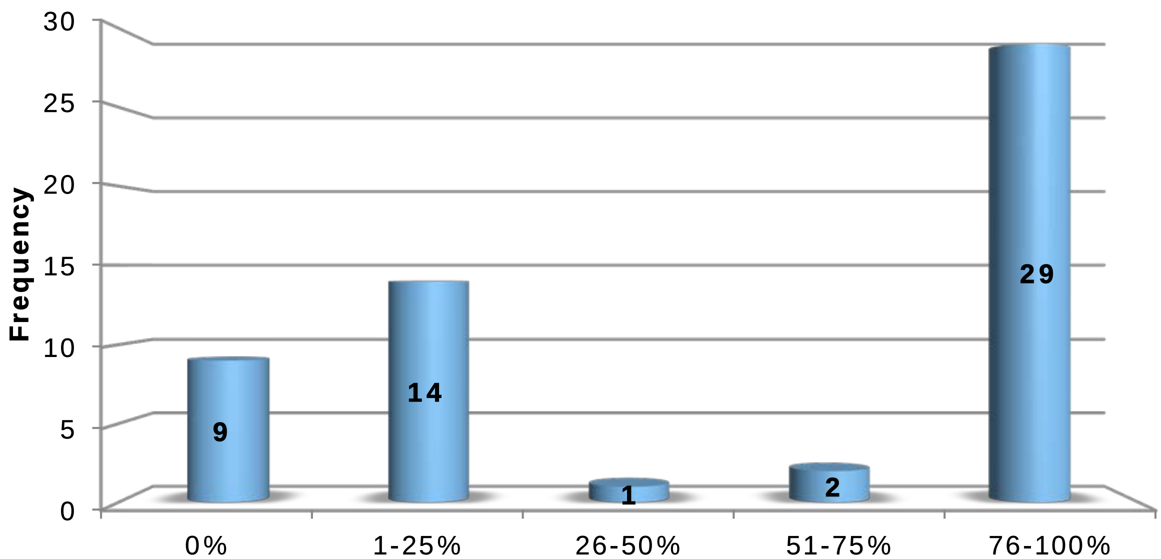
2.0 Deployment Status of Smart Grid Technologies

Approximately 86% (n=55) of the participants responded to the extent of AMI deployment of smart grid technologies by their respective utilities.

Advanced Metering Infrastructure Deployment

As shown in Figure 3 over half of the respondents (n=31) indicated their utilities had fully deployed or were in the final stages of advanced metering infrastructure (AMI) deployment. However, 27 % (n=15) of the respondents were still in the early stages and 16% (n=9) indicated they had not initiated AMI deployment yet.

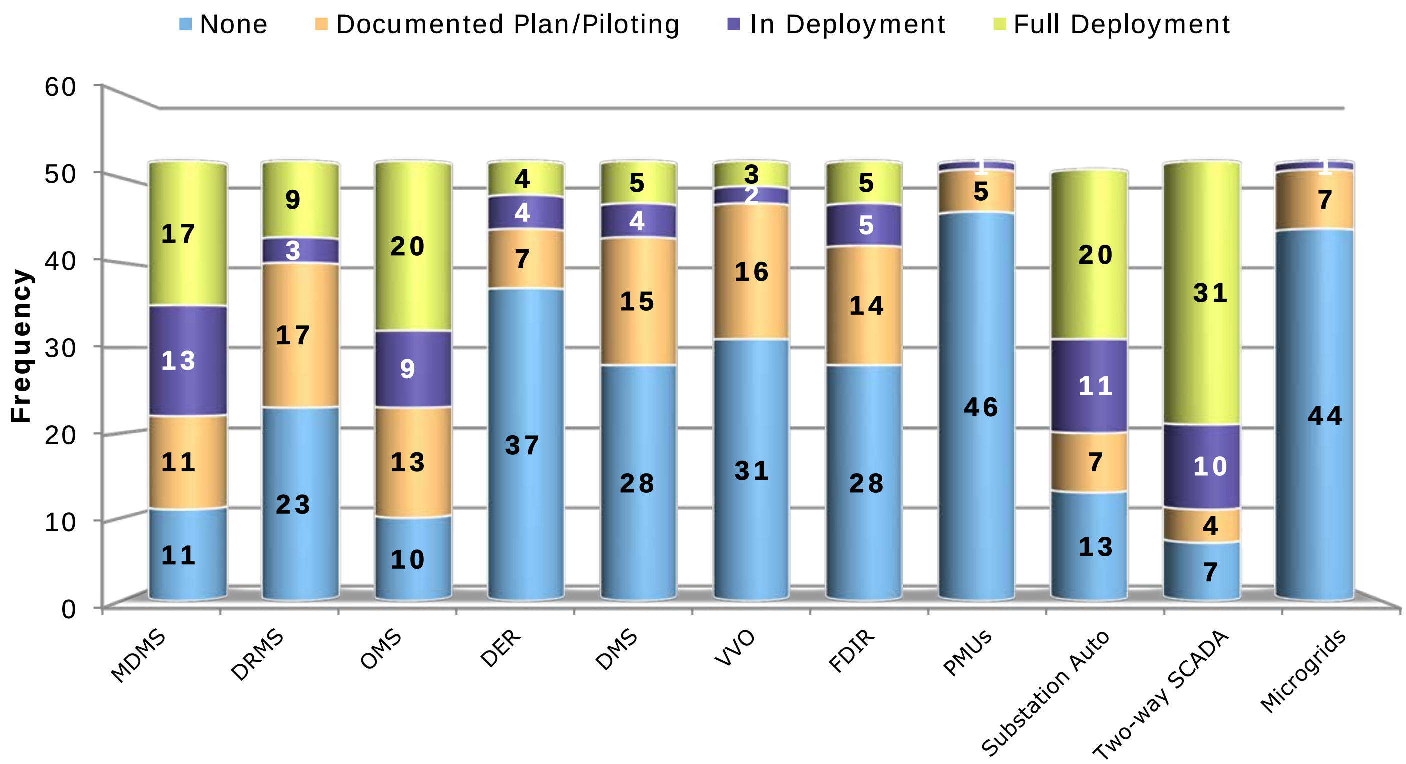
Figure 3: Estimation of AMI Deployment



Deployment of Grid-Side Technologies

Approximately 81% (n=52) of the participants responded to the extent of grid-side technology deployment (see figure 4). Most municipals in this sample were still in the early stage of deploying many grid-side technologies. Deployment of two-way SCADA was most advanced compared to other technologies. Other noteworthy deployments by municipals were substation automation, outage management system (OMS) and meter data management system (MDMS). The deployment of Phasor measurement unit (PMU) and micro-grids was minimal.

Figure 4: Deployment Status of Grid Side Technologies

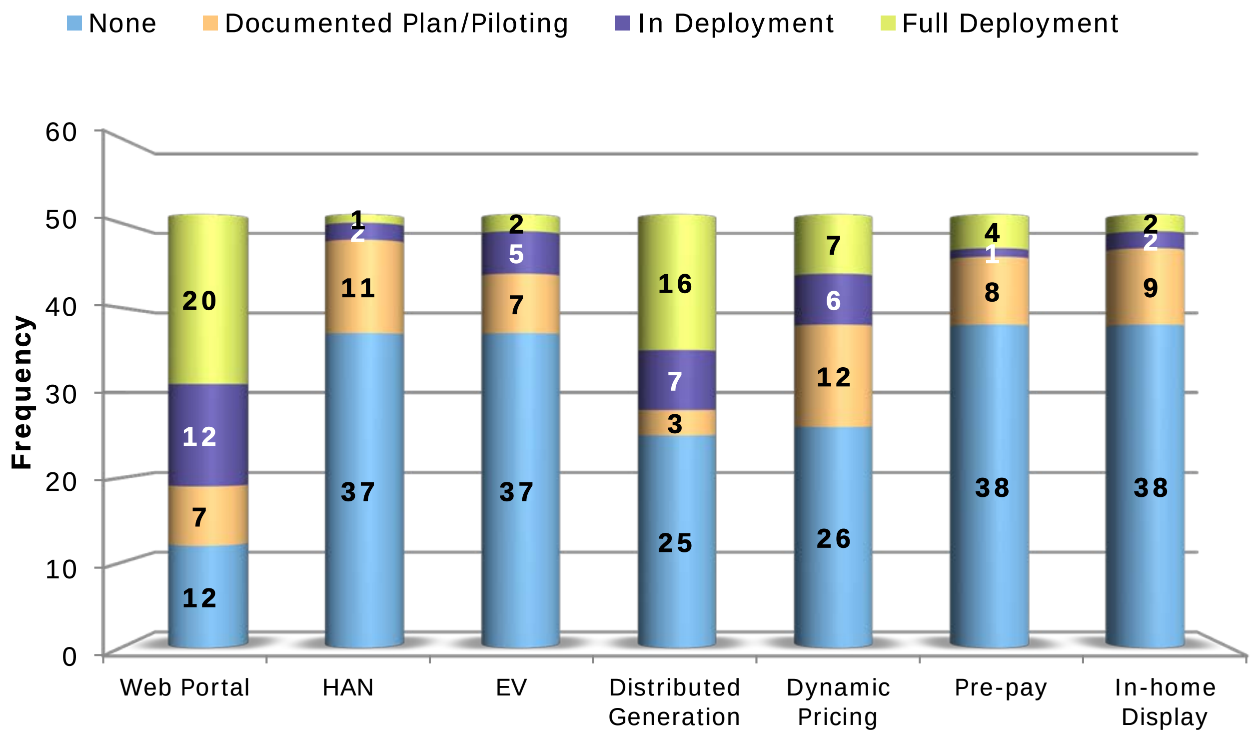


Deployment of Customer-Side Technologies

Approximately 80% (n=51) of the participants responded to the extent of customer-side technology deployment (see figure 5). Compared to AMI and grid-side technologies, the deployment of customer-side technologies was least advanced, as a great number of respondents didn't even have a deployment plan for most customer-side technologies. Customer web-based portals were the most widespread technology in use, with 40% (n=20) of utilities having fully deployed and 24% (n=12) in deployment. Distributed generation was also popular, with about a third of utilities having fully deployed distributed generation programs and 15% (n=16) in deployment.

Technologies such as dynamic pricing, home area network (HAN), electric vehicles (EV), pre-pay service and in-home displays were mostly still in the pre-planning stages, and most respondents indicated that there were no deployment plans for these technologies.

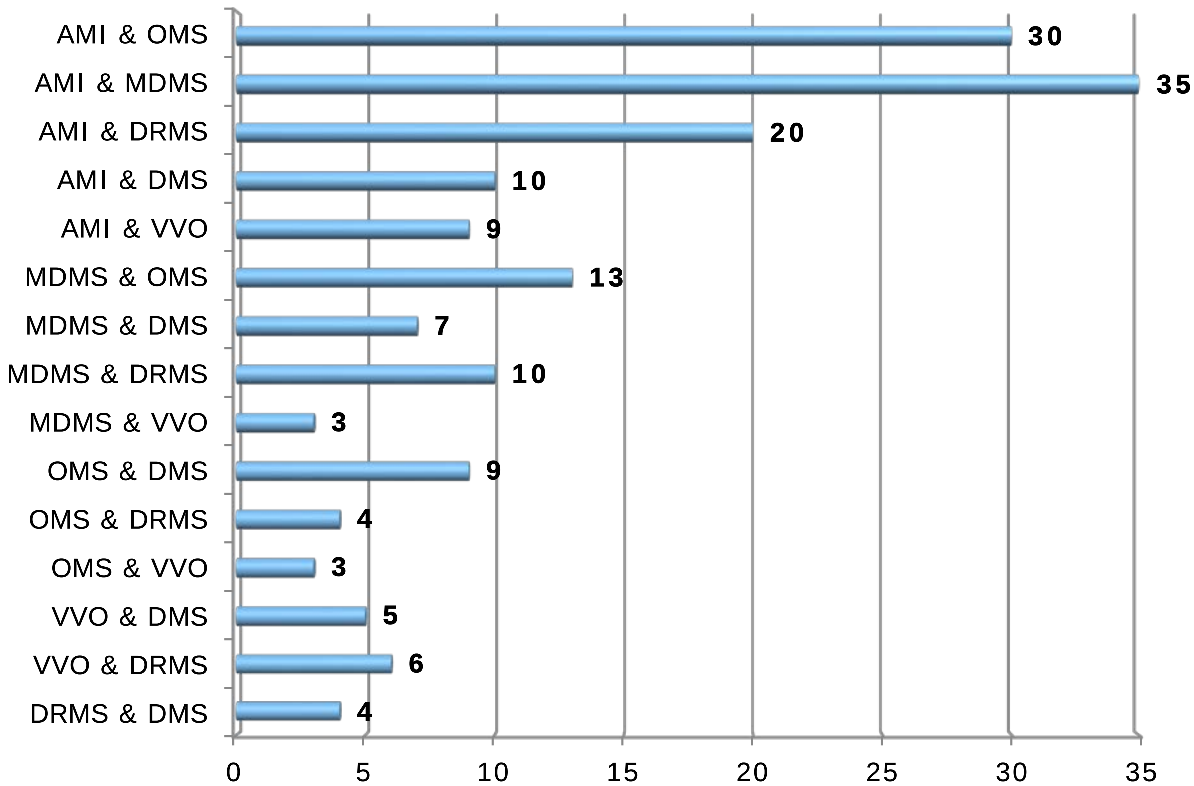
Figure 5: Deployment Status of Customer Side Technologies



Current System Integration

Respondents were asked to indicate which of the current systems were integrated (see figure 6). There was a 78% (n=50) response rate to this question. From the responses, it was evident that most technologies were yet to be integrated. AMI was most commonly integrated. The highest occurrences were between AMI and MDMS at 55% (n=35) and AMI and OMS 47% (n=30). Integration of AMI and other systems were less prominent; demand response management system (DRMS) 31% (n=20), distribution management system DMS 16% (n=10) and volt-var optimization (VVO) 14% (n=9). MDMS was the other system that was substantially integrated. Besides AMI, this system was integrated with OMS 20% (n=13), DRMS 16% (n=10), VVO 14% (n=9) and DMS 11% (n=7). Besides AMI and MDMS pairing, in some cases OMS was also paired with DMS 14%(n=9).

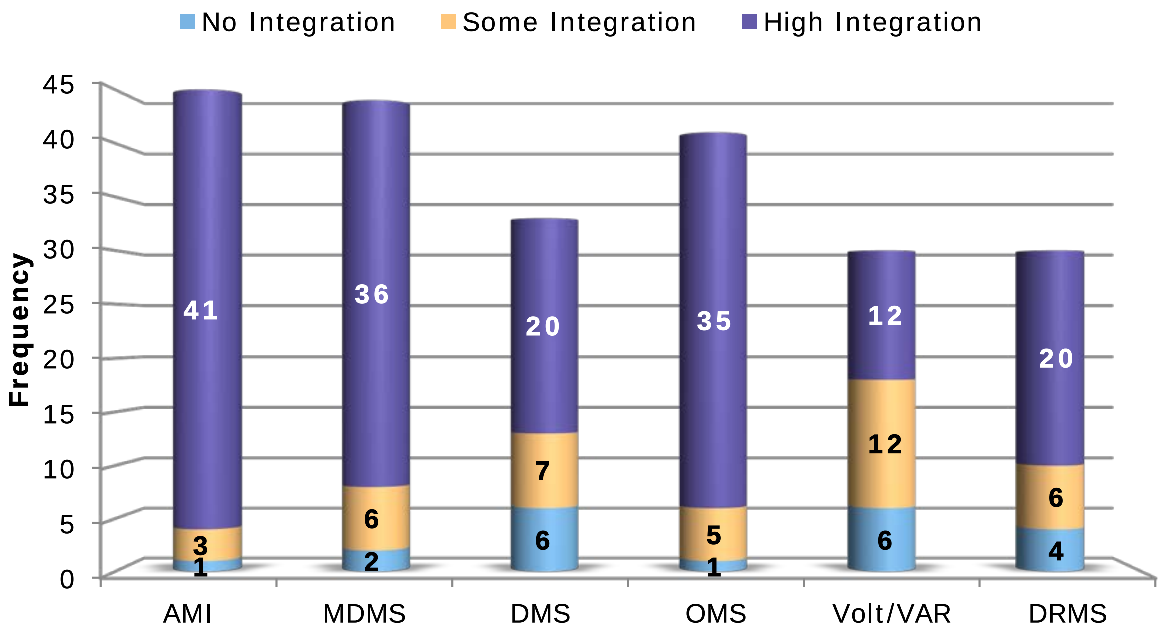
Figure 6: Paired Integration of SG Technologies (number of respondents)



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 7). Participants were asked to determine their future integration plans for six major smart grid technologies on a scale from 1 to 5. The responses ranged from 50% to 70%. Most respondents saw the need for high integration of AMI, MDMS and OMS. These integration efforts were part of their current plans. DMS and DRMS were also considered important to some respondents. The integration of VVO was not a high priority compared to other technologies.

Figure 7: Integration plans of each SG Technologies



3.0 Motivations and Obstacles Influencing Smart Grid Adoption

Participants were asked their motivations for and obstacles to the adoption of smart grid technologies. The response rates for these questions were approximately 67% (n=43).

Motivations for adopting SGTs

Most respondents indicated that improving outage recovery (n=41), improving reliability (n=41), improving operational efficiency (n=40), and reducing costs (n=40) were very important in encouraging smart grid adoption (see figure 8). Respondents were also asked to rank the top three motivations based on importance (see figure 9). Reducing costs was the top motivator, ranked by 18% (n=4) as the first most important, 55% (n=12) as the second most important and 27% (n=6) as the third most important. This was followed by improvements in operational efficiency, customer empowerment and reducing costs.

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

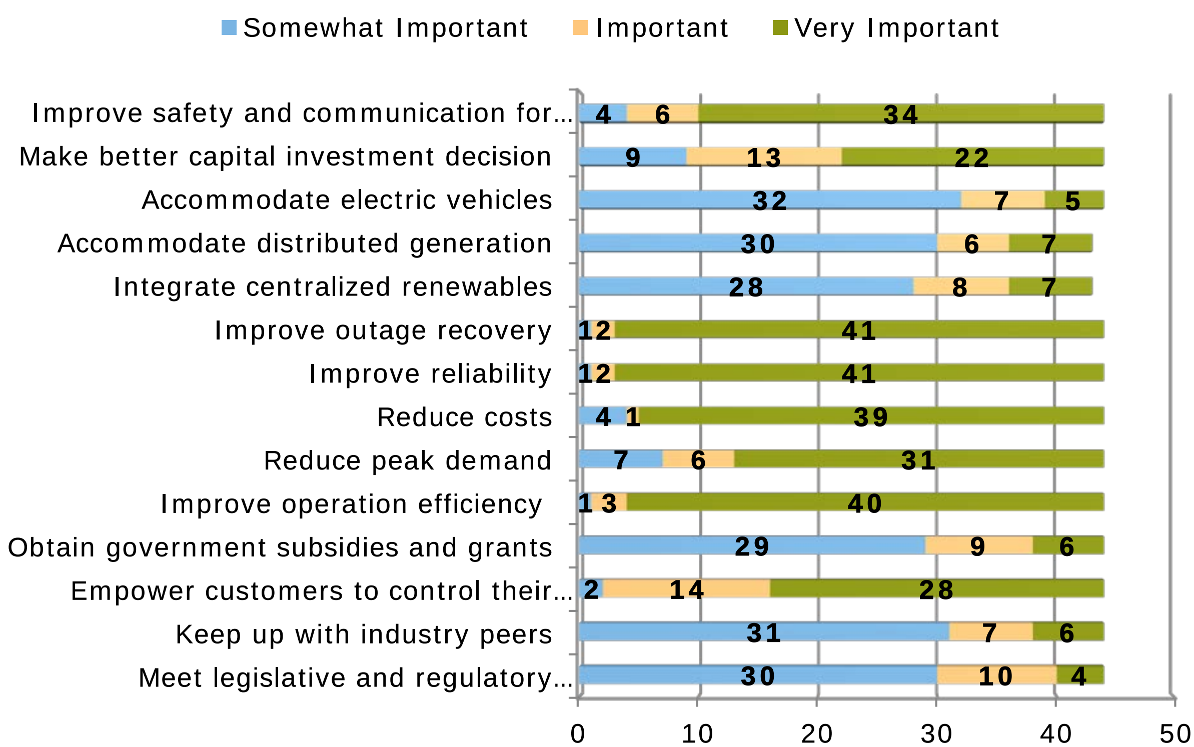
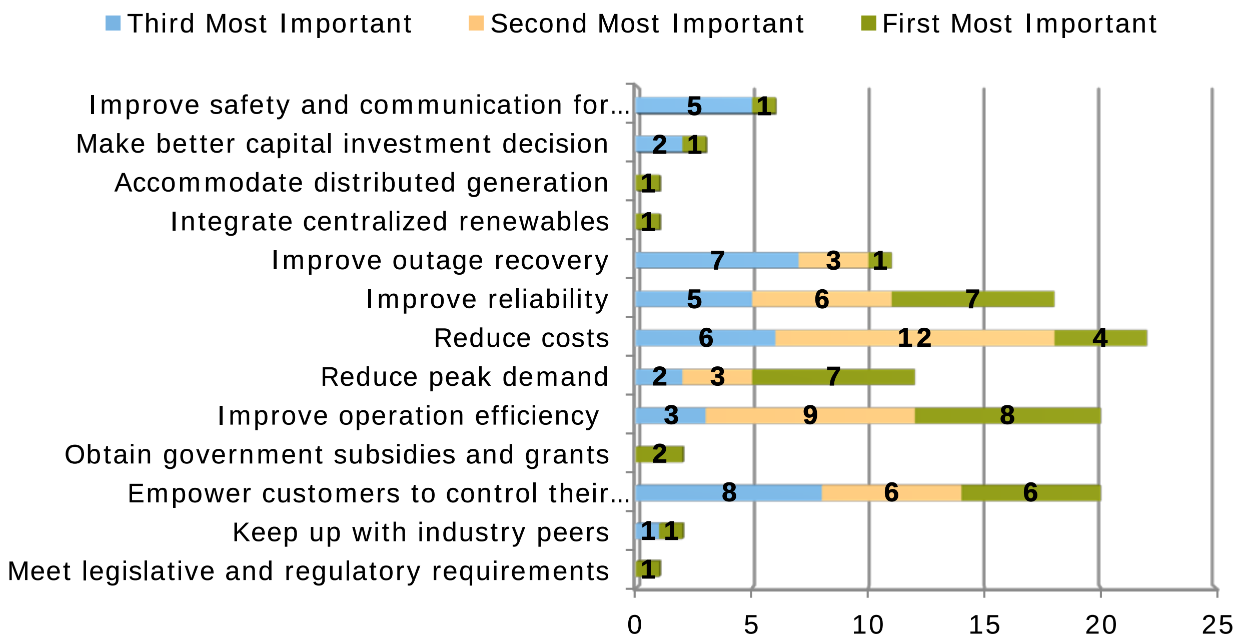


Figure 9: Rankings of Organizational Motivations for SG Adoption (number of respondents)



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 (see figure 10). Most respondents indicated that lack of funds to implement (n=19) and technology immaturity (n=17) were very important in hindering adoption. When asked to rank the top three obstacles (see figure 11); technology immaturity was chosen the most times with 43% (n=10) ranking as the most important, 39% (n=9) as the second most important and 18% (n=4) as third most important. This was followed by lack of funds to implement and lack of internal expertise.

Figure 10: Organizational Obstacles to SG Technologies Adoption (number of respondents)

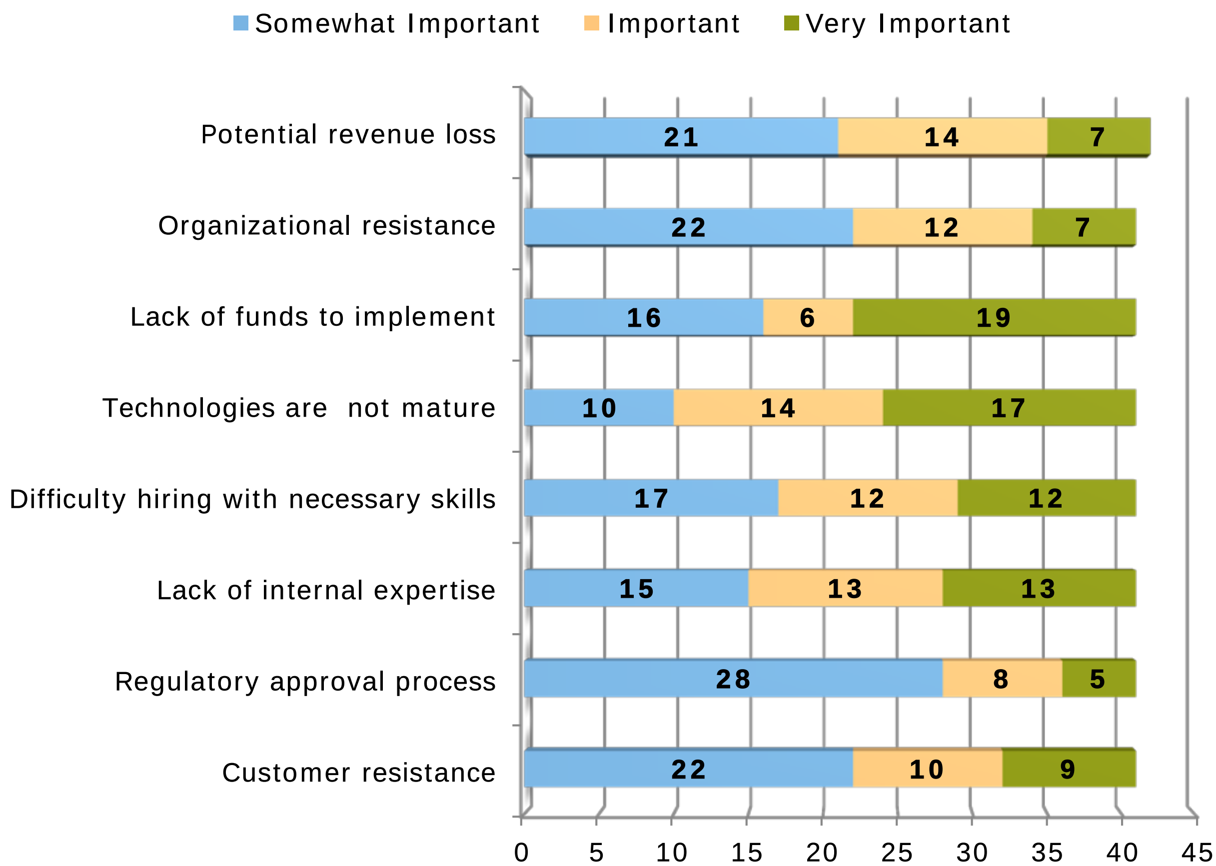
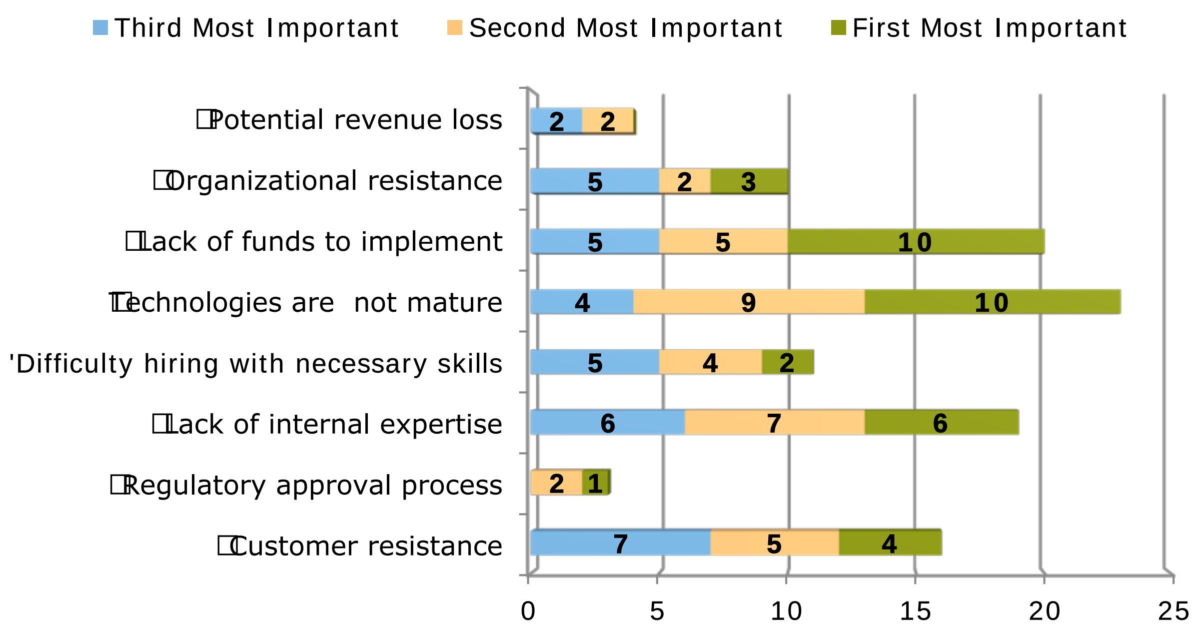


Figure 11: Rankings of Organizational Obstacles to SG Technologies Adoption (number of respondents)



4.0 Operating Environment

Respondents were asked to answer questions on competition they faced and their views about their board of directors. Approximately 64% (n=41) participants responded to these questions.

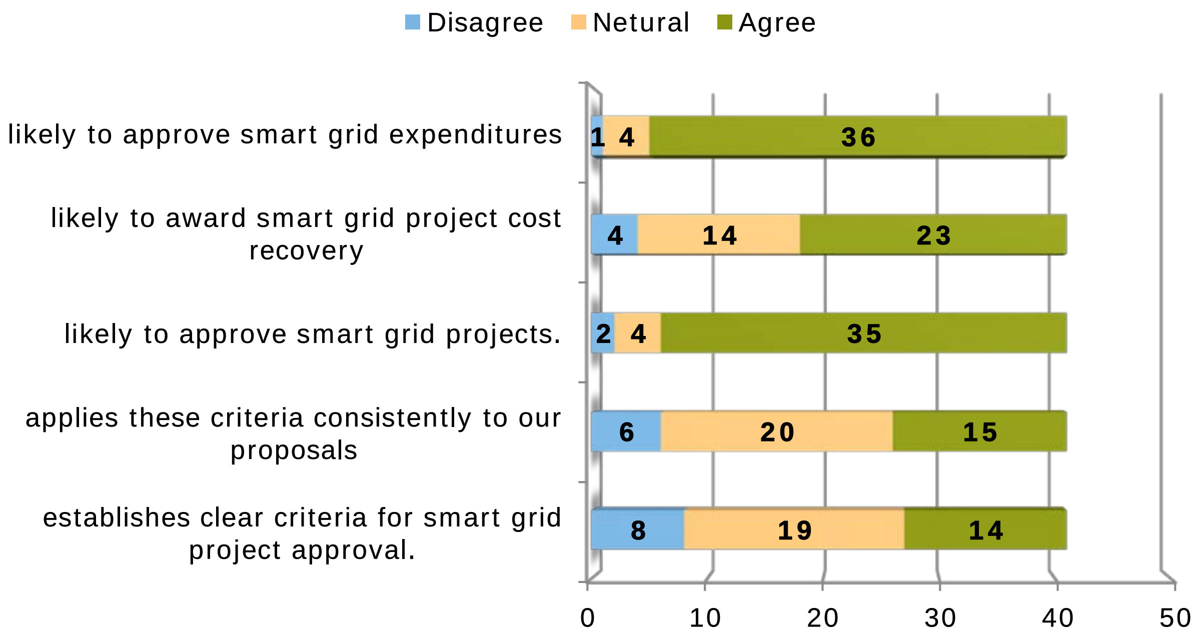
Competition

Two out of the 64 participants (3%) stated that they faced direct competition. All two respondents indicated that they had one competitor. One indicated that its competitor had not started smart grid deployment yet and one estimated that its competitor's smart grid deployment of smart grids was 76-100% completed.

Board of Directors' Attitude to SGTs

Municipals are usually regulated by city councils. Respondents were asked to specify their level of agreement or disagreement about their city councils' attitude to SG technologies (see figure 12). In general, city councils were supportive of smart grid adoption. 90% (n=36) of the participants agreed that their city councils were likely to approve smart grid expenditures, 85% (n=35) agreed that they were likely to approve smart grid projects and 59% (n=23) agreed that they were likely to award smart grid project cost recovery. However, more felt that their city council needs to do a better job in establishing clear criteria for smart grid project approval and applying these criteria consistently to smart grid proposals.

Figure 12: City Councils' Attitudes Towards SG Technologies Adoption (number of respondents)



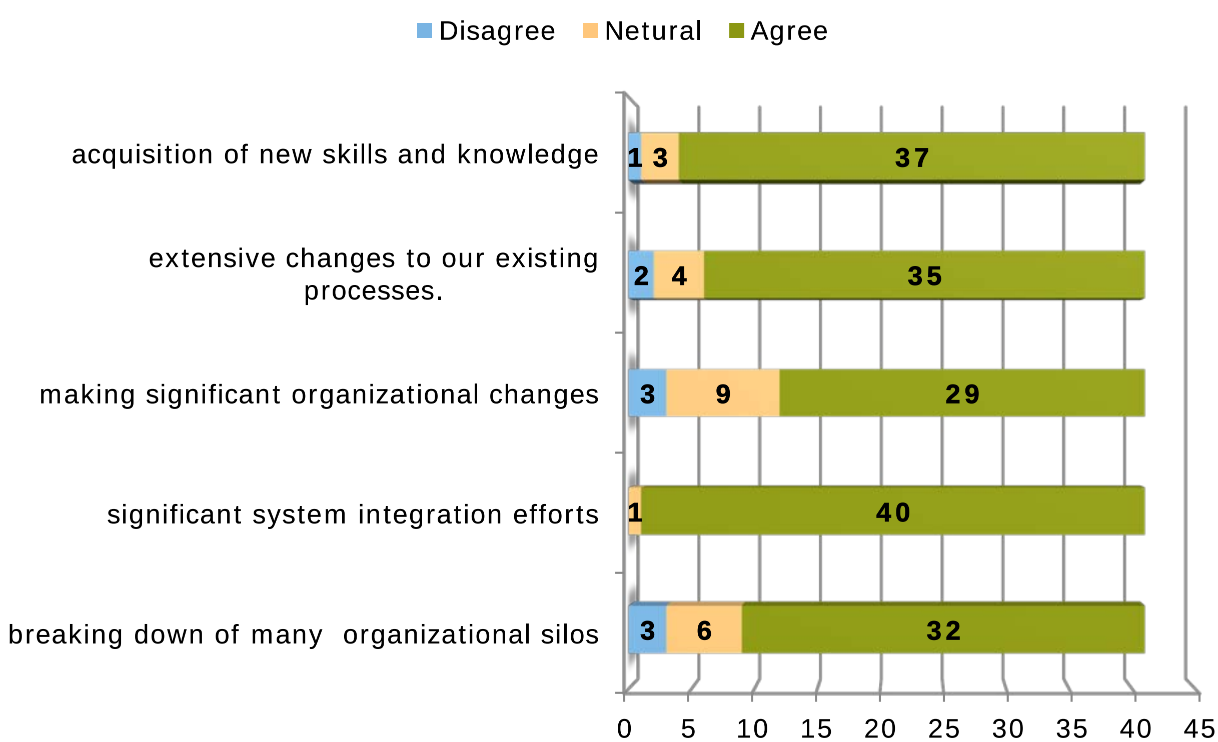
5.0 Organizational Perspectives

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 64% (n=41) of participants responded to this section of questions

Organizational Impacts of Smart Grid Adoption

Respondents were asked about the impacts of SG technologies adoption (see figure 13). In general, smart grid adoption is perceived to pose big organizational challenges. Almost all respondents (98%, n=40) agreed that adopting and implementing smart grid technologies requires significant system integration efforts. Approximately 90% (n=37) saw the need for acquisition of new skills, and knowledge, 85% (n=35) saw the need for extensive changes to existing processes, 78% (n=32) saw the need for breaking down of organizational silos, and 70% (n=29) saw the need for significant organizational changes.

Figure 13: Organizational Impacts of SG Technologies Adoption (number of respondents)



Organizational Choices to Acquire Knowledge & Skills

Respondents were asked about how their organization acquires knowledge and skills. To elicit the information the respondents were given three scenarios, and asked to choose the option their company were most likely to elect (see table 1). When there was a need for new skills and expertise 66% (n=27) indicated that their preference was to train current staff as opposed to using temporary or contract workers. By contrast, when there was a need to implement new technologies, 66% (n=27) 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 76% (n=31) indicated that they were more likely to send their staff to conferences as opposed to hiring consultants or outside expertise.

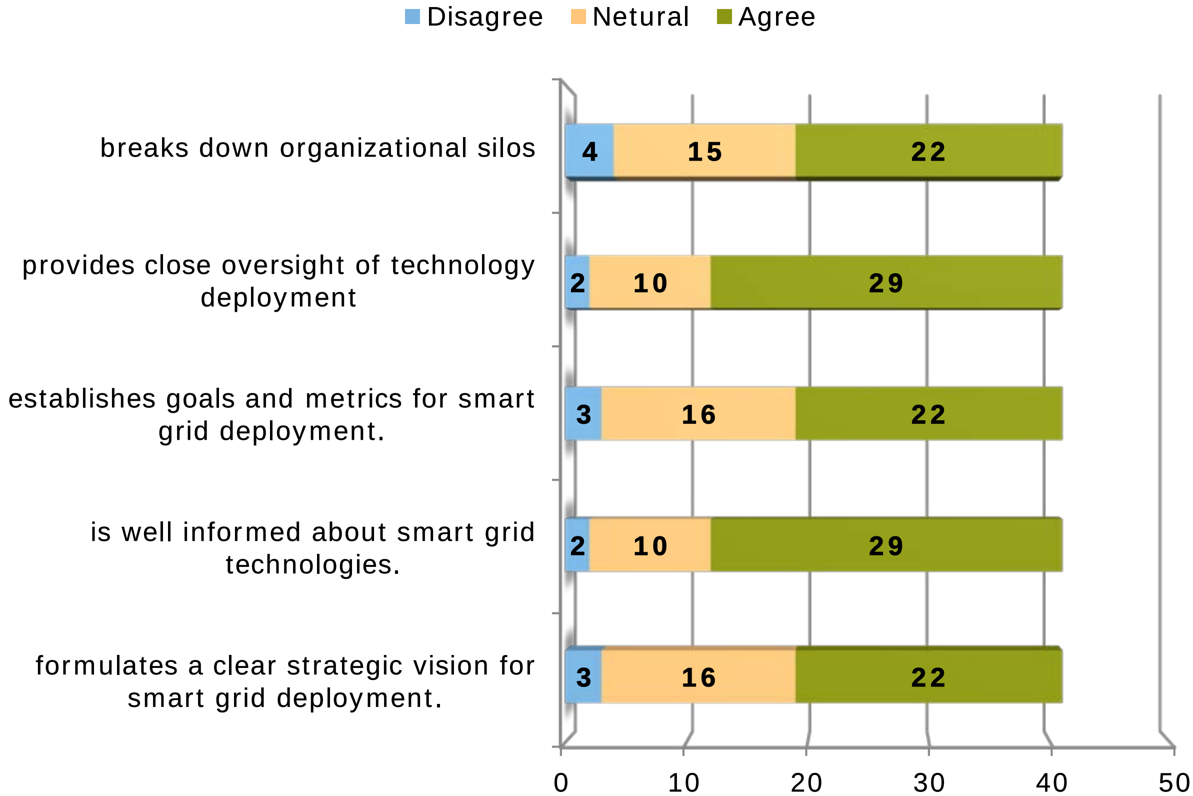
Table 1: Organization Choices to Acquire Knowledge and Skills

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
27	14	14	**27**	**31**	10

Top Management Attitudes

Participants were asked to respond by indicating their level of agreement towards statements about top management's attitudes towards smart grid adoption (see figure 14). Most participants indicated that top management had a positive attitude towards smart grid technologies. About 71% (n=29) felt that their senior executives were well informed about smart grid technologies and provided close oversight of smart grid deployment. To a lesser degree, 54% (n=22) agreed that their top management formulated a clear strategic vision for smart grid deployment, established goals and metrics for SG technology deployment, and assisted in breaking down organizational siloes.

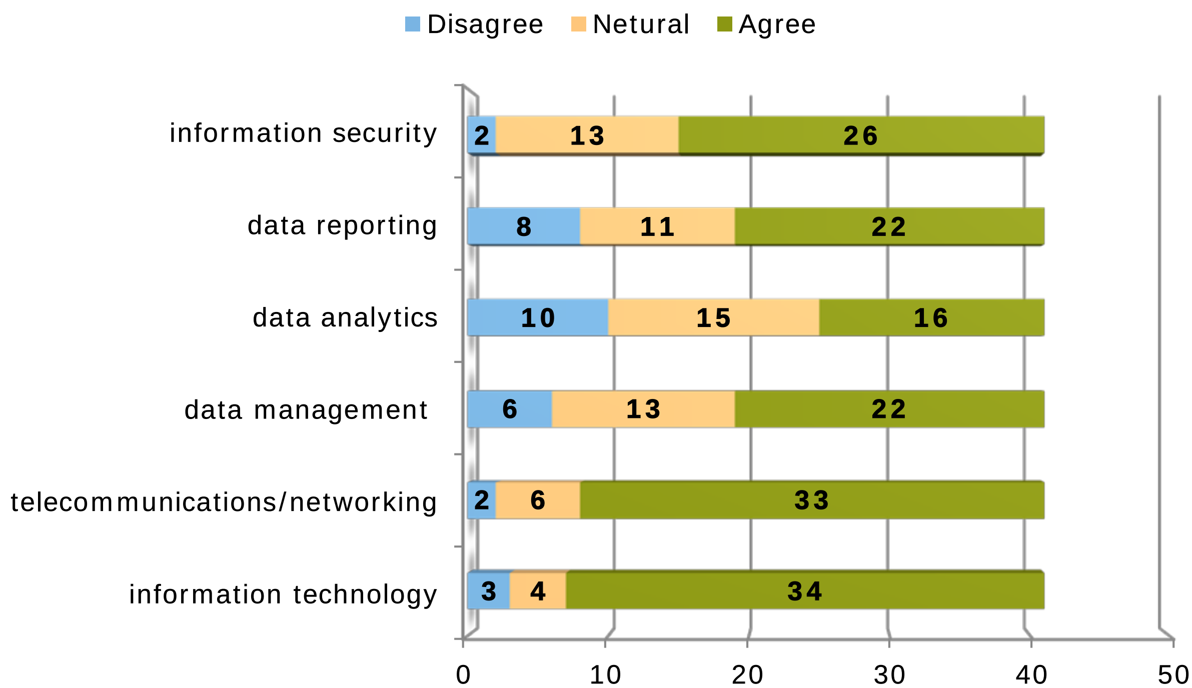
Figure 14: Top Management Attitude Towards SG Technologies (number of respondents)



Organizational Expertise

Participants were asked to respond to statements about their organization's level of expertise in selected areas (see figure 15). Most participants, 83% (n=34) were confident in their expertise in information technologies and 80% (n=33) on telecommunications and networking. About 63 % (n=26) were assured in their expertise in information security. Expertise in data related technologies and skills were lower compared to others proficiencies. Only 54% (n=22) indicted that they had expertise in data analytics and data reporting and 31% (n=16) for data management.

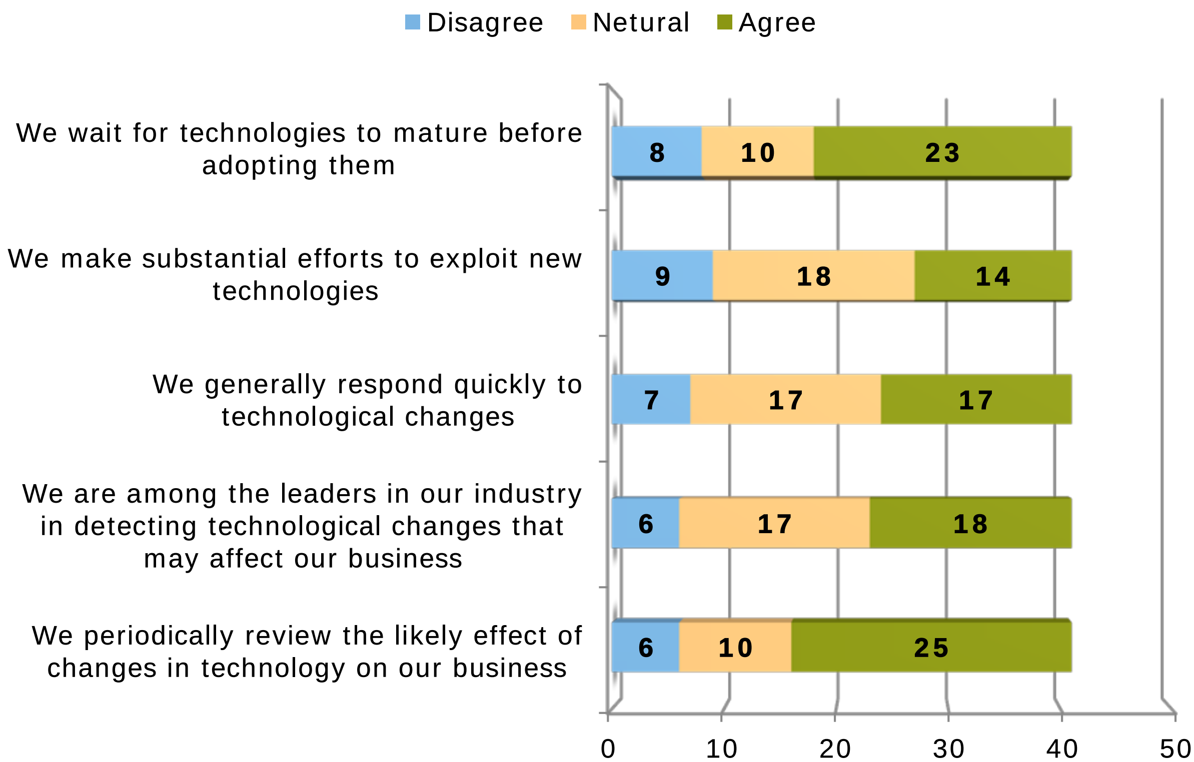
Figure 15: Organizational Expertise (number of companies)



Organization Culture and Practices

Participants were asked to respond to statements about their organization's culture (see figure 16). 61% (n=25) of the respondents indicated that their organization periodically review the possible effects of changes in technologies in the business and 56% (n=23) stated that their organization prefers to wait for technologies to mature before adoption. 44% of the respondents (n=18) saw themselves as leaders in the industry in detecting technological changes that may affect the business and 41% (n=17) indicated that they generally respond quickly to technological changes. Only 34% (n=14) of the respondents indicated that their organizations make substantial efforts to exploit new technologies.

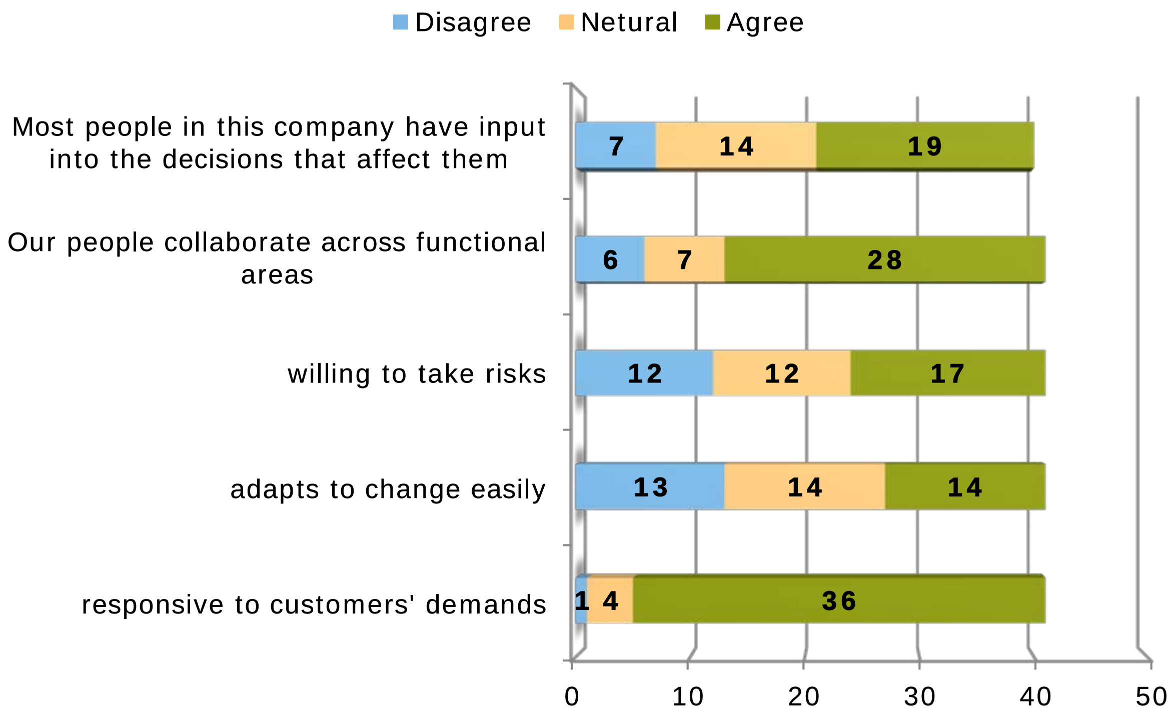
Figure 16: Organizational Culture and Practices (number of companies)



Organization Adaptability

Participants were asked to respond to statements about adaptability of their organization to change (see figure 17). Most respondents 88% (n=36) felt that their organization was responsive to customer's demands. It was also noteworthy that 68% (n=28) people in their company collaborate across functional areas. Less than 50% agreed that people in their organization have input into the decisions that affected them, their organization adapts to changes easily and their organization is willing to take risks.

Figure 17: Organizational Adaptability (number of companies)



6.0 Future Directions

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 report is part of 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. As we've already finished the cooperative report prior to this study, we will focus on investor-owned utilities in the next step.

Appendix 1

States Represented in Survey

States	Number of Respondents
No Retail Competition States	
AZ, FL, GA, IN, MO, NE, WA	1
AR, CO, ID, KY, NM, SC, WI	2
IA, KS,	3
NC	4
TN	6
Retail Competition States	
MN, OH, OR	1
NY, PA, TX	2
MI	3
MA	6
Suspended Retail Competition States	
VA	1
CA	5