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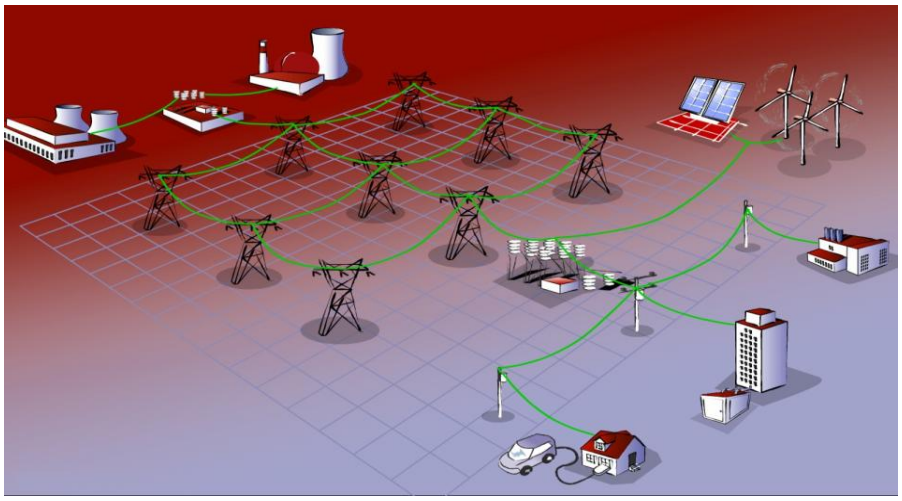

Sharing Smart Grid Experiences through Performance Feedback

March 31, 2011

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List of Acronyms and Abbreviations

CA	Corrective Action
DOE	Department of Energy
EEI	Edison Electric Institute
EPRI	Electric Power Research Institute
ER	Event Reporting
GWA	GridWise Alliance
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
INPO	Institute of Nuclear Power Operations
IOU	Investor Owned Utility
NAP	National Action Plan (Coalition)
NARUC	National Association of Regulatory Utility Commissioners
NETL	National Energy Technology Laboratory
NRECA	National Rural Electric Cooperative Association
O&M	Operations and Maintenance
PFP	Performance Feedback Program
RCA	Root Cause Analysis
RTO	Regional Transmission Organization
SGCC	Smart Grid Consumer Collaborative
SGI	Smart Grid Implementation
SGIC	Smart Grid Information Clearinghouse
SGMM	Smart Grid Maturity Model

Executive Summary

Transforming today's electric grid into a Smart Grid is a monumental undertaking that faces significant challenges in a number of areas. Much work is underway to address the technical challenges that will make the Smart Grid possible. And numerous organizations are working to meet the associated legislative, regulatory policy, and consumer involvement challenges. Still, much remains to be done.

The Smart Grid transition should not be carried out as a series of independent and isolated events. If it is, the Smart Grid may still be achieved ultimately— but not without large numbers of stops and starts, significant amounts of rework, unfavorable pushback from stakeholders, unnecessary costs, and unexpected delays. Experience-sharing during the transition, to identify what works and what doesn't, can help prevent many of these inefficiencies.

The challenges are twofold. First, we must overcome the expected reluctance to share experiences and second, we need to identify methods that help us identify, analyze, and implement those experiences that can accelerate the Smart Grid transition.

Some argue that stakeholders will be reluctant to share their Smart Grid experiences. But today's culture suggests otherwise, as millions openly share their life experiences, opinions, and good ideas using technologies such as Facebook and YouTube. If we can tap this sharing culture that is so prevalent today, we can create a foundation for sharing our Smart Grid experiences.

Performance feedback during the Smart Grid transition is an important mechanism to improve experience-sharing. How a performance feedback process might be used to improve experience-sharing among stakeholders is addressed in four fundamental areas:

- *Performance Monitoring*
- *Analysis*
- *Results and Validation*
- *Communication and Education*

This paper identifies opportunities for identifying and sharing best practices and lessons learned, leading to a more efficient and effective Smart Grid transition that will benefit all stakeholders. The ideas presented are not offered as a prescription but rather as a vehicle to raise the level of debate and to encourage the various stakeholders to consider those that fit their unique situations. Possible solutions for some of the challenges facing the development and implementation of these performance feedback concepts are also discussed.

Experience-sharing can accelerate the progress of those just beginning their Smart Grid journey. Therefore, it is recommended that the various Smart Grid industry groups consider the options presented here and encourage their members to share experiences across the industry. Leadership from these groups will help reduce any reluctance to share experiences, either directly or anonymously.

The performance feedback and experience-sharing concepts described are expected to be key components for achieving the Smart Grid vision, but it will take time for them to be understood, accepted, and implemented. Unless and until they are, less formal processes will be needed to enable an effective experience-sharing process. While a number of Smart Grid publications and blogs are currently addressing best practices, additional effort will be required to accommodate the increasing number and complexity of Smart Grid activities and a growing Smart Grid audience.

To provide support during this interim period, a case study process that can be widely applied by the various industry groups is described in the Appendices.

Introduction

Since 2005, much has been done to define the vision for the Smart Grid and to communicate that vision to stakeholders. As a result, ***understanding*** has increased and many, but certainly not all, stakeholders have generally ***aligned*** behind these Smart Grid concepts. A number of incentives have ***motivated*** some of the aligned stakeholders to make Smart Grid investments, conduct pilots, and begin projects to install Smart Grid technologies and processes. These investments will soon produce ***results***.

As these results are achieved, progress will be made toward achieving a Smart Grid. But that progress may be limited in efficiency and effectiveness unless processes are put in place to monitor and collect project successes and difficulties. The lessons learned and best practices that are derived from actual projects can greatly benefit others if they are well documented, analyzed, validated, and effectively communicated and shared. This vital "***sharing and coaching***" aspect of the change management process, wherein those who've blazed the trail share their experiences with others, is currently limited as a component of the Smart Grid transformation.

This paper presents thoughts on a Performance Feedback Program (PFP) for optimizing the Smart Grid transformation, a program aimed at supporting the "sharing and coaching" element of an effective change management process. The following vision describes the Smart Grid PFP:

> *"The Smart Grid Performance Feedback Program facilitates the sharing of Smart Grid experiences and learnings, thereby allowing stakeholders to continuously improve, avoid pitfalls, and build upon the best practices of others to more effectively, efficiently, and safely achieve their Smart Grid vision."*

The PFP is applicable to all areas of the Smart Grid transition including planning, design, construction, testing, operations, maintenance, and regulatory policy. It also covers the interfaces with all Smart Grid stakeholders including customers, vendors, and third parties. It is intended to provide a timely stream of Smart Grid experiences that can be captured and analyzed. From these experiences, best practices and lessons learned may be identified early and shared among the stakeholder groups. And unresolved issues that limit the progress of the Smart Grid transition could be more readily identified and resolved.

The Smart Grid PFP described in this paper is intended to facilitate the Smart Grid transition making it more efficient and effective. The success of the Smart Grid PFP, however, faces two main challenges—the lack of a national leader or leaders to support the program and encourage participation and the potential reluctance of stakeholders to share their experiences with others.

The Smart Grid transition has begun and it is now time to begin sharing experiences with all stakeholders. Since the Smart Grid PFP will take some time to develop, the use of Smart Grid case studies offers an immediate way to help close the "sharing and coaching" gap. The case study is a well known feedback and teaching mechanism and will ultimately be part of a mature PFP.

Why is Performance Feedback Important?

Performance feedback provides a vital mechanism for linking the many Smart Grid implementation activities. The collection and analysis of data and information and its sharing for the benefit of all builds upon the alignment and motivation created during the initial phase of the Smart Grid transition. Often, large change management efforts fail because this feedback process is not put into place or is ineffective. It's not enough to just "get the Smart Grid implementation ball rolling" and assume it will be successful in finishing on its own.

The value in putting a PFP in place is real and positive. For example, a PFP can:

- Improve the efficiency and efficacy of Smart Grid Implementation
- Keep implementation costs down and help optimize the cost / benefit equation
- Create a process for corrective action to keep "us" on track with plans and schedules
- Maintain Smart Grid implementation momentum
- Reduce the potential for repeating "missteps" by taking advantage of lessons learned
- Prevent "reinventing the wheel" by taking advantage of other's experiences
- Provide guidance for future codes and standards development
- Provide a means to communicate progress to the stakeholders to encourage their support and feedback
- Aid in the understanding of the collective value of diverse approaches
- Support the ability to determine the actual value of smart grid investments
- Create "best-in-class" for various Smart Grid applications that will enable others to benchmark their projects.

What is Performance Feedback?

The transformation of today's electric grid to the Smart Grid of the future has been underway for several years. Phase one of the change is the "getting started" phase and is illustrated in Figure 1 below. Although certainly not yet complete, this first step has overcome the industry's initial reluctance to change.

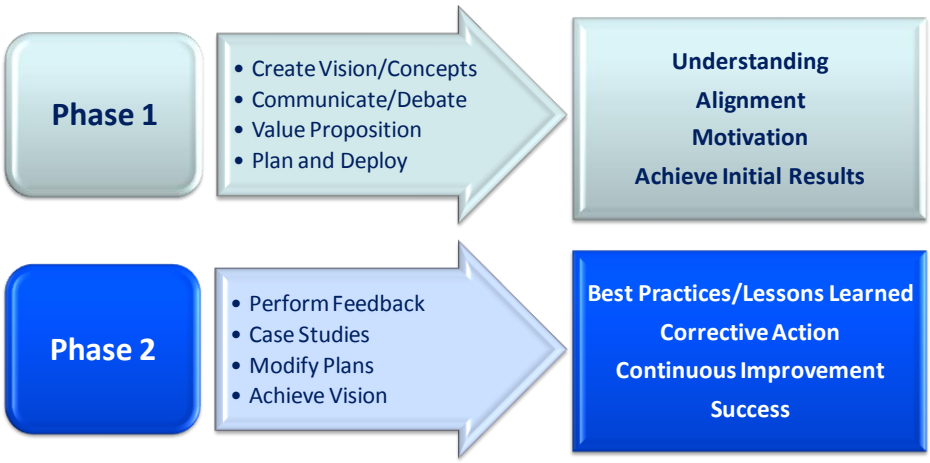

Figure 1: Components of Managing Change

Today, most stakeholder groups generally understand the Smart Grid vision and concepts. Many have aligned around the vision and concepts, while approaching detailed implementation in various ways. A number of incentives are available, including government stimulus funds, to motivate investment and deployment of new Smart Grid applications, technologies, processes, and practices. Results are being achieved and the Smart Grid transition is well underway.

Phase two of the transformation is the "getting it done" phase. As the level of Smart Grid implementation increases, a number of salient experiences will occur—some good and some not so good. Not all technologies will work as planned, software issues will arise, "myths and legends" will emerge that impede progress, unexpected events will occur, good ideas and practices will be identified, workforce training weaknesses will become apparent, progress may not be achieved at the expected rate, and benefits will not be realized as expected. At the individual project level, each of these issues will be experienced and addressed with varying degrees of success. However, without an effective PFP, the value of these experiences may not be passed on to others. As a result, many of the mistakes will be repeated again and again, and the benefits of best practices or "tricks of the trade" will not become available to others. We are now transitioning from Phase one to Phase two and a successful Smart Grid transformation depends on how well this next phase is executed.

The concept of performance feedback is normally applied to completed projects that are operational such that those activities can be continuously optimized. For example, the Nuclear Power industry implemented a PFP which helped it become a more successful industry with respect to costs and safety [1, 2]. Similarly, performance feedback will be a critical component of the future *operating* Smart Grid, but it is even more important today as its *implementation* begins and the change management processes become even more impactful on the transition.

A successful PFP contains four fundamental components. The first component is to monitor and collect data on the performance of the activities of interest as viewed from various key perspectives. The collected data is then converted to information and analyzed to reach initial conclusions on how future performance could be improved. The conclusions are then validated and formulated into recommended actions that might benefit others. Finally, and perhaps most important, is the effective communication of the results to those stakeholders who are potential beneficiaries of these recommendations. The process steps are presented in Figure 2 and discussed below.

Figure 2: Components of a Performance Feedback Program

Performance Monitoring

The first component of the Smart Grid PFP is Performance Monitoring. The performance monitoring processes should include both direct transition activities such as project planning, design, engineering, construction, testing, maintenance, and operations, as well as the impacts of externalities such as legislation and regulatory policy and the input from and relationship with consumers. To effectively cover this breadth of performance monitoring, a number of processes should be considered.

Corrective Action

The corrective action process can be used to address issues experienced in all Smart Grid transition activities. The fundamental objective of a corrective action (CA) process is to document issues, mistakes, unintended consequences, etc., so that an effective corrective action plan can be formally identified and implemented to prevent recurrence. The first step is to ensure process participants are willing to identify problems that meet predetermined criteria. A threshold is needed to define the level at which an issue should be addressed by the CA process; otherwise the process can become overwhelmed with insignificant items. Next, remedial actions are identified and carried out to resolve the immediate problem(s). Problems are also trended to identify any that need further root cause evaluation and to determine any generic corrective actions needed to prevent recurrence. The resulting CA plans are then communicated and tracked to ensure all actions are completed. Over time, the effectiveness of the CA process in correcting problems and preventing their recurrence is evaluated to ensure the process itself is effective.

Corrective action processes are often used at the project level to manage issues that arise during project implementation. During the Smart Grid transition, the opportunity exists to raise the project level CA processes to a higher, more integrated level, to the state, regional or perhaps even national level to provide a broader perspective. This integration could also include legislative, regulatory and consumer issues as they arise. This "systems approach" could help identify generic issues that apply to multiple levels and various stakeholder groups and thereby create an environment where broader and more effective solutions can be identified. Integration at these higher levels would clearly require a process owner to be most effective.

Event Reporting

Significant events will undoubtedly occur during the transition. The fundamental objective of the event reporting (ER) process is to quickly communicate such events to give others an early "heads up". These events, both positive and negative in nature, can represent substantial opportunity for the general Smart Grid community; therefore, they should be understood and accurately and effectively communicated. The method of communication will vary depending on the significance of the event.

Some examples of reportable events might include a technology breakthrough that greatly improves a Smart Grid process (on the positive side), a significant failure (see also Failure Monitoring described below) in a feature of a widely deployed Smart Grid device (on the negative side), or the correction of misinformation that may have been previously reported before all the facts were in and evaluated.

The event reporting process should define a reportable event by briefly describing what was expected and how the results differed from the expectations. It should also provide guidance on how soon it should be reported and to whom. This guidance could be in the form of a simple priority scheme such as high, medium, and low. The level of severity would then prescribe to which stakeholder group the event should be reported.

As an example, the order of event reporting might be:

- Low priority events would be communicated to project staff
- Medium priority events would also include management
- High priority events would include peer groups and key stakeholders

An industry-wide repository, such as the Smart Grid Information Clearinghouse (SGIC) [3], is needed to house the history of reportable events for future reference by all stakeholders. The ER process also needs a process owner to maximize its effectiveness.

Failure Monitoring

The objective of failure monitoring is to identify and document the failures (and failure types) of key Smart Grid devices and software applications. When failures of hardware and software components occur at the project level, they are often considered random failures, particularly if the population of these components is small. The failure monitoring process provides the methodology for reporting such failures to a central clearing house for trending so that generic weaknesses at the component level can be recognized and acted upon.

This process requires that stakeholders who are implementing Smart Grid technologies report failures on predetermined types of devices and applications. The failure monitoring process owner is responsible for trending the failures and monitoring these overall trends to identify potential generic issues. Generic issues identified by the failure analysis process could become reportable events to alert Smart Grid stakeholders. Root cause analyses may be needed to determine the corrective action

needed to prevent recurrence. Once determined, the issue and solutions might also be communicated using case studies.

Metric Reporting

A metric is a measurement of a key parameter and, in this case, one linked to the planning, design, installation, testing, operation, maintenance, or consumer outreach aspects of the Smart Grid transition. Metrics are objective and can be measured over time to enable trending. Successful application of this method of performance monitoring depends on the selection of the correct parameters (i.e., the right metrics), the continuous monitoring of those parameters over time, and an understanding of the metric's desired end state, either directionally or through a specific target or goal. Well-defined metrics allow stakeholders to have an accurate understanding of Smart Grid build-out and performance.

Selection of specific metrics should be done carefully because the monitoring and communication of metric results will influence the behavior of stakeholder groups over time. The visibility of metrics and their goals will drive the direction of the Smart Grid transition.

For the Smart Grid, metrics have been identified for two different aspects of the Smart Grid transformation—"build metrics" and "impact metrics". Build metrics measure progress during the implementation of the Smart Grid, (e.g., the number of smart meters deployed in a given area.) A number of build metrics were identified during the DOE Smart Grid Metrics Workshop held June 19-20, 2008 [4]. These metrics are aimed at monitoring progress in building out the Smart Grid and therefore are similar in nature to other project management type metrics.

Impact metrics measure the change or impact in the response of the grid and all its associated assets, including hard assets and human resources, as well as the impact on consumers and their level of engagement, as a consequence of the newly deployed Smart Grid systems. Some examples of impact metrics include the reduction in the number of outage minutes per year in a given area, the average dollar savings per month per customer, etc. These impacts are then used to quantify the benefits to the stakeholders, usually in terms of dollars. Impact metrics associated with DOE Smart Grid demonstration projects will be reported as these projects are placed in operation. A framework [6] for identifying and analyzing the appropriate impact metrics for these projects has been developed and documented in EPRI report 1020342.

Another category of metrics, yet to be defined, may be of value to the Smart Grid transformation. A number of barriers currently prevent or impede stakeholders from moving forward with Smart Grid implementation. These barriers exist across multiple stakeholder domains. Examples include legislative and regulatory policy, consumer interest, technical hurdles, etc. Development of "barrier metrics" and reporting on these metrics might help drive resolution of some of the barriers to Smart Grid implementation.

A number of benefits result from metric reporting. For example, understanding the trend of metrics can help:

- **Keep us on track**
  - ✓ Identifies successes and opportunities for improvement
  - ✓ Initiates corrective action to address problems identified by trends
  - ✓ Reinforces good progress
  - ✓ Serves as an effective communication tool
  - ✓ Creates alignment and motivation among stakeholders

- **Enable us to project future progress**
  - ✓ Establishes baseline for target setting
  - ✓ Provides insights for interdependent efforts
  - ✓ Keeps the "end in mind"

Metric reporting for the Smart Grid requires the willingness of stakeholders to report the data and the identification of an owner to collect, manage, and report the data.

Surveys

Two basic data gathering methods for surveys are questionnaires and interviews. Questionnaires are usually web-based or paper and pencil instruments that a respondent completes, while interviews involve a person interviewing the respondent and collecting data based on answers from the respondent. Either method can include closed ended questions (i.e., yes or no, or multiple choice) and open-ended questions where the respondent provides the answer in his or her own words. Choosing the right type of data gathering tool, the right questions to ask, and best way to ask those questions is critical to understanding the topics of interest. Both questionnaires and interviews can be useful for obtaining key performance feedback data and information that can be beneficial to the broader Smart Grid stakeholder communities. Below is a comparison of these two basic survey methods:

Table 1: Survey Methods

Survey Type	Pros	Cons
Questionnaires • Web-based • Mail • Group Administered	• Typically less time involved for both respondent and interviewer • Lower cost to execute • Can reach a broader audience • Simple tools now available on-line • Results more controllable, more quantitative	• No ability to probe or ask clarifying questions • Lack of verification of respondent - may not be the right person in the organization
Interview • Personal • Telephone • Focus group	• Can probe and ask clarifying questions enabling deeper understanding of the topic • Ability to uncover other organizational behaviors and complexities that may impact the findings • Creates synergy when interviewing multiple subjects	• Labor intensive for both respondent and interviewer

To ensure accurate results from surveys and questionnaires, it is important they be distributed to a broad array of stakeholders representing all groups and entities impacted or who have an impact on the final results.

The performance monitoring component of the PFP provides the data and information streams that describe the state of the Smart Grid transformation as it evolves. The next step is the analysis of that data and information to formulate conclusions and recommendations that can lead to best practices

and lessons learned. Without an effective performance monitoring process, the identification of best practices and lessons learned may be limited in number and anecdotal in nature.

Analysis

The performance monitoring process described above creates the opportunity to harvest data and information from projects and experiments that may have value to other stakeholders. The second component of the Smart Grid PFP is to analyze and understand their meaning, relevance, and significance. Conclusions reached from the analysis process should be validated to ensure accuracy — sharing and communication of inaccurate conclusions is obviously counterproductive. A number of recommended fundamental process steps for implementing the Analysis component are discussed below.

Trend Analysis

The objective of trend analysis is to first, determine if a trend exists and second, to determine the direction of the trend. Actual trends that deviate from the expected or desired trend expose opportunities (e.g. alerts) for taking corrective action to more closely achieve the desired outcome. For example, failure trending can identify when device or application failures have exceeded the designed failure rate. These failures might not otherwise be detected as a generic issue at the local level. Automobile recalls are an example of a failure trend analysis. Analyzing trends from events identified by the corrective action process and from the reporting of metrics can expose similar issues. Often, adverse trends require root cause analysis to determine the root cause and appropriate generic corrective actions. In general, information gathered in the performance monitoring process lends itself to trend analysis which, in turn, creates the opportunity to identify otherwise undetectable issues.

Root Cause Analysis

Root Cause Analysis (RCA) is an analytical method used to address a problem or non-conformance in order to get to the "root cause" of the problem. Root cause is defined as the fundamental breakdown or failure of a process. Elimination of the root cause prevents recurrence. The objective of root cause analysis, therefore, is to identify problems and permanently correct them.

Adverse trends, alerts, significant events, etc. identified from the performance monitoring process are all candidates for root cause analyses. The magnitude and impact of these conditions warrant the effort to ensure the root cause is identified and the issue does not recur. In simple terms, the RCA process repeatedly asks the question, "Why did this condition occur?" As an example, assume a smart outdoor meter fails to report unexpectedly. A series of "why" questions such as these might lead to the root cause:

- Why did the meter fail to report? (the communications system between the meter and the collection server failed)
- Why did the communications system fail? (the communications connector at the meter was corroded)
- Why was the connector corroded? (the connector metal was not coated)
- Why wasn't the connector coated? (it was an indoor connector which does not require a coating)
- What is the Root cause? (improper installation, wrong connector type used)

Once the RCA is completed, both remedial and generic corrective actions can be identified. In this example, the remedial corrective action might be to inspect all meters for the correct connector type. The generic corrective action might be to update the "meter installation" procedure and train the

installer on the proper connector to be used for outdoor meters. Generic corrective actions are "lessons learned" which, when widely communicated, can benefit other stakeholders.

Often RCA is more complex than the example discussed above. Other tools to assist in performing RCA include:

- Brainstorming—gathering diverse focused ideas in a short time
- Pareto Chart—graphing magnitudes by category
- Fishbone Diagram—graphically identifying and organizing many possible causes of a problem (also known as cause and effect diagrams)
- Scatter Diagram—plotting points on a graph to identify a trend
- Flowchart—plotting the process from start to finish to understand the flow of data and its impact on the end product
- Histogram—plotting data in time based bins to show the frequency aspects of the data
- Control chart— plotting output data using statistical boundary limits to show when a process is trending out of control
- Tree diagram— a type of picture that shows all possible outcomes

Benchmarking

Benchmarking compares various attributes of a policy, product, program, technology , etc., with standard measurements or similar measurements of the best-in-class peers. The objectives of benchmarking are to determine what and where improvements are needed and how other peers achieve their high performance levels. This information can then be used to identify "best practices" that, when widely communicated, can improve the overall performance of other stakeholders.

Benchmarking has been widely used in the utility industry as a technique to validate capital and operations and maintenance (O&M) expenditures and to determine one utility's performance when compared to other similar utility groups. Often, best practices are initially identified and the organization completing the benchmarking conducts a comparison of current performance to the best performer group. Two types of benchmarking are often used:

Performance benchmarking — performance metrics that are quantifiable are compared. Performance benchmarking generally identifies areas needing improvement and/or areas of excellence from a financial or operational perspective. Some recommended steps for conducting performance benchmarking include:

- Select key performance metrics relevant to the Smart Grid area of interest
- Compare performance against industry metrics
- Determine gap between performance and top performers in peer group
- Analyze data to identify opportunities for improved performance

Process benchmarking — used by companies to evaluate aspects of a business process in relation to identified best practices. This often leads to process improvement projects necessary to achieve best practice level performance. Some recommended steps for process benchmarking include:

- Prioritize and identify processes for comparison relevant to the Smart Grid area of interest
- Collect data on selected processes through process mapping and identification of outcomes
- Identify and involve partners for comparison
- Identify performance gaps
- Develop alternatives
- Analyze alternatives (does an alternative meet the defined goal?)

- Make and implement recommendations
- Track revised process against goals

Benchmarking is difficult to conduct in isolation. Peers need to be solicited to participate; otherwise information may need to be extracted from publicly available data. Entities used for comparison should be carefully selected to ensure similar circumstances exist for the areas compared to avoid potential skewing of the benchmarking results.

Self Assessments

Self-assessment is the process of evaluating a business, process, or event using internal staff to identify strengths and opportunities for improvement. A self-assessment is typically conducted when an industry is changing due to new customer requirements, competitors affecting the market, or new regulations or technologies affecting how business is conducted. Another driver for conducting a self assessment is that the organization or process is among the best in the industry or the business model is very successful. Self assessments are a good way to sustain continuous improvement and "calibrate" quality assurance programs.

The expected outcomes of a self-assessment are the identification of successes and opportunities for improvement, the initiation of a change management program, the identification of lessons learned, and/or a plan to better align resources with the organization's strategic objectives. The self-assessment is also similar to benchmarking in that the results can be used to assess the organization's performance against its competition, assess how to deliver best in class results, and identify best practices.

There are several self-assessment tools that address organizations and processes. The most prominent tool in the United States is the Baldrige Performance Excellence Program [7]. The goal of this program is "to improve the competitiveness and performance of U.S. organizations". The steps outlined in the assessment processes are as follows:

1. **Define Requirements** — focus on core business areas that affect the organization or process under assessment:
    - Leadership
    - Strategic planning
    - Customer focus
    - Measurement, analysis and knowledge management
    - Workforce focus
    - Operations focus
    - Results
2. **Establish the Assessment Process —** assign responsibilities and a schedule
3. **Allocate Resources —** create a mechanism for resources to conduct the work
4. **Plan the Assessment:**
    - Understand each criteria
    - Identify who in the organization is a resource for information
    - Develop a project tracking tool
    - Determine who can best collect information
    - Schedule meeting and interviews
5. **Research —** collect information on the process or service focusing on the steps, who participates, what are the responsibilities, when activities occur in the process, what are the metrics, what are the inputs and outputs, etc.

6. **Document —** report on data collected during the research task including graphs, trends, benchmarks, and goals
7. **Evaluate—** analyze the data to identify best practices and opportunities for improvement
8. **Act—**prioritize opportunities for improvement, develop action plans, and assign personnel to execute the plans
9. **Plan the next Assessment—** as part of a continuous process, the activities are monitored and re-evaluated in an ongoing basis.

The Smart Grid Maturity Model (SGMM) [11] program under the stewardship of the Software Engineering Institute at Carnegie Mellon University is another example of a self-assessment tool. This process can help utilities, municipalities, and cooperatives better understand their current level of maturity in Smart Grid space and define their future aspirations for moving forward with a Smart Grid transition. The SGMM's *"Navigator"* process utilizes Smart Grid industry experts, certified on the use of the SGMM tool, as facilitators help utilities evaluate their Smart Grid maturity level.

Peer Team Assessments

Peer teams enable objective assessments of candidate cases for importance and applicability to the industry. This gives the candidate case credibility. Peer teams include members with a wide range of backgrounds, which enables them to extract the essence of the value in the candidate case. Peer team assessments can be managed by a standard review process that assures thoroughness and consistency.

While self-assessments provide value, there is additional objectivity and credibility in peer team assessments. This comes from involving independent reviewers who are industry professionals and knowledgeable peers in areas that the case represents.

The nuclear power industry uses the peer assessment process. The Institute of Nuclear Power Operations (INPO) developed and utilized a peer review process that started more than 25 years ago, and continuing today, to assess key performance areas of a nuclear power plant's operations, engineering, maintenance, training, quality, and management functional areas. The peer review teams evaluate events and ongoing processes, and identify areas for improvement and best practices that can benefit the whole industry. Case studies are then developed from these findings. There is substantial value in the team's evaluation because of the credibility that comes from a broad team of utility peers, technical experts, and process experts coming to a consensus on nuclear power plant issues and any resulting case studies. A peer team assessment process that evaluates the performance of Smart Grid implementation could enjoy similar benefits as those experienced over the last 25 years in the nuclear power industry.

Case Studies

Case studies focus on specific topics or events whose clear description and communication might benefit stakeholder groups. Case studies are expected to be a popular method for collecting performance feedback data, analyzing that data, and communicating the results. A complete discussion on case studies is included in the Appendices.

Results and Validation

The objective of performance monitoring and analysis is to generate conclusions that can benefit other Smart Grid stakeholder groups. Defining actionable results and recommendations from these conclusions and validating them to ensure they are right, reasonable, and relevant is the third component of the Smart Grid PFP.

PFP results will generally take one of three forms:

- ***Best Practices***—during the change process, implementers frequently identify processes, shortcuts, methods, policies, "tricks of the trade", etc. that prove to be beneficial and applicable to other stakeholder groups. Sharing these best practices can leverage other stakeholders positively as they move forward with Smart Grid implementation.
- ***Lessons Learned***—also during the change process, implementers identify unintended consequences that negatively impact their ability to move forward efficiently and effectively. Again, sharing these lessons learned can help prevent others from repeating the same "mistake" and give them an opportunity to chart a different, more successful course. Alerts are time sensitive, high priority lessons learned.
- ***Clarification of issues (i.e. "myth-busting")***—throughout the change process, barriers to progress emerge. Often these barriers are created from unresolved or misunderstood issues which tend to paralyze progress. Sometimes these issues generate conflicting opinions on the appropriate solution or approach and sometimes these opinions are not completely based in fact. Results in this category are used to provide an objective and factual solution to the unresolved issue to remove the uncertainty and therefore enable Smart Grid progress to resume.

The value of best practices, lessons learned, and issue clarification is their ability to influence the actions of other stakeholders regarding Smart Grid implementation. As these results are expected to be widely communicated and leveraged, it is critical that they are factual, accurate and objective. The final step prior to the communication of results is to ensure they are validated.

Validation

Validation of results and conclusions ensures that only good and accurate information is conveyed to the Smart Grid stakeholders. Communication of inaccurate or ambiguous information would undermine the credibility of the larger PFP and, even worse, could result in the promulgation of bad advice to many Smart Grid stakeholders.

Validation is "assessing whether data collected and measured are a true reflection of the performance being measured and having a clear relationship to the mission of the organization" [8]. The validation process applies a set of criteria to help determine if the stated descriptions and conclusions are credible. Some or all of the following can be considered, depending on the nature of the study**:**

- Goal/Measure is realistic, measurable, and understandable to users
- Source data are well defined, documented
- Definitions are available and used
- Data are verified
- Any data limitations are explained and documented
- Third party evaluations are conducted
- Responsible party has certified that procedures were followed and data accuracy has been checked each reporting period

Validation is necessary when providing information to decision makers. It helps teach good practices in the preparation of publications and sits as a cornerstone of professionalism. The application of the validation techniques described above is essential to the evaluation of projects, their attendant case studies and the performance metrics thereby obtained.

Documentation of the final and validated results and conclusions may take a number of forms, including reports, presentations, magazine and newspaper articles, case studies, etc. The real value depends on how well these results and conclusions are communicated to the Smart Grid stakeholders.

Communication and Education

Many aspects of the Smart Grid PFP have been discussed so far. All the information garnered and gathered will be inconsequential, however, if Smart Grid stakeholders don't know it exists. Therefore, communication of the various types of performance feedback to stakeholders is the fourth component of the Smart Grid PFP. Continuing the education of the industry through various methods is critical to successfully propel the Smart Grid forward.

As discussed, PFP will take several forms, including:

- Corrective Action
- Event Reporting
- Failure Monitoring and Analysis
- Metric Reporting/Benchmarking
- Surveys
- Self-Assessment
- Peer Team Assessment
- Trending and Root Cause Analysis
- Case Studies

The output of these processes is normally documented in "alerts", analytical reports, and case studies which ultimately provide the content from which the communication methods are developed.

Information that needs to be disseminated quickly is best distributed through an "emerging news" communications mechanism. For example, safety recalls are sent immediately via news releases and bulletins to consumers that have purchased faulty products so that they can take action quickly and avoid problems. *Corrective Action*, *Trending, Root Cause Analysis*, and *Event Reporting* types of performance feedback may require an Alert or Notice distributed quickly to those stakeholders involved in that element of the Smart Grid. The Alert, in a bulletin type format, could be sent electronically to stakeholders. One well known system to issue such an Alert is utilized by the Nuclear Regulatory Commission (NRC). An *NRC Information Notice* identifies the recipients (addressees), and covers the purpose, circumstances, discussion and contacts related to the issue [9].

Information that is not as time sensitive and is developed through analysis and study can be most effectively communicated through a detailed analytical document. This is the appropriate communications method for *Failure Analysis*, *Self-Assessments, Peer Team Assessment, Case Studies* and *Metrics Reporting/Benchmarking*. Some possible communication venues include:

- Presentations at conferences
- Workshops
- Articles in Smart Grid publications
- Website Postings
- Webcasts
- Release to Smart Grid stakeholder groups
- Social Media
- Blogs

Case Studies, in particular, are expected to be a common form of performance feedback and should be widely communicated by posting on key Smart Grid websites such as the Smart Grid Information Clearinghouse, SmartGrid.gov [5], NETL SGIS website, and others, depending on who prepares them and the target audience. In addition to documenting the results in a written report and making the

document available on key websites, additional communication techniques should be considered, including articles for electronic and print media, presentations, and workshops.

Utilizing the information learned from the PFP and developing more in-depth workshops to present its results will continue to advance the education of industry stakeholders. In a more formal workshop setting, evaluation of the participants' understanding can ensure successful knowledge transfer has occurred.

Development of Communications Plans for communicating Smart Grid PFP results should consider these essential elements:

- **Context** – what's happened before? What's the history?
- **Environmental Scan** – what are the key factors – What's known now?
- **Stakeholders** – who are the relevant groups/individuals to receive communications?
- **Objectives** – what is to be achieved in communicating?
- **Strategy** – what is the best method to communicate the information?
- **Audiences** – what are the key forums/groups/sites to reach stakeholders?
- **Announcements** – will a press release type of announcement aid success?
- **Messages** – what are the main points to communicate and how to say them?
- **Tactics** – how will the strategy be implemented? Before, during, and after the main announcement?
- **Issues** – what problems may need to be overcome?
- **Budget** – what will it cost?
- **Evaluation** – how will the communication and education effort's success be judged?
- **Both types** of Smart Grid PFP communication— emergent through bulletins and ongoing through documents, presentations, and articles—are essential to the Smart Grid transition. They are also important elements of the on-going education of industry stakeholders.

Summary

Figure 3 illustrates how the Smart Grid PFP closes the performance feedback loop. Beginning at the source—the actual Smart Grid transition activities—key parameters are monitored by the performance monitoring processes. The outputs of the performance monitoring processes are information and insights that, after analysis, can yield opportunities for improving performance. These opportunities are validated, formulated into recommendations, and communicated to the appropriate Smart Grid stakeholder groups. When acted upon, these recommendations are expected to improve the performance of future Smart Grid transition activities—and the cycle continues—leading to continuous improvement for the Smart Grid transition.

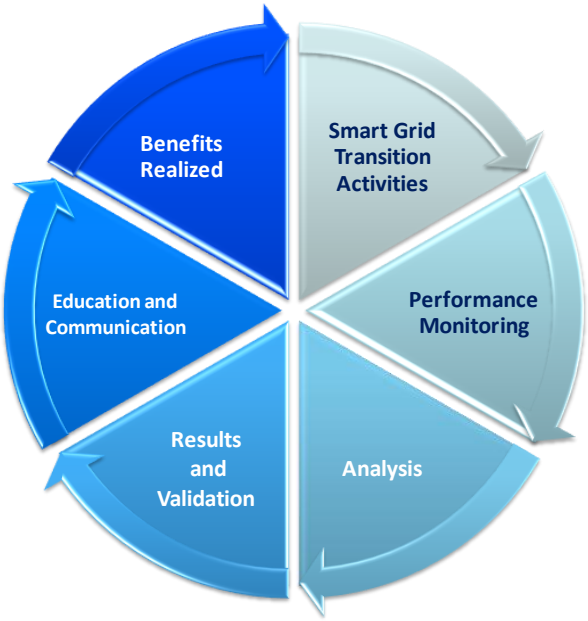

Figure 3: The Performance Feedback Cycle

Challenges

Withholding bad news is human nature. This is the root of the challenge of performance feedback. In spite of understanding that sharing problems and weaknesses among peers helps all to improve, when it comes to sharing one's own problems, few are willing to step forward.

An additional challenge is that utilities are often advised by legal counsel to not make any information available to anyone outside the company unless required by law. The basis for this advice is that information made available may help a case against the utility in proceedings. Therefore, due to human reluctance and advice of counsel, voluntary participation in a ***public*** performance feedback process may be limited.

Voluntary participation in a ***private*** performance feedback process is more likely. In a private performance feedback process, the confidentiality of participants is maintained and results may be shared publicly without disclosing the participating utilities by name. While the human and counsel motivations are still in place, the protection and ownership of information can be maintained to an extent. For example, if a utility hosts a peer team assessment of some aspect of performance or an event, the team can be held to a confidentiality agreement. Thus, the results of the assessment of performance can be very detailed with the utility and the peers participating in the assessment, and any case study that results from the assessment of performance or events can be detailed. Then, the performance feedback and/or case study can be "sanitized" to the utility's satisfaction, while still retaining the valued content, before sharing with a broader audience. If a peer organization that has participated in the case study desires additional details, it can contact the reporting utility and negotiate additional detailed information.

An additional challenge to the establishment of a robust performance feedback program occurs when ownership of the various processes has not yet been defined. Emergence of process ownerships at specific stakeholder group levels is needed to maximize the effectiveness of Smart Grid experience-sharing.

The above challenges represent barriers to a complete, timely, and open learning environment for peer utilities and organizations. If Smart Grid stakeholder groups participate in either the public or private performance feedback processes suggested above, important lessons learned can be shared. The emergence of change leaders is also needed to encourage this voluntary process to progress. Otherwise, a meaningful Smart Grid PFP process where lessons learned and best practices are identified, validated, and shared in the industry may not occur.

Conclusions and Call to Action

This document describes a Smart Grid PFP that includes a number of proven processes for collecting data and information. Additional methods are presented for evaluating and analyzing these data and information to arrive at logic-based conclusions. The context of these conclusions is formulated into actionable best practices and lessons learned or position statements that clarify or resolve key Smart Grid issues. The Smart Grid PFP naturally generates case studies and alerts as outputs but will only be successful if the Smart Grid stakeholders are willing to participate and share their experiences.

A number of questions need to be answered to move the performance feedback concept forward:

- Who should lead the development and implementation of the various aspects of a Smart Grid PFP?
- How might Smart Grid stakeholders be encouraged to support the Smart Grid PFP and willingly share their experiences for the benefit of others?
- What should the standard format and content be for documenting results?
- Where should the results reside (centralized repository)?

The first two questions are of high priority and must be addressed first. Clear ownership and leadership for the development and implementation of the various PFP processes is needed. With effective collaboration, various organizations could assume leadership for specific processes, i.e., it may not be necessary for one organization to "own" the entire Smart Grid PFP. What is important is the "care and feeding" of these processes such that a stream of information is generated to support the development and communication of case studies and other formats for the benefit of Smart Grid stakeholders.

Additionally, the reluctance to share experiences at the individual stakeholder level can greatly hamper the program and limit its effectiveness in benefiting others. Industry organizations representing specific stakeholder groups could assume a leadership role at their "membership" level, encourage the sharing of experiences needed to support case studies, publish the case studies, and maintain anonymity at the member level. Collaboration among industry organizations will be needed to minimize duplication of effort and to gain cross-functional data and information when appropriate.

The good news is that a number of industry organizations exist that generally "cover the waterfront" of Smart Grid stakeholders. Leadership at this level could create an environment for sharing and coaching. It could also serve to protect proprietary information and anonymity of individual members, yet still enable a free flow of information that would be helpful to the Smart Grid PFP and other stakeholders. Examples include:

- National Action Plan Coalition (NAP)
- GridWise Alliance (GWA)
- Smart Grid Consumer Collaborative (SGCC)
- Institute of Electrical and Electronics Engineers (IEEE)
- Edison Electric Institute (EEI)
- National Rural Electrification Cooperative Association (NRECA)
- Electric Power Research Institute (EPRI)
- Software Engineering Institute— Smart Grid Maturity Model (SEI)
- National Association of Regulatory Utility Commissioners (NARUC)
- NETL Smart Grid Implementation Team (SGI)
- University Research Consortiums
- Smart Grid Interoperability Panel (SGIP)

The full development of the Smart Grid PFP will take time and depends on whether or not this concept is accepted by the industry. It is time to raise the level of debate on the need for a Smart Grid PFP and how its development might move forward. This debate and discussion should begin at each of the Smart Grid stakeholder group organizations. A united front among these groups is needed to move the Smart Grid PFP forward.

While the debate ensues, Smart Grid activities are continuing. We must not, and cannot, wait until all the Smart Grid PFP questions are answered before beginning an experience-sharing process that can benefit others. Otherwise, great opportunities for improving the transition will be missed. Case studies could be a good first step.

Clearly, Smart Grid Case studies would be enriched if they could tap the data and information-rich stream created by the Smart Grid PFP. But even without that program, the case study represents a singularly effective and immediate mechanism for sharing experiences for the benefit of other Smart Grid stakeholders. A common approach for conducting case studies would be helpful in making their collective understanding and communication most effective. Appendices A through E outline a recommended approach for Case Studies and provide guidance on how the last two questions listed above might be answered.

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Appendix A: What are Case Studies and why conduct them?

Case studies are a good method to document the experiences and results identified during the Smart Grid transition. A number of organizations are already preparing case study type documents on various aspects of the Smart Grid transition—issues related to regulatory proceedings, issues with technologies (e.g. smart meters, communications, etc., time-of-use pricing experiments, etc.). Many of these case studies are being done by consulting groups and print media. This is a good first step.

To fully leverage the effectiveness of case studies, more are needed that cover the breadth of the Smart Grid transition— addressing such topics as resolving Smart Grid barriers, identification of best practices and lessons learned, successful regulatory approaches, project planning and management , design, installation, testing, operation, and maintenance of technologies and applications, consumer issues and involvement, etc. Additionally, a means is needed to help minimize duplication of effort on case studies, i.e., some form of coordination at a leadership level. Consistent approaches, content, output, and timely and effective means for communicating results would also be helpful.

Types of case studies

The primary objective of a case study is to identify actionable results that, when communicated to the affected stakeholders, can help them be more efficient and effective with their Smart Grid transition. Generally three categories of results are expected from case studies:

- **Best Practices** –proven processes that demonstrate positive results and, if implemented broadly, would represent much benefit for the industry.
- **Lessons Learned** – negative results from experiences that were ultimately corrected by revised methods. Well-communicated lessons learned prevent other stakeholders from making costly errors during the transition. Case studies about operational events, key regulatory disputes, failed projects, customer pushback, etc., represent broad lessons learned for the industry.
- **"Myth busting"** – unresolved issues or conflicting opinions on key Smart Grid transitional matters tend to paralyze progress. Resolution of these issues and opinions can reduce or eliminate uncertainties enabling progress to proceed.

The subjects of case studies are expected to be wide and varied. Development of case studies creates the opportunity to identify best practices and lessons learned and to clarify fundamental Smart Grid issues throughout the transition. These results can encourage better planning and risk management for future events that are first-time evolutions. And, when case studies are collected into a case study library and made available to all Smart Grid stakeholders, their complete value can be leveraged by all involved.

Why do a case study?

"Those that fail to learn from history are doomed to repeat it." – Winston Churchill

The electric industry directly touches every aspect of our society, so it is incumbent on the industry to minimize negative issues that arise from the Smart Grid transformation. Across the industry many changes are first-time evolutions for the stakeholders in the electric system. This often means the industry is taking action on uncertain ground. Mistakes are inevitable and many unknowns will be discovered, sometimes with undesirable results. The stakeholder community, including regulators, will tolerate a few mistakes along the way, but they will not tolerate the failure to learn from those

mistakes. Therefore, the industry must find ways to share the lessons learned and best practices across the stakeholder community.

One way for the industry to undergo change without experiencing the downside of recurring issues is to identify those key events and processes from which major learning can occur. These key events or processes can be examined, evaluated, and validated for their value across the industry. Each "case" can be documented and shared broadly, outlining those actions leading up to an event, the results of the event, the risks it represents, the effective corrective action taken, and any pre-event action that could have prevented it. Where necessary, anonymity can be maintained within the case study format.

Collaboration has proven to be a successful methodology for utilities, even after the onset of the competitive regulation arena. Examples include Edison Electric Institute (EEI), Electric Power Research Institute (EPRI), International Electrotechnical Commission (IEC), Institute of Electrical and Electronic Engineers (IEEE), etc., where ideas and research are shared for mutual gain.

What's in it for the utility? (The utility-centric case for collaboration)

The choices are:

- Conducting one or more pilot programs in many areas of contemplated Smart Grid technologies, under the varying conditions of the utility service territory, resulting in a fairly high dollar cost
- Conducting a smaller number of pilot programs and leveraging the experience gained by others in their pilot programs, thus saving money for the consumer to the satisfaction of the utility consumers and regulators (an expected lower total dollar cost)

Case studies and best practices may lead to the development of common standards and practices for Smart Grid deployments. Standards and practices based on real installation experiences are of common interest to individual utilities. Common standards and practices help to create a lower cost profile for Smart Grid assets by minimizing design types, standards, and protocols. It is less expensive to install, operate, and maintain fewer software systems, security systems, communication platforms, and equipment types.

Additional value can be achieved by avoiding or streamlining regulatory rate cases for pilot programs. By sharing best practices and lessons learned, regulators will see the cost effectiveness and performance issues leading them to hone in on specific areas of improvement or, if satisfied, acceptance. Regulators can submit case studies publishing the results of combined pilot programs under their jurisdiction, thus educating the regulatory community and other stakeholders and paving the way for expedited future Smart Grid programs.

These standards and practices may also be of long term value as utilities choose to merge and acquire Smart Grid assets that can be easily integrated, operated, and maintained after the acquisition. In addition, this would support future expansions providing backup to existing parts of the utility service territory, and existing parts of neighboring utility service territories.

What's in it for the consumer? (The consumer-centric case)

The residential consumers' view of the industry is formed by a mix of high expectations for good reliability, low cost of service, and superior customer service. When compared to the services provided by other industries these characteristics fall short in some respects, leaving consumers with a belief that the electric power industry just doesn't always stack up to others. The telecommunications and entertainment transformations of the last 20 years have set new consumer expectations for the electric industry.

The commercial and industrial consumers' view of the industry is formed by a mix of past curtailment of services and consumer business challenges. Businesses expect their suppliers to constantly find ways to provide better equipment, devices, and services at lower unit prices. This is driving a growing expectation for the electric industry to do the same— provide better service at lower prices. However, there is evidence that the commercial and industrial consumers have turned to others to mitigate the risk that the electric industry poses to their business. For example, the US businesses continue to spend about $5.5 billion in emergency and standby generation applications per year [10]. And the costs of poor power quality have been estimated to be in the billions of dollars per year.

Consumers expect a 21st century electric service to support their 21st century lifestyles and business needs. Consumers implicitly expect the electric service providers (utilities and retailers) to have processes in place to continuously improve service and hold the line on cost. Just as consumers expect utilities to know when outages occur or power quality is poor, they expect utilities to have processes in place to learn from their own or another's mistakes and best practices. Case studies are a mechanism that can help fulfill this need.

What's in it for the industry as a whole? (The Industry Case)

To date, many of the 3,300 US utilities have embarked on, or are contemplating, Smart Grid pilot projects. Having a thousand similar pilot programs will undoubtedly mark the industry as wasteful, uncoordinated, weak in the rollout of new technology, and not well-suited for future government grants for technology demonstration. The Smart Grid national rollout can occur earlier if pilot and early adopter results are shared and incorporated, thus attaining the performance results earlier than would occur if each utility embarked on a singular journey without sharing its experiences for the benefit of others. Experience sharing in this area should be viewed favorably by regulators who ultimately determine rate structures and which utility costs are recoverable from consumers.

There is momentum in the industry to tie utility performance to business revenue or loss thereof. As consumer businesses become more sensitive to losses, there will be increased pressure on individual industry sectors to avoid the loss of jobs and harm to the local economy. Infrastructure-intensive industries, like electric power, deemed in need of repair will face significantly increased regulatory oversight and inspection aimed at correcting the perceived deficiencies. Continuous improvement in overall operational metrics as well as during the deployment of Smart Grid systems across the country is needed—and case studies as part of a the Smart Grid PFP can help.

Why select the case study as a method for sharing?

The case study represents a common method for sharing lessons learned and best practices. Using a common format, case studies can facilitate reader understanding, making it easier for all to grasp the importance and applicability of the particular issues under study. Case studies can also be collected into a common library to support the education of all stakeholders. Enabling a common location for finding the latest and historical case studies requires less search time, facilitating the learning process. And case studies can be prepared in a fashion that "protects" the organization under evaluation, making the case study a simple and non-threatening method for identifying and sharing experiences across the industry.

Appendix B: When are case studies needed and of major value?

When prioritizing processes or performance to evaluate in a case study, high value topics can be determined by focusing on the intersection of areas with high financial impact, areas important to stakeholders, areas that can be realistically accomplished, and areas of broad applicability. Case studies in such high value areas will provide readers actionable recommendations to advance and improve their Smart Grid projects.

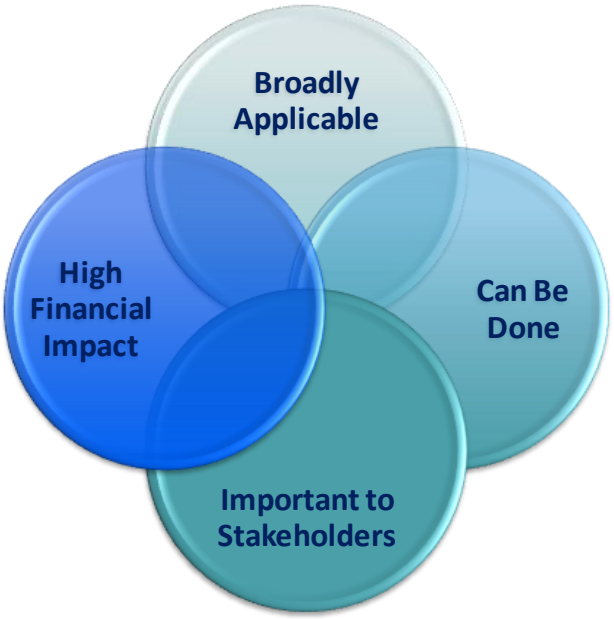

Figure 4: Identifying High Value Case Studies

Not every event, process, experience, or practice warrants a case study, therefore, selection criteria are helpful for identifying high value topics in each of these areas. Examples of such criteria include:

Importance to Stakeholders

- Deep value in a narrow area of each utility, energy provider, consumer, regulatory authority, or other stakeholder
- Mid to long-term value for the industry at-large or some stakeholder group in the industry
- A breakthrough or "game-changing" technology, process, or policy
- A detailed example of an event or best practice that is counter to the prevalent industry assumptions about a technology, process, or policy i.e., a "Myth Buster"
- Details about a technology, process, or policy that far exceeded or fell short of stakeholder expectations
- Explanation of current and troubling implementation issues (e.g., consumer engagement and acceptance, regulatory treatment, interoperability, cyber security policy, etc.)
- Breakthrough technologies and applications that have the potential to substantially reduce Smart Grid implementation costs or accelerate the benefits realized, (e.g., low cost energy storage)
- Approaches during planning and pre-implementation periods that have the potential to greatly reduce transition costs

Broad Applicability

- First-time evolutions that represent high risk and large financial consequences if unsuccessful
- Early identification of trends that, left unresolved, represent large future expenditures
- Specific applications/events that are common to a majority of regions that facilitate a more generic application of the results

Do-able

- The scope and cost of developing and sharing the case is realistic and achievable
- Data is available and accessible by the case study team to build and validate the case study
- Host stakeholders are willing to participate and provide the data and information needed to conduct the case study

High Financial Impact

- First-time evolutions that represent high risk and large financial consequences if unsuccessful
- Early identification of trends that, left unresolved, represent large future expenditures
- Breakthrough technologies and applications that have the potential to substantially reduce the cost of Smart Grid implementation
- Disruptive technologies and applications that can accelerate the benefits of the Smart Grid, e.g., low cost energy storage
- Approaches during planning and pre-implementation periods that have the potential to greatly reduce transition costs
- Solutions that can be scaled to allow significant economies

The best portfolio of case studies, over time, will be one that provides a broad, deep, and diverse knowledge base around the various aspects of the Smart Grid transition and considers the unique challenges the various stakeholders face. Some perspectives include:

- Geographical differences across the nation
- Physical location differences including temperature, humidity, dew point, elevation, sunlight, and air quality
- Cost structure differences including operating cost, construction cost, and consumer cost or revenue gained
- Regulatory environments where the results are impacted by wholesale markets and regional transmission organizations
- Regulatory programs such as Demand Response, interruptible rates, net metering, "de-coupling", etc.
- Consumer profiles related to urban / suburban / rural areas, income levels, and consumer education, in addition to change management programs employed during implementation
- Differences in stakeholder perspectives
- Various types of electric service providers (e.g., cooperative, municipal utility, investor-owned utility, retail electric provider, private third-party, etc.)
- Alternative technologies to address a common objective or set of objectives

Multiple case studies might be considered where operational or topological conditions vary. This will ensure the results are applicable to the differing situations, i.e., "one size may not fit all." Additionally,

conditions outside of normal expectations should be evaluated to ensure the results of the case studies are robust.

Table 2 identifies additional areas where case studies might lead to the identification of opportunities for improving the Smart Grid transition.

Table 2: Potential Areas for Case Studies

Project Management	Technical Aspects	Human Elements	Project Objectives
Project Planning	Requirements	Communication	Customer Satisfaction
Resource Management	Specification	Team Experience	Technical Success
Change Control	Test Plan	Sponsor Interaction	Product Quality
Procurement	Construction	Customer Interaction	On Schedule
Budget Management	Testing	Management Involvement	Within Budget
Risk Management	Rollout	Quality of Meetings	
Quality Control	Operations and Maintenance	Vendor Interaction	
Status Reports	Training	Employee Response	
Vendor Selection and Management	Documentation	Employee Training	

Appendix C: Who might want to conduct Case Studies and why?

Managing the case study portfolio includes developing an industry knowledge base with a high level of importance and applicability. From one perspective, it is desirable to make the submission of case studies to the portfolio open to all industry participants. This could result in a flood of candidate cases of which many would not pass the criteria for importance and broad applicability and perhaps create some duplication of effort unless topics are well coordinated. From another perspective, limiting submission of case studies to energy providers or any other single stakeholder could be viewed unfavorably by consumers and regulators. Those who are in the best position to prepare and communicate the most useful case studies include:

- Electric service providers including investor-owned utilities (IOUs), cooperatives, municipal utilities, retail electric providers, private third-parties, etc.
- Wholesale Market Operators
- Bulk power market participants (including transmission owners, generation owners, aggregators, etc.)
- Consumer advocacy groups
- Agencies representing policymakers and regulatory bodies
- Vendors and consultants
- Universities

Case studies on Smart Grid transition events that have either exceeded or fallen short of expectations in areas of cost, performance, customer acceptance, regulatory approval, and installation time are potentially high value activities for all stakeholders. The motivation and interest to develop a case study would probably lie with the stakeholder group who has the most to gain. Unfortunately, this may not be the organization in the best position to conduct the case study, particularly if the situation is one where the event results fell short of expectations. This may lead to other stakeholder groups conducting the case study, particularly if the results are expected to be significantly impactful to the overall Smart Grid transition.

For example, wholesale market operators would see substantial value in conducting case studies on Smart Grid solutions that decrease the cost of energy in the marketplace, solve congestion problems using distributed generation that unload congested nodes, or decrease the need for transmission expansion projects. Regional Transmission Organizations (RTOs) are expected to operate the transmission system reliably and at a low cost. Leading or participating in case studies that examine improvement opportunities in these areas would be in their best interest to support.

Participation in developing case studies requires motivation. In practice, many of the high value case studies will be related to the direct activities of electric service providers. However, as noted above, the motivation to develop a case study may not always be consistent with corporate objectives. Stockholders place value on increasing profits, which today come from the regulated return on investments. A smart grid project whose implementation delivers a new service to consumers with a reduced asset base ultimately may reduce stockholder profits under the current regulatory treatment.

Developing a case study solely for the benefit to the industry and the Smart Grid transition may not be adequate for encouraging some stakeholders. Some form of reward or requirement may be necessary to encourage stakeholders to embrace the case study concept.

How to overcome reluctance to participate in case studies

Case studies that highlight best practices and the more negative lessons learned have potentially high value, however, the reluctance to share experiences, particularly negative ones, is expected to be a challenge. If only positive results are published, stakeholders might repeat the same mistakes. Methods must be developed to convince stakeholders to share, particularly the lessons learned from missteps.

Stakeholders, such as electric service providers, must see a reward or requirement that is specifically applicable to them to become active participants in developing case studies. Presenting results of a negative event to the industry or public for the "good of the industry" is not likely to occur. Presenting results of a negative event to the industry or public because there is a reward or positive outcome is more likely.

Electric service providers might view recognition in the form of industry magazine articles as valuable if the article is positive. A stakeholder receiving the industry's "Top Ten Best Practices of the Year" award would be of high value. Such an award can bring positive attention to the utility or agency among its peers and regulators. On the other hand, consider a utility named as a lead contributor to one of the year's "Ten Worst Smart Grid Events". This latter case is not positive and one that most stakeholders would want to avoid. However, if the recognition was framed as a contribution this stakeholder made to preventing recurrence of this Smart Grid Event, i.e., the years "Ten Greatest Contributions to Smart Grid lessons learned", the incentive to share might be increased.

Rewarding, rather than punishing those stakeholders who are taking the early risks and are courageously implementing first time evolutions, is needed to provide the incentive for them to participate in a Smart Grid PFP and specific case studies. Financial rewards for both best practices and lessons learned should be considered. And, regulators should find methods to encourage utilities to take manageable risks and share their lessons learned without the fear of significant penalty. The risk—reward equation must be balanced if we expect to see forward progress with the Smart Grid transition. This is where case studies, properly performed, could stimulate forward progress.

In addition to specific rewards, participation can be encouraged through other industry efforts. While not having the power of individual rewards, peer recognition in industry organizations can provide encouragement for participation. For example, Edison Electric Institute (EEI) and GridWise Alliance (GWA) might sponsor industry workshops around newly identified lessons learned and best practices, influencing the attendees to share case studies. Early success stories published by a larger industry group can create an environment of "peer pressure" and encourage national interest in performance feedback and case studies. In addition, the independence and neutrality of the National Energy Technology Laboratory's (NETL) Smart Grid Implementation team might afford an objective environment that would encourage sharing of information.

How might data be collected to support a meaningful case study?

The Smart Grid PFP described earlier in this paper includes a number of processes from which data and information needed to support case study development can be acquired. Until a PFP and its processes are put in place and "owned" by key industry leaders, other means may need to be used to support case study development.

Industry organizations such as EEI, GridWise Alliance, Smart Grid Consumer Collaborative and the National Action Plan (NAP) Coalition are likely places for leading the development of case studies. Under the umbrella of these organizations and with collaboration among them, some of the performance feedback processes described above could be launched. And, by leading case studies under the banner of these organizations, the anonymity needed to protect individual stakeholders could

be provided. This would allow the free flow and exchange of data and information among the group members.

Appendix D: Case Study Content

A consistent format and content for case studies could help make the communication of their results more efficient and effective. Additionally, consistency will enable case studies to be more easily categorized, searched, and assembled into a cohesive library or portfolio. Such a library of case studies would facilitate the transfer of Smart Grid knowledge to the new generation of workers.

Generally, the case study should be an easy-to-read and understandable narrative. Complex and detailed discussions should be included as appendices to the report to give the more technical audience an option to "dig into the details" yet prevent disruption of the higher level discussion desired in the narrative. A suggested content for case studies is discussed below.

Executive Summary

The executive summary should be no longer than 10% of the length of the entire document. Executive summaries should be written for an audience who most likely do not have the time to read the entire document, so the content of this section should summarize the bottom line of the case study. Accuracy is essential because decisions may be made based on the content of this summary.

After beginning with a summary statement of findings, the executive summary should go on to provide a specific recommendation(s) for action geared toward the targeted executive level audience. This section should also provide an analysis and/or justification for the proposed action in terms the audience will consider important. This might involve a monetary analysis, but actions can be justified many ways, depending on the concerns of the audience and the topic of the case study. Other points to be discussed in the Executive Summary include:

- Clear description of the topic of the case study and its context
- Purpose and objective of the case study—why it was written
- Methodology / approach used to conduct the study
- Description of the technology, methodology or process used in the pilot project to be described in the case study

Issue Definition

This section should briefly but clearly describe the topic being studied and why this topic is important to the Smart Grid transition.

Case Study Methodology

This section should include a brief discussion on the methodology used to conduct the case study. The methods should be described including how the data and information was collected, evaluated and the results determined. The performance feedback processes described above should be referenced when appropriate.

Evaluation and Analysis Details

This section should include the high level details of the case study, summarize the input data and information, discuss the insights that emerge from its evaluation, and describe how those insights relate to the topic under study. The following content areas should be considered for inclusion in this section:

- ***Chronology***—a timeline of activities related to the case study topic should be presented, including all pertinent activities to provide the overall context and help the reader understand the timing and interaction of key activities

- ***Industry O*verview**—provides the relevant background on how the overall industry dealt with the matter in the past and information on the current status
- **Relevant History** — describes the specific situation of the case study players, as it relates to the subject studied
- **Technology Status**—describes the role of technology and applications relative to the topic. Technology includes traditional information technologies, communication systems, and other physical devices such as power electronics, energy storage, etc
- ***Conditions / environment*—**a discussion on the conditions existing when the topic being study occurred, such as,
  - Intangibles (e.g., attitudes and feelings of consumers, employees, regulators, etc.)
  - Technical attributes (e.g., engineering parameters, demographics, bandwidth, capacity, etc.)
  - Environmental attributes (e.g., temperature, humidity, elevation, geographic location, etc.)
- ***Options / Alternatives considered***—a discussion on the various considerations and perspectives considered when arriving at the stated conclusions
- ***What worked***—a discussion on the successful or positive elements of the study that are worthy of repeating in the future
- ***What failed and how was it resolved***—a description of the negative or unsuccessful aspects discovered during the study and any corrective actions that were taken, or could have been taken, to prevent them

Results

The results of the analyses and evaluation of the event or topics under study should be described in this section. The conclusions reached as well as the logic used to reach the conclusions should be discussed (logic based conclusions). Best practices and lessons learned should be clearly presented along with clear actionable recommendations. Cost / benefit analyses should be included when appropriate. If the objective of the case study is to clarify an issue or state a position (myth busting), the basis and rationale for the stated position(s) should be presented. Applicability of the recommendations to those who would use them to improve their Smart Grid implementations should also be delineated. The use of charts, graphs, and images may be helpful in expressing the results.

Validation

Performance validation is assessing whether data collected and measured are a true reflection of the performance being measured and having a clear relationship to the mission of the activity. This definition is also appropriate in the validation of a case study. Validation insures that only accurate information is conveyed to the reader. Publication without validation allows editorializing and, even worse, advertising, and bad or misleading information produces poor decisions. Validation of the results can occur in several ways depending upon the content of the case study. Examples of validation techniques and criteria include:

- Goals/Measures are realistic, measurable, and understandable to users
- Source data are well defined, documented
- Definitions are available and used
- Data are verified
- Any data limitations are explained and documented
- Comparison to similar databases are done and documented
- Comparisons with similar work performed by other industry groups

- Alignment check with DOE developed Smart Grid Principal Characteristics
- Peer reviews conducted by independent industry experts to verify accuracy and quality of data
- Interviews with industry professionals familiar with the topic studies
- Follow-up interviews with those who were involved in the event or topic to ensure accuracy of the information used to formulate conclusions
- Calculations done by other independent methods
- Certification by responsible party that data accuracy has been checked each reporting period
- Certification by responsible party that applicable procedures were followed during the conduct of the case study

Discussion Questions/ Open Issues

Identify and discuss specific or implied questions that were not fully addressed by the study, or new issues that the study raised. These may then be recommended for evaluation in future case studies.

Call to Action

This section includes a brief discussion on how the results of the case study could be applied to change behaviors and practices across the industry, or certain segments of the industry. Expected benefits resulting from the implementation of the recommendations are summarized to provide motivation for all stakeholders.

References

Provides a listing of sources used in the conduct of the case study.

Figures/Exhibits

These supplement the text of the case study. Technical details that support the narrative in the body of the document should be included here to give the more technical audience a more detailed basis for understanding the report.

Searchable Key Words

Create a list of key words to aid in searching for topics of interest.

Appendix E: How might the results from Case Studies be communicated?

Communication of information gained during the performance of Case Studies is a critical component for advancing the Smart Grid Transition. Many stakeholders in the Smart Grid arena will be interested in the improvements recommended in the Case Study findings, including regulatory bodies, technology and system vendors, utilities, consulting organizations, Smart Grid alliance groups, and governmental agencies.

There are several methods recommended for communicating Case Studies to Smart Grid Stakeholders:

- Presentations at conferences
- Workshops
- Articles in Smart Grid publications
- Website Postings
- Webcasts
- Social Media
- Blogs

Use of blogs, webcasts, and other social media should be leveraged as more organizations and event planners utilize these communication methods. Communication methods may also differ based on the type of case study, whether the results fall into the lessons learned, best practices, or myth buster categories. For example, the details in a case study that expose a lesson learned during a Smart Grid implementation may warrant a workshop setting that enables deep discussion and debate of the findings, while a best practice discussed in an article or posted on a website may be sufficient to communicate the details effectively.

Generally, it is recommended that the performer of the Case Study communicate the findings to the stakeholder groups. When case studies are developed by industry groups, the results might be posted on the organization's website and considered for the group's larger conferences to ensure its members are made aware of the results. Broader communication is often appropriate for case studies that reach beyond the specific industry group—the Smart Grid Clearinghouse and other Smart Grid trade journals should be considered for wider dissemination. The NETL Smart Grid Implementation (SGI) team expects to prepare several case studies in the near future and post on the NETL SGI website (http://www.netl.doe.gov/smartgrid) to complement the expected delivery of presentations and workshops on the findings when requested.

Sharing the results of the Case Studies by these methods will go a long way to increase the industry's understanding and alignment as the Smart Grid transition continues. Coaching by leading industry organizations, to proactively reach out to those who can benefit from the information, will also accelerate experience-sharing.