Best Practices for Utility Storm Response

Lavelle A. Freeman
GE Energy

Gregory J. Stano
Wisconsin Public Service Corporation

Martin E. Gordon
Gordon Utility Consulting

DistribuTech 2010

http://www.dstar.org
Outline

DSTAR Overview
Storm Damage
Before the Storm – Preparation
During the Storm – Response
Communications
Use of Technology
After the Storm – Recovery
DSTAR Overview
This work was sponsored by DSTAR

**D**ISTRIBUTION **S**YSTEMS **T**ESTING, **A**PPICATION, AND **R**ESEARCH

DSTAR is a consortium of utilities organized to cooperatively sponsor *practical* distribution systems research. [http://www.dstar.org](http://www.dstar.org)
What Distinguishes DSTAR?

• Practical, near-term distribution focus
  – Equipment testing and product evaluation
  – Niche software for standards and engineering support
  – Whitepapers and reports on pressing industry issues
• Responsive, intimate, direct control by members
  – Members select, prioritize and direct project execution
  – Program members own an undivided share of IP
• Low overhead, efficiently managed organization

Serves A Largely Overlooked Area of Research
Active Member Utilities
Program 11 and Program 12

Ameren Corporation
Aquila/KCP&L
Duke Energy
NRECA
PacifiCorp

Progress Energy
South Carolina Electric & Gas
Southern Company
We Energies
Wisconsin Public Service
DSTAR Program Structure

• Research project bundling
  – multiple topics in each “Program”
  – meets diverse needs of member utilities
• Membership in a Program provides all R&D fruits of projects in Program
• Program duration 1.5 - 2 years
• Member contribution is $40k or $90k per program (depending on size)
• Utilities can obtain retroactive membership for prior programs to secure results and deliverables
• Planning meeting twice per year
• GE Energy’s EA&SE group provides program management and administration services

Same Structure Since Inception in 1986
Some Research Area Examples

Engineering and economic productivity tools
- Engineering design and analysis software
- Total owning cost & economic analysis tools

System protection, operating safety, and reliability
- Ferroresonance Guidelines
- URD overvoltage protection
- Padmount transformer fault withstand

Engineering guidelines and industry perspectives
- Distribution engineering eHandbook
- DG interconnection white paper
- Storm response best practices white paper

<table>
<thead>
<tr>
<th>Program</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
<th>P11</th>
<th>P12</th>
<th>P13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Analysis Software</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Guidelines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Testing/Evaluation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry Perspectives/White Papers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Reliability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend
DSTAR Program 12 Projects

Program 12 is wrapping up

1. Software maintenance and website update activities
2. SEDS Enhancements – loss optimization, lighting design
3. Electronic Data handbook (eHandbook) expansion
4. Improving energy efficiency of utility systems
5. Impact of non-wood poles on reliability
6. Changing nature of loads and the impact on utilities
7. Guidelines for current-limiting fuse application
8. Capacitor control guidelines: choosing optimal type and settings

Program 13 is kicking off – now is the time to join!
Storm Damage
Utility Outage Events and Primary Causes

The majority of utilities (87%) face an emergency outage event at least once per year.

23% face it more than 5 times per year.

Recent storm occurrences

In March 2010 a wind and rain storm swept through the greater New York area causing a tremendous amount of damage and over 255,000 outages in the five boroughs and on Long Island.

In each of the last three years Ameren has been hit with severe wind and ice storms that have caused tremendous infrastructure damage and disrupted millions of customers in Missouri and Illinois, some for up to eight days.

In 2005, Hurricane Katrina swept through Florida and then slammed into Louisiana, Mississippi and Alabama destroying entire communities, devastating lives and causing millions of outages across several utility systems, many lasting as long as months.

In 2004, Florida was hit with three hurricanes within a month that caused widespread outages for weeks on Florida Power & Light and Progress Energy Florida systems.

In 2003, Hurricane Isabel struck the mid-Atlantic causing power outages to more than 3 million customers in Maryland, Virginia and Washington DC for 1 to 2 weeks.

In December 2002, a major ice storm in the Carolinas disrupted power to nearly 2 million Duke and Progress Energy Carolinas electric customers, some for over two weeks.
NY wind and ice storm damage

Images from http://www.newrochelletalk.com/node/1658
Hurricane Katrina Damage
Hurricane Damage
Tornado damage at a substation
Ice storm damage

From 2003 Kentucky PUC Ice Storm Report
Utilities doing more with less …

Storm restoration activities are under more scrutiny

• recent particularly devastating events
• increasing customer awareness
• customer demand for better performance and service

“Based on equipment damage, recent storms are not any more or less severe than storms in the past. But, the rate at which responding utilities can restore systems has increased, even while as the number of restoration workers deployed has decreased.” ~2004 EEI Report
Before the Storm
Storm Hardening

When a 60-foot tree which is 40 feet from a power line falls on that line, no amount of tree trimming is going to prevent an outage – Ameren Chairman, CEO and President after 2006 ice storm

Trees are the root of the problem

It must … be emphasized that even if all of the trees in AmerenUE’s service territory were trimmed per current procedures immediately before these storms hit the St. Louis area, much of the damage observed would have still occurred – Missouri Public Service Commission
Storm Hardening Activities

Tree trimming and vegetation management

System design and maintenance
  • Undergrounding OH lines
  • Pole inspection/replacement
  • Robust design and construction

Backup and standby generation
Emergency Response Plans

Develop and maintain a comprehensive ERP to

- provide a uniform, corporate-wide approach for managing emergencies,
- define roles, responsibilities and accountability,
- document recovery procedures
- provide business continuity plan (BCP)

CRN Emergency Restoration Planning Guide,
Training and Drills

• Provide flexible training options
  – sub-annually, on demand, at orientation, on role changes
• Budget and track training costs
  – not just assign to overhead!
• Evaluate effectiveness by testing and measuring
• Conduct annual storm drills to exercise and refine all phases of the ERP
• Use outside advisors to observe and make recommendations
Early Warning and Tracking

AmerenUE August 2005 Thunderstorm

- On Saturday afternoon August 13, 2005 at approximately 4:00 p.m., a series of thunderstorms developed over central and eastern Missouri, moved into the St. Louis metro area and passed into western Illinois. By 5:00 p.m. AmerenUE reported 151,000 customers out, and before the event was over, approximately 217,000 customers lost power. However, for hours after the storm passed through AmerenUE’s service territory, AmerenUE did not know the extent of the damage; the National Oceanic and Atmospheric Administration (NOAA) had not yet reported any information regarding the downbursts.

Highest outage areas are where downbursts occurred
Storm Predictability

Inherently difficult to predict and forecast certain storm events

Based on data from a DSTAR utility member survey

Within minutes of the Florida coast on a Friday afternoon, Hurricane Charley, baffled scientists by suddenly strengthening and making a last-minute swerve to the right striking 70 miles south of where it was predicted to hit, flattening the Florida town of Punta Gorda in Lee County, killing several people and injuring many others. A large number of residences and businesses in Lee County lost power during the storm, some remaining without for as long as a week. A Florida Power & Light spokesman commented, “I don’t know that we expected (the hurricane) coming down there and being the category that it was.”
Weather Prediction and Advanced Warning Measures

• Use storm detection and tracking technology for early warning

• Wide range of available products and services …
  – NOAA National Weather Service
  – Public News, Media and Internet Sources
  – Private and Commercial Meteorological Services
  – Commercial Weather Forecasting Applications
Emerging Storm Warning Technology

NWS Storm-Based Warnings
- shift away from county-based warnings to warnings based on storm boundaries

Deep Thunder (IBM)
- uses a mini-supercomputer to include information about the local area $\Rightarrow$ increased resolution
- Real-time downburst information

Deep Thunder operational forecast for ConEdison January 2005 windstorm, Westchester County, NY
Forecasting Storm Damage

Use damage prediction methods to forecast:

- damage severity
- Location
- resource needs
- restoration times

Storm classification tables

Computerized storm models

Commercial damage prediction applications
Activation and Mobilization

Key mobilization questions and decisions

- When should the storm center be activated?
- When should crews be mobilize and external resources secured?
- How many resources are needed to reduce outages as desired?
- When should resources be increased, reduced or released?

Develop a categorization method that prescribes levels of activation based on storm characteristics

<table>
<thead>
<tr>
<th>Storm Center Activation Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Level Zero (normal conditions)</td>
</tr>
<tr>
<td>- Dispatching from Central Dispatch Center</td>
</tr>
<tr>
<td>2. Level One (more than normal, less than 8 hours) —</td>
</tr>
<tr>
<td>- Dispatching from Central Dispatch Center with added resources</td>
</tr>
<tr>
<td>3. Level Two (more than 8 hours, less than 12 hours) —</td>
</tr>
<tr>
<td>- Storm site mobilized for resource management</td>
</tr>
<tr>
<td>- Dispatching continues from Central Dispatch Center with added resources</td>
</tr>
<tr>
<td>4. Level Three (more than 12 hours, less than 24 hours) —</td>
</tr>
<tr>
<td>- Storm site mobilized for resource management</td>
</tr>
<tr>
<td>- Nearest Regional Dispatch Site is mobilized for dispatch of the storm site.</td>
</tr>
<tr>
<td>5. Level Four (more than 24 hours) —</td>
</tr>
<tr>
<td>- Storm site mobilized for resource management</td>
</tr>
<tr>
<td>- Regional Dispatch site is mobilized for dispatch of the storm site; Storm Site assumes dispatching functions with resource assistance.</td>
</tr>
</tbody>
</table>
Baltimore Gas and Electric's Hurricane Isabel Mobilization Timeline

Hurricane Isabel struck the Southeast coast of the U.S. on September 18, 2003, causing widespread damage and flooding, and disrupting power to almost 800,000 customers in Baltimore Gas and Electric’s (BGE) territory. In response to the storm, BGE mobilized the largest workforce in its history – nearly 6400 people, including over 2800 external personnel mobilized from 27 states and Canada.

- **September 6th, 2003** – BGE began monitoring Hurricane Isabel as a tropical depression
- **September 8th, 7 a.m.** – Mid-Atlantic Mutual Assistance (MAMA) conference call to discuss Hurricanes Fabian and Isabel and Tropical Depression Henri
- **September 15th** – Based on the hurricane track and intensity, BGE initiated its Severe Impact Storm (SIS) procedures and decided to pre-mobilize crews
- **September 15th, 7 a.m.** – BGE participated in a MAMA Conference Call where it formally requested the assistance of 300 external construction crews. Other MAMA utilities were also requesting aid. No commitments were received because of the threat to most of the East Coast
- **September 15th, 9:30 a.m. and 5 p.m.** – BGE participated in Southeastern Electric Exchange (SEE) Mutual Assistance Conference Calls and received commitments of 150 line personnel from Entergy and 107 line personnel from Southern Company
- **September 15th, 6 p.m.** – MAMA conference call, BGE learns that no MAMA utilities could provide assistance until after the storm had passed
- **September 15th, evening** – BGE began contacting Edison Electric Institute (EEI) member utilities and contractors within a 1000-mile radius of Baltimore and the leadership of contractor organizations within 500 miles to secure resources
- **September 16th** – BGE continued to monitor the weather and participate in daily mutual assistance calls as well as contact outside construction entities via the External Mobilization Team
- **September 17th** – By evening, about 150 external overhead crews were on the BGE system
- **September 18th** – Storm hits the East Coast; BGE continued to monitor and participate in daily mutual assistance calls
- **September 19th** – By early morning, an additional 134 overhead crews were pre-positioned to begin service restoration, bringing the total of pre-mobilized crews to 284 overhead and 85 tree
- **September 19th** – BGE received commitments for additional crews bringing the total to 308 external overhead crews and 135 external tree crews

September 19th, 10 a.m. – It was decided to increase the number of external overhead crews to 450; commitments were secured by mid-afternoon

- **September 19th, early evening** – Based on the magnitude of the damage and number of customers impacted, it was decided to bring in a total of 600 external overhead crews and 190 external tree crews, and have additional crews ready to work by Monday, September 22nd at 5 a.m.
- **BGE continued to participate in twice-daily Mutual Assistance Calls throughout the weekend**
- **September 23rd** – After another storm caused another 56,000 outages overnight, the number of external overhead crews was increased by 40 and external tree crews by 10. BGE secured commitments from utilities to the north (PECO and PP&L) who were releasing contractor crews

In total, 711 total external overhead construction crews (utility and contractor) as well as 200 external tree crews were secured and deployed on the BGE system.
Mutual Assistance

- Develop an internal mutual assistance plan that is integrated into the ERP
- Have strong in-place mutual aid agreements
- Maintain relationships with partners year-round
- Explore IOU-Cooperative mutual aid relationships
- Develop processes for forecasting, capturing and tracking mutual aid costs

**SEE Joint Mobilization Process**

**Pre-storm Planning**
- Conference calls
- Weather forecast
- Damage prediction
- Initial resource requirements
- No releasing of SEE resources pending joint decision (regionally significant events)

**Commitment to Action**
- Identification of resource pool
- Identification of needs
- Joint decision on which companies will respond to those in need

**Mobilization**
- Interim staging for deployment (as necessary)
- Companies in need work directly with assigned supporting companies
- Joint SEE decisions are honored
Materials Management and Logistics

Backbone of the restoration effort!

You can’t work more people than you can logistically house and feed!
During the Storm
Storm Restoration Priorities

Transmission

Substations

Distribution restoration

Safety calls

3-phase feeder

Priority customers

1-phase lines

Lines serving neighborhoods and multiple customers

Individual customers
Damage Assessment

Typically two phases:

• Initial (quick) assessment - 1 to 4 hrs
• Detailed (full) assessment - 24 to 48 hrs (20-40-40 rule)

Develop processes/technology to efficiently collect and transfer damage data to operations center

Use mobile communication technology, GIS, OMS, AMR/AMI to streamline collection and reporting
Service Restoration

- Crews are dispatched to repair damage and restore service after damage assessment data is analyzed to determine the best strategy
  - Deploy crews in proportion to damage as well as outages
  - Continually assess needs and redeploy crews as restoration progresses
  - Coordinate tree crew movements with line crews needs
  - Subdivide areas and push responsibility down the line
  - Coordinate switching and clearance activities for maximum efficiency

At Puget Sound Energy, the operators in Electric System Operations issue clearances for the distribution system. The process is reasonably straightforward, requiring only open radio communication between the crew leader, and the regional operator. However, during the December 2006 windstorm the abundance and backlog of requests for clearances delayed crews in the performance of repairs. In many cases, crews routinely waited for up to two hours to obtain clearances before starting work. This meant that four to eight people were standing around until the clearance was obtained, delaying restoration, and leading customers observing the crews to believe that they were simply not working. ~ Puget Sound Energy, Lessons Learned from December 2006 Windstorm
External Communications

Our customers do not want to be in the dark literally or figuratively. ~ Tom May, CEO NSTAR

Comprises all contact outside of the utility,

- with customers, government officials, community leaders, the media, public safety organizations, other utilities and emergency management organizations

**Good communications** makes it much easier to bolster and maintain the perception of a successful restoration effort and well run utility

**Poor communications** can doom an otherwise statistically and logistically successful effort, in the eyes of consumers, the media, elected officials, regulators and shareholders
Good Communication Practices – With Customers

• In an outage, customers typically want to know 3 things:
  – Does the utility know my power is out?
  – When will power be back on?
  – What caused the outage?

• Provide customers with additional information about the outage when they call to report

![Chart showing PQ&R Score for different numbers of information points provided.](chart.png)
Good Communication Practices
– With the Media

The goal of media communications should be to provide all the necessary information to the media for public consumption

• Use the media to establish a favorable impression of the restoration effort
• Be proactive in taking your story to the media, especially stories that highlight the restoration workers
• Consider giving the media controlled access to areas of activity in order to shape the story
• Communicate restoration goals and trends
Good Communication Practices
– With Officials, and Other Utilities

Some of the loudest complaints and demands are from government officials and emergency management personnel who need data to distribute information or make contingency plans

• Maintain a contacts database and update at least annually and after each election
• Designate liaisons to provide information to government and emergency management officials
• Include city and county officials in major-outage-related informational meetings prior to storm season
• Coordinate with electric cooperatives and other resellers that rely on the utility for power
• Provide collaborative planning and training ("storm schools")
Estimated Time of Restoration (ETR)

• Providing accurate and timely ETRs directly affects customers’ perception of restoration efforts
  – Delayed and overestimated ETRs lead to frustration
• Use internal metrics to monitor and improve ETRs and outage performance
• Provide accurate, stable, and reasonable ETRs
• Communicate ETRs to customers proactively via different modes
• It may be better to avoid providing specific ETRs if they are not reliable

KCPL has developed a leading outage communication system that notifies customers of outages, ETRs and restoration via cell phones, email and pagers, with voice and text, and updates the messages every hour. 43% of their customers have registered to receive messages from the system. ~ T. Burke, N. McCurry, and R. Hogan, KCP&L Outage Communication: How KCP&L keeps Everyone Up to Speed When the Lights Go Out,
Internal Communications

- Communications within the utility enterprise needed to manage and coordinate the storm response
  - Control critical-to-mission communication systems
  - Coordinate communications among responding utilities and with public safety entities
  - Deploy backup communication systems
  - Include IT personnel in command center
  - Install and maintain permanent backup generation at service centers and communication facilities
Technology Use

- Interactive Voice Response Units
- Outage Management Systems
- Automated Meter Reading/Advanced Metering Infrastructure
- Geospatial information Systems
- Storm Center Web Portals
  - Attributes: Prominent Storm Center/Outage Link, No. of Clicks, Report Outage Online, Storm Alert Sign-Up, Outage Data/Maps, ETR availability, Storm Prep/Safety Information, Restoration Processes & Priorities, Customer Responsibility, Spanish Language Info/Content
After the Storm

Ramp-Down
• Conduct follow-up inspections to identify missed repairs or unsafe conditions
• Verify and document circuit state, equipment and topology

Clean-Up
• Perform extensive survey or as-repaired system and implement a standardization plan
• Use GIS and GPS-enabled technology to aid post-storm survey

Review – Lessons Learned
• Survey mutual-aid utility personnel and off-system contractors
• Conduct town-hall meetings and survey customers
• Prepare or commission a comprehensive assessment report with issues and recommendations

“Nearly all of the affected utilities continued to work jobs associated with the ice storm well into the summer months. Lines that were “temporarily” fixed in order to restore service had to be permanently repaired. Poles that may have been “spliced” were replaced. During restoration, lines are often cleared just enough to restore service, and vegetation management practices take a back seat to getting power back on. This speeds up repair, but it is essential that utilities document and return to areas that need further trimming. Danger trees, which are those with hanging limbs, dead sections, etc., still pose a threat to electric lines even months after the storm, especially in windy conditions.” ~ The Kentucky PSC, Assessment Of Electric Utilities Response to the February 2003 Ice Storm, February 6, 2004
Thank You!

For more information, contact DSTAR

http://www.dstar.org