Minnesota All Hazard Mitigation Plan Rural Electric Annex

Introduction

Electric Cooperatives are private, locally operated electric utility businesses that provide service to Minnesota customers. Electric cooperatives are owned and regulated by their customers and governed by a board of directors elected from the membership of the customers. The board of directors set policies, procedures, and rates that are implemented by the cooperative's professional staff. Electrical cooperatives pride themselves in providing near-cost electric service to members. Nationally, investor-owned utilities maintain approximately 73% of all customers, municipally owned utilities maintain 14% and cooperatives maintain approximately 13% of all customers[i]

History

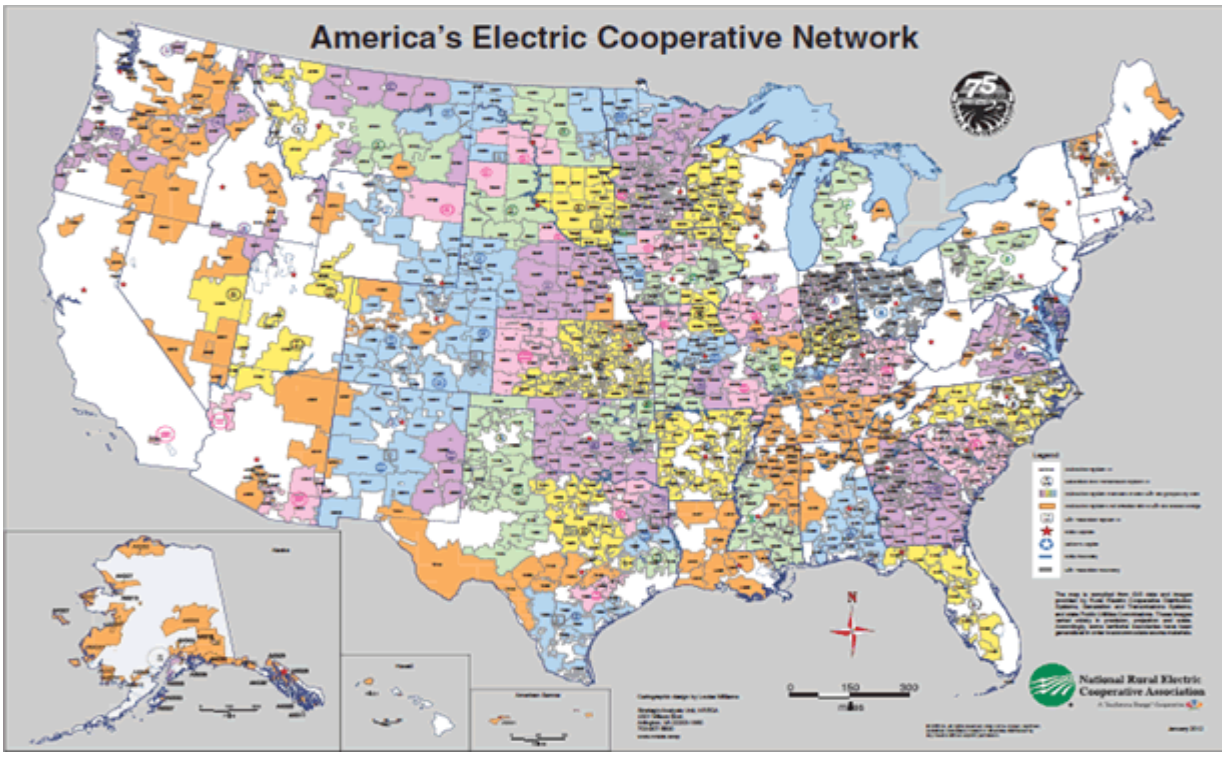
The establishment of electric cooperatives was the result of a lack of electrical service to rural areas of the United States. The 1930's rural areas across America were still without electricity – an estimated nine out of ten rural homes were without electricity[ii]. Investor-owned utility companies not willing to provide service to rural areas throughout the country. Investor-owned utilities believed there would be insufficient revenue in rural areas to support the needed infrastructure investments. The Rural Electrification Administration, established under Franklin Delano Roosevelt's "New Deal", was created on May 11th 1935, with the primary goal of promoting rural electrification.

America's Electric Cooperative Network

The electrical transmission network of the United States is complicated and involves three main sections (Eastern Interconnection, Texas Interconnection and the Western Interconnection). These sections supply power to the U.S. which cooperative networks (G & T and Distribution) are consumers or providers to the network.

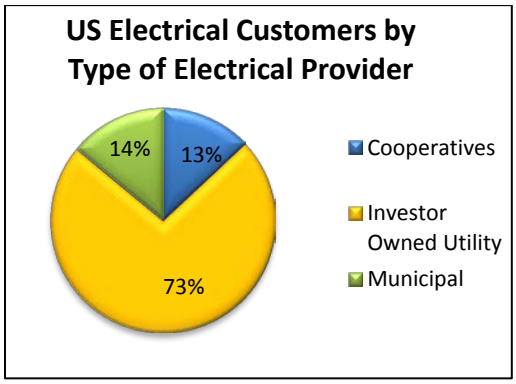
According to the U.S. Energy Information Administration (EIA) there are 812 cooperatives in the United States. Of these cooperatives, some are generation and transmission and some are solely distribution cooperatives. Typically, generation and transmission cooperatives serve a large number of distribution cooperatives who in turn serve consumers.

Figure 1 America's Electric Cooperative Network



Consumers are served by; cooperatives, investor owned utility companies, or municipalities. According to the National Rural Electrical Cooperative Association cooperatives serve approximately 13% of the U.S. electrical customers.

Figure 2 U.S. Electrical Customers by Type of Electrical Provider



The original intent of cooperatives was to serve rural areas so it is no surprise that cooperatives make up a significant portion (42%) of electrical distribution lines (Figure 3). Cooperatives also by their rural nature are more inclined to serve residential customers and not commercial or industrial service sectors. This is evident when comparing cooperatives percentage sales by kWh to municipal and investor owned providers (Figure 4). Co-ops are more likely to serve residential customers in rural parts of the U.S. compared to municipal and investor owned providers. This creates large networks for cooperatives to manage and maintain with less customers. When comparing revenue per mile it is clear that rural electric cooperatives are at a

significant economic disadvantage to investor owned and municipal distribution providers (Figure 4).

Figure 3 Percentage of Miles of Distribution Lines

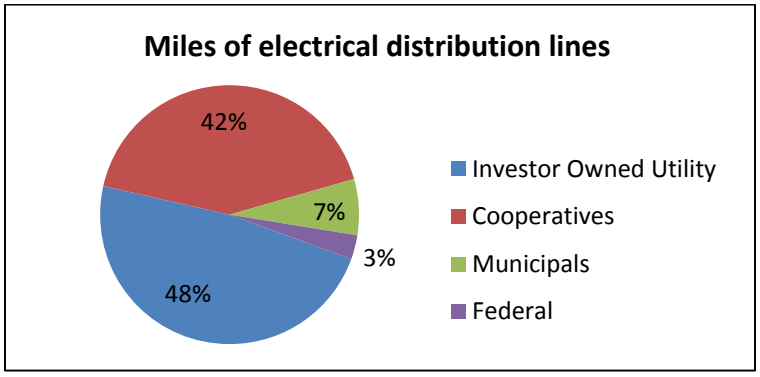


Figure 4 Percentage of Sales by kWh

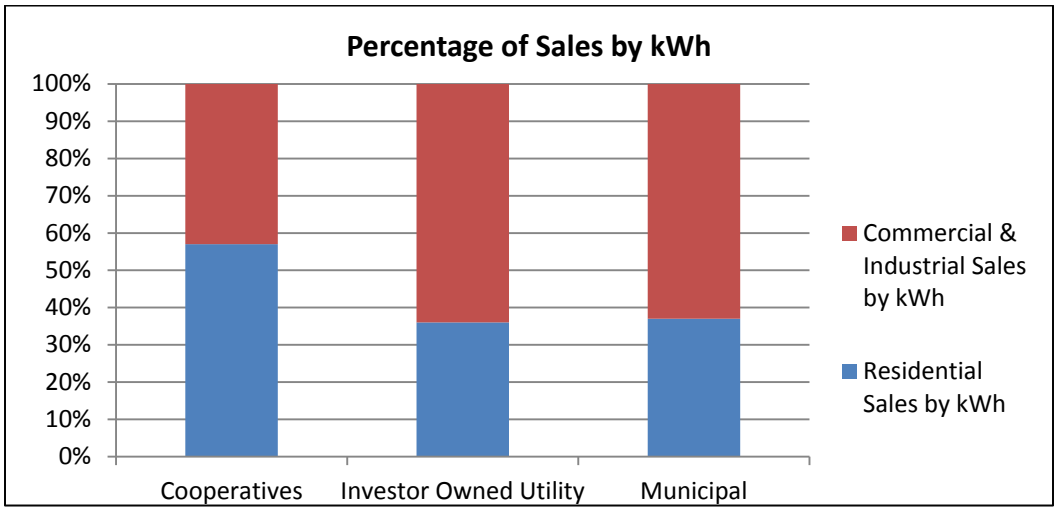
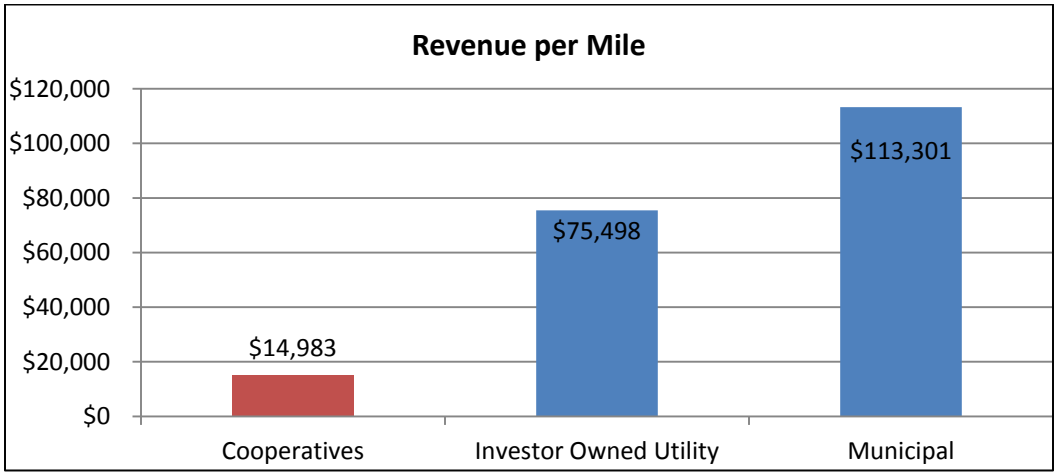


Figure 5 Revenue per Mile for Electrical Distribution Providers

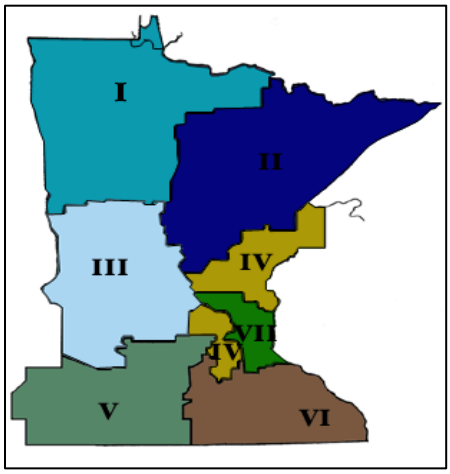


Minnesota Cooperatives

Minnesota electrical cooperatives are very similar to cooperatives nationwide. Cooperatives are split into two categories, electric distribution cooperatives and generation and transmission (G & T) cooperatives. Generation & Transmission Cooperatives generate electricity and transmit it to distribution cooperatives. Distribution cooperatives purchase wholesale power (usually from a generation & transmission cooperative) and deliver it to members. There are six generation and transmission cooperatives and forty-four electric distribution cooperatives that serve Minnesota.

The Minnesota Rural Electric Association has split the state into seven regions to better serve its cooperative members.

Figure 6 MN Rural Electric Association Regions



All cooperative businesses adhere to seven guiding principles:

1. Voluntary and Open Membership -- Cooperatives are voluntary organizations, open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination.
2. Democratic Member Control -- Cooperatives are democratic organizations controlled by their members, who actively participate in setting policies and making decisions. The elected representatives are accountable to the membership. In primary cooperatives, members have equal voting rights (one member, one vote) and cooperatives at other levels are organized in a democratic manner.
3. Members' Economic Participation -- Members contribute equitably to, and democratically control, the capital of their cooperative. At least part of that capital is usually the common property of the cooperative. Members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Members allocate surpluses for any or all of the following purposes: developing the cooperative, possibly by setting up reserves, part of which at least would be indivisible; benefiting members in proportion to their transactions with the cooperative; and supporting other activities approved by the membership.
4. Autonomy and Independence -- Cooperatives are autonomous, self-help organizations controlled by their members. If they enter into agreements with other organizations,

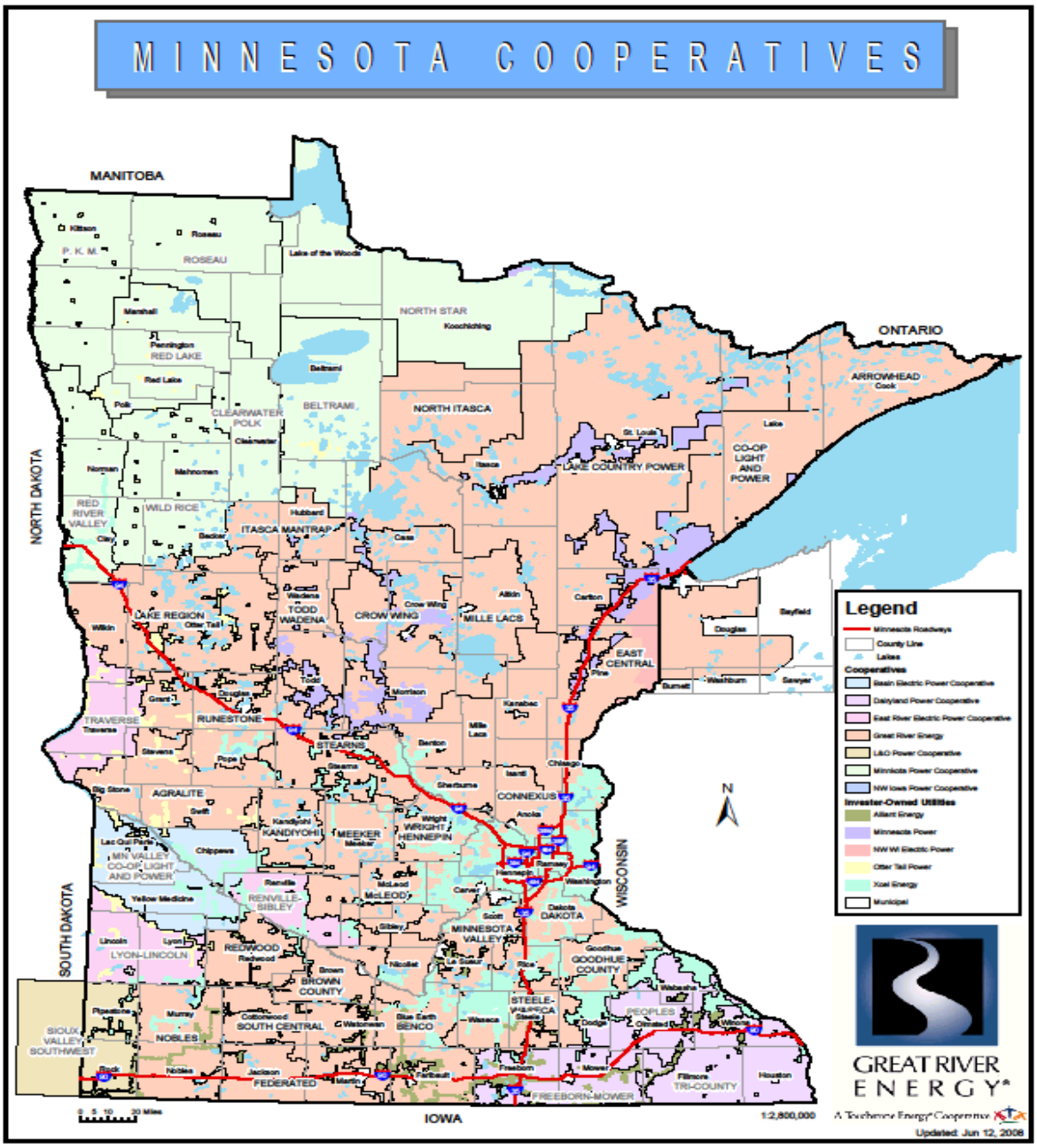
including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their members and maintain their cooperative autonomy.

5. Education, Training, and Information -- Cooperatives provide education and training for their members, elected representatives, managers and employees so they can contribute effectively to the development of their cooperatives. They inform the general public, particularly young people and opinion leaders, about the nature and benefits of cooperation.
6. Cooperation Among Cooperatives -- Cooperatives serve their members most effectively and strengthen the cooperative movement by working together through local, national, regional and international structures.
7. Concern for Community – …focusing on member needs, cooperatives work for the sustainable development of their communities through policies accepted by their members.

Minnesota is served by six generation and transmission cooperatives, five investor owned utilities and a number of smaller municipal operations. Figure 7 depicts the service area of all generation and transmission companies in Minnesota. Generation and Transmission companies can serve all or a part of a distribution company. Minnesota is also served by forty-four distribution cooperatives (Figure 8). Nearly all distribution cooperatives serve more than one county and very few are the only service provider for a county. Together the distribution cooperatives employ approximately 2,400 people in Minnesota, serve approximately 760,000 customer meters (about 1.9 million people, 35% of the state's population) and cover 85% of the geographic area of Minnesota[iii].

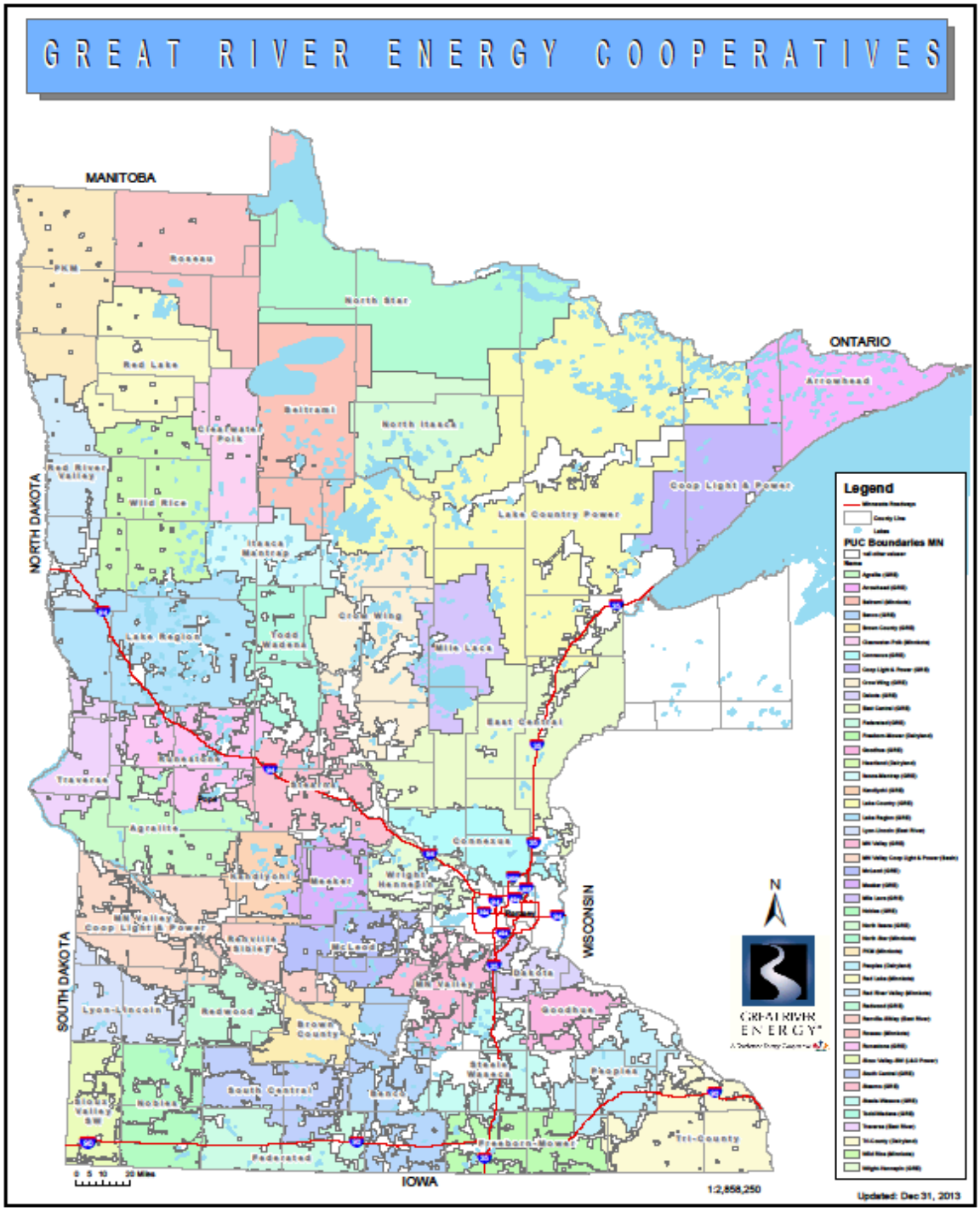
Total cooperative sales per kWh are approximately 18% (13.3 billion kWh) of the state total about $1 billion in revenues. The distribution cooperatives in Minnesota have the largest network in the state with more than 121,000 miles of electric distribution lines (Xcel has approximately 28,718 miles).[iv] Electric distributors in the state also have far fewer consumers per mile, 6 compared to 38 consumers for investor owned electric utilities and 48 per mile for municipal electric utilities[v]

Figure 7 Minnesota Generation and Transmission Cooperatives



Source: Great River Energy

Figure 8 Minnesota Distribution Cooperatives



Source: Great River Energy

Plan Participants

Twenty-five of the forty-four Minnesota Rural Electric Distribution Cooperatives participated in the Rural Electric Cooperative Annex to the Minnesota Hazard Mitigation Plan. Of the twenty-five distribution cooperatives that participated in the planning effort they serve all or a portion of 47 out of the 87 counties. The cooperatives that participated in the planning effort combine for a total of 83,101 miles of distribution lines that serve approximately 544,596 customers in Minnesota. Two generation and transmission cooperatives (Great River Energy and Minnetonka Power) also participated in the planning process and provide electricity to over half of the state.

The following table lists the participating cooperative, the counties in which they operate, the miles of distribution line and the number of customers per mile.

Table 1 Rural Electric Cooperative Participation and Service Area

Cooperative Name	Serving the Counties of	Miles of Distribution Line	Number of Customers	Customers Per Mile
Distribution Cooperatives				
Agralite Electric Cooperative	Big Stone, Stevens, Pope, Swift	2,405	5,089	2.12
Beltrami Electric Cooperative	Beltrami, Cass, Clearwater, Hubbard, Itasca, Koochiching	3,371	20,290	6.02
BENCO Electric Cooperative	Blue Earth, Nicollet, Faribault	3,210	14,192	4.42
Connexus Energy	Anoka, Chisago, Hennepin, Isanti, Ramsey, Sherburne, Washington	8,920	126,913	14.23
Dakota Electric Association	Dakota, Goodhue, Scott, Rice	4,011	101,995	25.43
East Central Energy	Kanabec, Pine, Isanti, Aitkin, Mille Lacs, Morrison,	8,231	52,770	6.41
Federated Rural Electric Association	Jackson, Martin	2,252	4,998	2.22
Freeborn-Mower Cooperative Services	Freeborn, Mower	1,990	5,968	3.00
Goodhue County Co-op Electric Assn.	Goodhue	1,288	4,922	3.82
Itasca-Mantrap Electric Cooperative	Hubbard, Becker, Cass, Clearwater, Wadena	2,050	11,391	5.56
Lake Country Power	Aitkin, Carlton, Cass, Itasca, Koochiching, Lake, Pine, and St. Louis	8,217	48,786	5.94
Lyon-Lincoln Electric Cooperative	Lyon, Lincoln	1,638	3,959	2.42
McLeod Co-op Power Assn.	McLeod, Renville, Sibley, Carver	1,889	6,607	3.50
Minnesota Valley Co-op L&P	Lac Qui Parle, Yellow Medicine, Lyon, Chippewa	3,020	5,245	1.74
Nobles Co-op Electric	Nobles	2,146	5,088	2.37

People's Cooperative Services	Olmsted, Dodge, Fillmore, Mower, Wabasha, Winona	2,565	14,545	5.67
Red River Valley Co-op Power Assn.	Norman, Polk, Clay	1,849	4,700	2.54
Redwood Electric Cooperative	Redwood, Brown, Murray, Lyon, Cottonwood	1,216	2,455	2.02
Renville-Sibley Cooperative Power Association	Renville, Sibley	1,140	1,920	1.68
Sioux Valley Energy	Rock, Pipestone	5,900	2,977	0.50
South Central Electric Association	Watonwan, Cottonwood, Martin, Jackson, Brown, Blue Earth	2,003	3,890	1.94
Stearns Co-op Electric Assn.	Stearns, Todd, Morrison, Kandiyohi, Pope, Douglas	4,009	24,850	6.20
Steele-Waseca CE	Steele, Waseca	2,022	9,582	4.74
Wild Rice Electric Cooperative	Becker, Clay, Mahnomen, Norman, Polk	3,923	13,828	3.52
Wright-Hennepin Co-op Electric Assn.	Hennepin, Wright	3,836	47,636	12.42
Generation and Transmission Cooperatives				
Great River Energy	28 cooperatives (Figure 7)	4,625		
Minnkota Power Coop.	11 cooperatives (Figure 7)	3,055		

Disaster Mitigation Act of 2000

The development of an electric cooperative annex to the State of Minnesota Hazard Mitigation is in response to the passage of the Disaster Mitigation Act of 2000 (DMA2K), which was signed into law by the U.S. Congress on October 30, 2000. The goal of the legislation includes reducing losses and future public and private expenditures, and improving response and recovery from disasters. Public Law 106-390 amended the Robert T. Stafford Relief and Emergency Assistance Act. The Act requires that local governments, tribal organizations, and states prepare an all-hazard mitigation plan in order to be eligible for funding from the FEMA Pre-Disaster Mitigation (PDM) Assistance Program, Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) Grant Program. Sub-applicants, such as electric cooperatives, are only eligible for funding provided their projects are included in a local or state all-hazards mitigation plan approved by the Federal Emergency Management Agency. The Act requires that natural hazards, such as flooding or severe weather, be addressed in the risk assessment and vulnerability analysis sections of the all-hazard mitigation plan.

Importance of Developing an Annex for Rural Electric Cooperatives

From 1999-2011 FEMA provided approximately $31 million dollars to private non-profits in Minnesota for disaster recovery efforts. Of the $31 million dollars, approximately $24 million was provided to electric cooperatives (15 cooperatives) to repair utility lines, clean-up debris or for protective measures. Rural electric cooperatives span the entire state and based on historical public assistance damage data cooperatives statewide are vulnerable to storms. In fact, some

Presidentially Declared Disasters probably would not have occurred had rural electric cooperatives and municipal cooperatives not been damaged (DR-4113, DR-4009, DR-1921, DR-1283) – damage would have occurred during the storm however, the State might not have met its threshold for a disaster declaration without the cooperatives. All four disaster events occurred within the past 15 years, with three of the four occurring in the past three years. Rural electric cooperatives are vulnerable and could very well be becoming more vulnerable without mitigating against future damages.

Public/Private Costs of Electrical Power Outages

Power outages caused by winter storms, high winds, and tornadoes can have significant economic impacts. These events may force the closure of businesses, schools and government offices. Homeowners may see food spoiled, move to a temporary shelter, experience flooding inside of their homes, or have their pipes burst all due to the lack of power.

Large-scale power outages due to extreme weather may require state and local governments to open shelter facilities and to care for people displaced from their homes. Events that reach the level of a Presidentially Declared Disaster, FEMA may allow local governments to recover some costs but in smaller events all the cost will be borne by the local government.

Power outages caused by weather may make vulnerable populations more vulnerable. People recovering from illnesses, the elderly, children, and low-income populations may be more vulnerable to the impacts of power outages than others. Frequently, the first calls to emergency responders come from hospitals, nursing homes, and other care facilities that have suddenly lost power.

Public agencies are frequently responsible for debris removal and clean-up in the event of a storm or tornado. Police and fire personnel may be responsible for public safety in the event that power lines come down and are determined to be dangerous to nearby residents.

Plan Development

Minnesota Division of Homeland Security and Emergency Management initiated the planning process in partnership with the rural electric cooperatives across the state. The annex is needed so that rural electric cooperatives are covered under the State All-Hazard Mitigation Plan and are eligible for FEMA's Hazard Mitigation Assistance (HMA) Program.

Hazard mitigation activities will be pursued by rural electric cooperatives so future natural disasters will have less of an impact of electric cooperatives and residents of the State of Minnesota.

In the most recent two Presidential Disaster Declarations, rural electric cooperatives were affected and part of the public assistance program. This has lead HSEM staff to pursue and develop, with guidance from FEMA, an Annex to the State Plan that provides a concerted effort to help electric cooperatives become less vulnerable to natural hazards.

The need for electric cooperatives to be covered under the state plan is apparent when viewing Appendix C. Table C-1 in the State Hazard Mitigation Plan where 25% of Minnesota Counties (22 counties) do not have an approved and adopted hazard mitigation plan making electric cooperatives ineligible for hazard mitigation assistance under their plan. Through the

development of this Annex even if a county hazard mitigation plan is expired rural electric cooperatives will still be eligible for FEMA funding under the state plan.

Benefits of Hazard Mitigation Planning

A cooperative hazard mitigation approach that includes Minnesota HSEM and electric cooperatives will result in consensus on action plans to reduce or eliminate long-term risks to human life and property from natural hazards.

This plan is intended to:

- Increase awareness of risks and utility infrastructure vulnerabilities to natural hazards
- Establish hazard mitigation goals
- Identify strategies to help implement mitigation measures
- Establish priorities for the use of cooperative and public resources to mitigate hazards
- Enable cooperative, as sub-applicants, to seek hazard mitigation funding from the Federal Emergency Management Agency
- Improve recovery efforts related to natural disasters
- Minimize public safety concerns and power supply disruptions to persons served by electric cooperatives.

Hazard mitigation funding has been provided to a number of rural electric cooperatives in the past. From 1996 to 2012 an estimated eighty-four (84) mitigation projects have been approved and/or closed at FEMA. The projects range in scope from rebuilding lines with heavier poles and shorter spans, converting overhead to underground lines, replacing guy wire grips, to converting from copper wire to T-2 lines. Sixty-two (62) of the eighty-four (84) projects involved converting overhead lines to underground lines. The total cost of the projects in this time period was approximately $26 million dollars.

Planning Overview

HSEM initiated the hazard mitigation planning process for rural electric cooperatives by contacting the Minnesota Rural Electric Association as the primary point of contact, conducting outreach to Minnesota Rural Electric Cooperative members at their annual Chief Executive Officer (CEO) meeting as well as the annual engineering conference and line superintendent's meeting. HSEM also sought cooperative feedback through meetings, an online survey, and the review of a draft plan.

Table 2 Rural Electric Cooperative Planning Meetings

Date	Discussion Topics	Meeting Attendees
8/13/13	Preliminary discussion on developing partnership to establish Rural Electric Annex to State Mitigation Plan	Minnesota Rural Electric Association, FEMA R-V, FEMA JFO, and HSEM
9/5/13	Presentation at REMA CEO Conference	Rural Electric Cooperative CEOs, HSEM

9/19/13	Presentation at REMA Engineering Conference	Rural Electric Cooperative CEOs, HSEM
11/5/13	Benefit Cost Analysis Course specific to rural electric cooperatives	Rural electric cooperatives, FEMA, HSEM
12/4/13	Plan development and input	Rural electric cooperatives, FEMA, HSEM
10/10/13-12/31/13	Online survey	Sent to rural electric cooperatives from MN Rural Electric Association
1/5/14	Presentation at REMA Line Superintendent's Annual Meeting	Rural Electric Cooperative Superintendents and HSEM
2/28/14 – 3/14/14	Minnesota Rural Electric Association & Electric Cooperative Review of Rural Electric Cooperative Annex	MREA distributed web-link of the plan to cooperatives across the state. MN HSEM posted to website

The December 4th meeting was a productive meeting which provided rural electric cooperative members an overview of the planning process and ways in which they can continue to participate. Members of the meeting were asked to provide a list of potential mitigation projects that they were considering and would like to include in the Annex.

Counties in Minnesota are quite often served by more than one electricity provider, cooperative or investor owned. In Minnesota every county is served by at least one electric cooperative (Figure 8). During the planning process 47 counties were represented by electric cooperatives that serve them, not all areas in the county were represented however, a vast majority of the service area participated in the planning process.

Table 3 County Representation through Rural Electrical Cooperatives

Counties Represented through Rural Electric Cooperative Annex			
Anoka	Dakota	Lincoln	Redwood
Beltrami	Faribault	Lyon	Rice
Big Stone	Fillmore	Martin	Scott
Blue Earth	Freeborn	Mower	Stevens
Brown	Goodhue	Murray	Swift
Cass	Hennepin	Nicollet	Waseca
Chippewa	Hubbard	Nobles	Winona
Chisago	Isanti	Norman	Wabasha
Clay	Itasca	Olmstead	Washington

Clearwater	Jackson	Polk	Wright
Cottonwood	Koochiching	Pope	Yellow Medicine
Dodge	Lac Qui Parle	Ramsey	

Hazard Profiles

During the planning process, HSEM discussed hazard threats with cooperatives through meetings, an online survey and informal discussions. HSEM identified 15 potential natural hazards that might affect the cooperatives based on the State Hazard Mitigation Plan (flooding, dam/levee failure, wildfire, windstorm, tornado, hail, erosion, winter storms, landslide/mudslide, land subsidence, earthquake, drought, extreme heat, and extreme cold). Of these natural hazards four (flooding, windstorms, tornado, and winter storm) were the greatest concerns for electric cooperatives and have affected/damaged them the most. Because of this, only these hazards will be profiled in the Annex, all other hazards are profiled in the State All-Hazard Mitigation Plan.

Flooding

Flooding is the accumulation of water within a water body (e.g., stream, river, lake, or reservoir) and the overflow of excess water onto adjacent floodplains. Floodplains are lowlands, adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected. Nationwide, hundreds of floods occur each year, making it one of the most common hazards in all 50 states and U.S. territories (FEMA, 1997).

Flooding History in Minnesota

Flooding was identified by cooperative survey participants as having affected/damaged critical electrical infrastructure for 59% of survey respondents. Flooding has the potential to damage buildings and utility infrastructure. Disaster events that involved flooding and high winds have the potential to significantly limit cooperatives from recovery efforts.

Two recent flooding and wind events (DR 1717 & 4009) affected cooperative buildings and utility infrastructure, making recovery efforts much more difficult. DR 1717 damaged 4.9 million dollars' worth of buildings for two cooperatives in the state but only affected the utility infrastructure of the cooperatives by approximately $195,000. DR 4009 saw the reverse effect on the buildings and utility infrastructure damaging buildings much less (approx. $367,000) than utility infrastructure (7.6 million).

The following table depicts the most recent flooding events in Minnesota. Three of the past four flooding disasters have resulted in damage to cooperatives resulting in participation in the disaster and recovery efforts through the Public Assistance program.

Table 4 Major Minnesota Floods Affecting Cooperatives (2011-2013)

Year	Disaster Number	Areas Affected	Cooperatives Affected
2013	DR 4131	Benton, Big Stone, Douglas, Faribault, Fillmore, Freeborn, Grant, Hennepin, Houston, McLeod, Morrison, Pope, Sibley, Stearns, Stevens, Swift, Traverse, and Wilkin.	Yes

2012	DR 4069	Aitkin, Carlton, Cook, Crow Wing, Dakota, Goodhue, Kandiyohi, Lake, Meeker, Pine, Rice, Sibley, St. Louis, and the Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 4009	Chisago, Isanti, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns, and Yellow Medicine Counties and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 1982	Big Stone, Blue Earth, Brown, Carver, Chippewa, Clay, Grant, Lac qui Parle, Le Sueur, Lyon, McLeod, Nicollet, Redwood, Renville, Scott, Sibley, Stevens, Traverse, Wilkin, and Yellow Medicine.	No

Probability of Occurrence to Flooding

Flood probability and magnitude are highly location-specific, so it is not possible to characterize these generally across the State in a meaningful way. Statewide, floods are rated High for probability in the qualitative ranking. The State-Wide Flood Assessment (2011) provides information for each county (and city) based on best available data.

Vulnerability of Electric Cooperatives to Floods

Of the electric cooperatives that participated in the mitigation survey 59% indicated that flooding has adversely affected/damaged critical infrastructure in their service area. Over the past four years cooperatives have been damaged in three of the four Presidentially Declared Disasters that had a flooding component. 44% of cooperatives surveyed indicated that the potential impact of flooding to critical electrical infrastructure was low; 39% indicated a medium impact and only 17% indicated a high impact to critical infrastructure. This does not necessarily indicate that cooperatives across the state are highly vulnerable to flooding however; it does indicate a strong correlation between flooding and damage to electric cooperatives.

Even though Presidentially Declared Disasters and responses to our survey indicate that flooding has affected cooperatives it is difficult to determine the vulnerability of each cooperative with respect to electrical infrastructure and flooding. Even though an area's roads and buildings might be susceptible to flooding, electrical utility infrastructure sometimes does not get damaged. Overhead electrical lines are protected from flood waters however, vulnerable to debris floating in the flood waters. The debris might damage the infrastructure immediately or decrease the life of the pole, which might not be recognized until another event – possibly high wind knocks down the pole later. Underground electrical lines are highly resistant to flooding however, flood debris can damage transformers knocking out power.

The removal of infrastructure from the 100 and 500 year flood plain is a highly desirable mitigation effort thus removing vulnerable structures from floating debris and damaging waters. A state-wide analysis to determine the number of structures in the flood plain would be nearly impossible; however, the identification of key infrastructure (substation, buildings, transformers etc.) is possible, but likely unrealistic due to the vast scope of facilities across the state and limited staff. A more likely approach would be educational outreach to electric cooperatives

with the intent of any future development of critical infrastructure to be placed outside of 100 and 500 year flood zones.

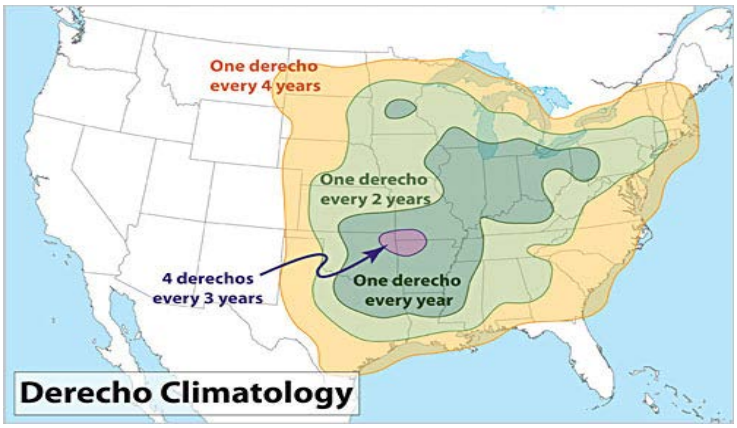
Windstorms

FEMA defines winds in excess of 58 miles per hour, excluding tornadoes, as windstorms. Straight-line winds and windstorms are used interchangeably in the Plan. This hazard is treated as a different category than Tornadoes (which may also include high winds). Windstorms are among the nation's most severe natural hazards in terms of both lives lost and property damaged.

Severe winds can damage and destroy roofs, toss manufactured homes off their pier foundations, and tear light-framed homes apart. There are several different types of windstorms. A "downburst" is defined as a strong downdraft with an onrush of damaging winds on or near the earth's surface. When people experience property damage from a downburst, they often do not believe that "just wind" could have caused the damage, and they assume that they were hit by a tornado. Downbursts may have wind gusts up to 130 mph and are capable of the same damage as a medium-sized tornado. A "gust front" is the leading edge of the thunderstorm downdraft air. It is most prominent near the rain-free cloud base and on the leading edge of an approaching thunderstorm and is usually marked by gusty, cool winds and sometimes by blowing dust. The gust front often precedes the thunderstorm precipitation by several minutes. Straight-line winds, when associated with a thunderstorm, are most frequently found with the gust front. These winds originate as downdraft air reaches the ground and rapidly spreads out, becoming strong horizontal flow.

A long-term wind storm that exceeds 58 mph and extends for more than 240 miles is a windstorm that can be classified as a derecho storm. Because derecho storms are long lived and travel great distances, Minnesota rural electric cooperatives are highly vulnerable. Derechos are most common in the late spring until late summer. Severe wind event research of this kind is relatively new. However, research from the NOAA from the 1980's to 2001 showed that Minnesota is subject to derecho events at different levels across the state, with the most indicating one derecho event every year.

Figure 9 Derecho Occurrences Factor Based on Data from 1980-2001



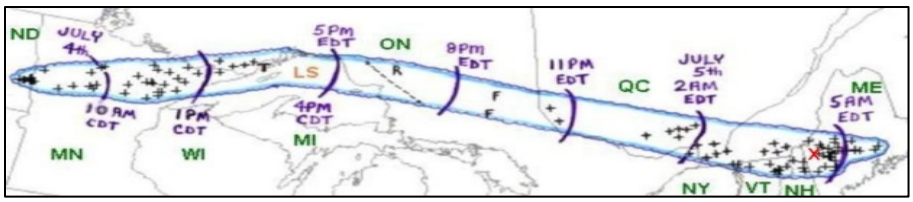
Source: http://www.spc.noaa.gov

Windstorm History in Minnesota

According to the National Climatic Data Center, there have been 8,961 high wind events between 1/1/1955 to 8/31/2013. This number may be misleading because the same storm data may have been reported at multiple locations. However, due to these events there were 10 deaths and approximately $881 million dollars in property damage.

The Boundary Waters-Canadian Derecho on July 4-5th of 1999 is an example of how derecho systems are large (traveling from North Dakota to Maine - 1,300 miles) and can have damaging effects to states and regions. This system produced wind estimates from 80-100 mph and damaged at least 7 counties in northeastern Minnesota causing destruction to buildings and blowing down tens of millions of trees.

Figure 10 Boundary Waters-Canadian Derecho Path (1999)



Source: http://www.spc.noaa.gov

Table 5 Major Minnesota Wind Storm Event Affecting Cooperatives (2011-2013)

Year	Disaster Number	Areas Affected	Cooperatives Affected
2013	DR 4131	Benton, Big Stone, Douglas, Faribault, Fillmore, Freeborn, Grant, Hennepin, Houston, McLeod, Morrison, Pope, Sibley, Stearns, Stevens, Swift, Traverse, and Wilkin.	Yes
2013	DR 4113	Jackson, Murray, Nobles, Pipestone, Rock	Yes
2012	DR 4069	Aitkin, Carlton, Cook, Crow Wing, Dakota, Goodhue, Kandiyohi, Lake, Meeker, Pine, Rice, Sibley, St. Louis, and the Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 4009	Chisago, Isanti, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns, and Yellow Medicine Counties and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 1990	Anoka and Hennepin	No
2011	DR 1982	Big Stone, Blue Earth, Brown, Carver, Chippewa, Clay, Grant, Lac qui Parle, Le Sueur, Lyon, McLeod, Nicollet, Redwood, Renville, Scott, Sibley, Stevens, Traverse, Wilkin, and Yellow Medicine.	No

Probability of Occurrence Windstorms

Windstorms can occur throughout the State of Minnesota, at any time of the year. Most occur during the months of April through September. This recurrence is expected to remain relatively stable, although there will be year-to-year fluctuations. Long-term changes in weather patterns may also influence the number of windstorms that occur.

Vulnerability of Electric Cooperatives to windstorms

Windstorms can be widespread and highly damaging or result in limited site specific problems for electric cooperatives. Of the cooperatives that participated in the mitigation survey all respondents indicated that they have had electrical infrastructure adversely affected/damaged by windstorms. 83% of respondents also indicated that windstorms have a high potential to impact to electrical infrastructure, the second only to winter storms (89%). Since 2011, electric cooperatives have been damaged in four of the past six wind-related Presidentially Declared Disasters.

The most vulnerable electrical structures to wind events are overhead utility lines and the poles. Of the 46 distribution cooperatives in the state, only 5 cooperatives have more miles of underground lines than overhead lines[vi], making them only slightly less vulnerable. State-wide there is an estimate 127,669 miles of distribution lines, of which only 35% (45,372) are underground and less vulnerable to windstorms. The resulting 64.5% (82,297) of the overhead distribution lines owned and maintained by the cooperatives are vulnerable to damage from windstorms.

In order to create a less vulnerable system to windstorms, more overhead lines would need to be converted to underground or strengthened to withstand high wind events. However, to implement such a mitigation effort both FEMA and fiscally responsible cooperatives would need to support construction efforts that are cost beneficial. In most rural parts of the State, the number of customers per mile does not support a cost beneficial mitigation strategy. Cooperatives in very rural parts of the state have a per mile customer rate of less than 1. The statewide average for the 46 cooperatives is 4.94 customers per mile.

Tornados

Tornadoes are defined as violently-rotating columns of air extending from thunderstorms to the ground, with wind speeds between 40-300 mph. They develop under three scenarios: (1) along a squall line; (2) in connection with thunderstorm squall lines during hot, humid weather; and (3) in the outer portion of a tropical cyclone. Funnel clouds are rotating columns of air not in contact with the ground; however, the column of air can reach the ground very quickly and become a tornado.

Since 2007, tornado strength in the United States is ranked based on the Enhanced Fujita scale (EF scale), replacing the Fujita scale introduced in 1971. The EF scale uses similar principles to the Fujita scale, with six categories from 0-5, based on wind estimates and damage caused by the tornado. The EF Scale is used extensively by the NWS in investigating tornadoes (all tornadoes are now assigned an EF Scale number), and by engineers in correlating damage to buildings and techniques with different wind speeds caused by tornadoes. The table below outlines the Fujita Scale, the derived EF Scale and the operational EF Scale. Though the Enhanced Fujita scale itself ranges up to EF28 for the damage indicators, the strongest tornadoes max out in the EF5 range (262 to 317 mph).

Table 6 Fujita Scale, Derived EF Scale, and Operational EF Scale

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Scale	Fastest ¼-mile (mph)	3-second Gust (mph)	EF Scale	3-second Gust (mph)	EF Scale	3-second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	>200

http://www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornado History in Minnesota

In Minnesota, tornadoes have occurred in every month from March through November. The earliest spring verified tornado in Minnesota occurred on March 18, 1968, north of Truman, and the latest fall tornado was on November 16, 1931, east of Maple Plain.

Despite a higher number of tornadoes reported in recent years, the number of fatalities and injuries due to tornadoes has been decreasing. This is thanks in part to better National Weather Service tools in detecting tornadoes, namely the NEXRAD Doppler radar network installed in the mid-1990s. Also, the ability of alerting the public has improved with more National Weather Service radio transmitters and a close relationship with media outlets. An energetic spotter network has also been a key to alerting the public in Minnesota. The increasing number of tornadoes reported may be a direct result of improved communication networks, public awareness, warning systems and training.

Table 7 Major Minnesota Tornado Events Affecting Cooperatives (2010-2013)

Year	Disaster Number	Areas Affected	Cooperatives Affected
2011	DR 4009	Chisago, Isanti, Kandiyohi, Lincoln, Lyon, McLeod, Meeker, Mille Lacs, Pine, Pipestone, Redwood, Renville, Stearns, and Yellow Medicine Counties and the Mille Lacs Band of Ojibwe.	Yes
2011	DR 1990	Anoka and Hennepin	No
2010	DR 1921	Faribault, Freeborn, Olmsted, Otter Tail, Polk, Steele, and Wadena	Yes

Probability of Occurrence to Tornados

According to the NCDC, Minnesota experienced an average of 27 tornadoes per year between 1950 and 2012. These hazardous events caused 99 deaths, 1,976 injuries and nearly $1.5 billion dollars in property damage. This equates to a yearly average of 1.6 deaths, 32 injuries, and nearly $23 million in property damage per annum. From the 62-year state total of 1,655 tornadoes, 27 were ranked at F4 or F5.

Although tornadoes can occur at any time of year, in Minnesota the peak months of occurrence are June, May, and July (in that order). The typical time of day for tornadoes in Minnesota ranges between 4:00 P.M. and 7:00 P.M. Most of these are minor tornadoes, with wind speeds under 125 M.P.H. A typical Minnesota tornado lasts approximately ten minutes, has a path length of five to six miles, is nearly as wide as a football field, has a forward speed of about thirty-five miles an hour, and affects less than one-tenth of 1 percent of the county warned.

Most of the deadly and damaging tornadoes occur in groups of outbreaks that often last from 6 to 12 hours. One of the worst outbreaks in Minnesota occurred on June 28, 1979, when 16 tornadoes slashed across the state, from northwest to southeast, in a 6½-hour period. Two additional tornadoes occurred in eastern North Dakota with this system. Many such outbreaks have occurred, including the April 30, 1967 cluster in south central and southeast Minnesota.

2010 was a historic year for tornadoes in Minnesota, with 126 recorded by the NCDC. There were three deaths and 46 injuries (all were on June 17 except one injury on August 13). This year beat previous records of 74 tornadoes in 2001 and 27 in one day on June 16, 1992 (June 17, 2010 had 60 on one day). 2011 witnessed 44 tornadoes in the state, while 2012 saw 38.

Vulnerability of Electric Cooperatives to Tornadoes

Electric cooperatives are highly vulnerable to tornados due to the vast expansive network, weak infrastructure - relative to tornados, and the fact that the majority of electrical distribution lines are not underground and protected from high winds.

Nearly all (94%) of cooperative surveyed indicated that they have been affected/damaged by a tornado in the past. 72% survey respondents indicated that tornados have a potential high impact to critical electric infrastructure. Mitigation efforts to limit the vulnerability of electrical infrastructure to tornados are limited to strengthening infrastructure and burying of overhead lines. As noted in the windstorm vulnerability section the majority of distribution lines are currently overhead and highly vulnerable to tornadoes. The vulnerability of underground lines to tornadoes exists as well. The electrical cabinets that support the underground system are almost always above ground. These cabinets can be damaged by debris that tornadoes cause even in the small events.

Winter storms

Winter storms vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury such as frostbite and death.

Winter storm occurrences tend to be very disruptive to transportation and commerce. Trees, cars, roads, and other surfaces develop a coating or glaze of ice, making even small accumulations of ice extremely hazardous to motorists, bicyclists, and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways that lead to vehicle and pedestrian accidents; collapsed roofs from fallen trees and limbs and heavy ice and snow loads; and felled trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe ice storms, telecommunications and power can be disrupted for days. Heavy snow or accumulated ice can also isolate people from assistance or services.

The NWS issues a Wind Chill Advisory for Minnesota when widespread wind chills of -40°F or lower with winds of at least 10 miles per hour (mph) expected. In some parts of southern Minnesota, the threshold may be -35°F. A Wind Chill Warning is issued when widespread wind chills of -40°F in northern Minnesota and -35°F in southern with winds greater than 10 mph are expected.

Winter Storm History in Minnesota

The topography, land-use characteristics and winter climate of western and southern Minnesota cause this area to be particularly vulnerable to blowing and drifting snow. The number of days with potential problems ranges from 115 in the south to 155 in the north. For an average winter season, taxpayers in Minnesota spend approximately $100 million in snow removal costs, with MnDOT expending $41 million. In the event of a winter season with anomalously high snowfall and exceedingly strong winds, as was the case for much of the state during the winter of 1996-97, the cost of snow removal can soar to $215 million.

Probability of Occurrence to Winter Storms

Minnesota experiences a variety of severe winter weather events annually. Although it is impossible to predict probabilities for this type of event over short periods of time, the State can probably expect one ice and ice/snow storm on average and one major blizzard per year.

Vulnerability of Electric Cooperatives to Winter Storms

Electric cooperatives are highly vulnerable to winter storms due to their expansive network across the state and the frequency of winter storms. 88% of electrical cooperative respondents indicated that their electrical infrastructure had been affected/damaged by winter storms. When asked what type of impact a winter storm has to potentially damage their infrastructure, 89% responded that that winter storms posed a high potential, the most out of all natural hazards. As noted in the windstorm and tornado vulnerability sections the majority of distribution lines are currently overhead and highly vulnerable to winter storms.

Winter storms pose additional challenges that put crews and equipment in danger. Very often with winter storms come decreased suitable winter driving conditions putting crews on icy or wind drifted snow roads. And in the case of ice storms and extreme cold winter temps - crews are subject to harsh conditions when repairing utility lines.

Climate Change – Impacts of Severe Weather on Minnesota's Electric Cooperative Network

The State All-Hazard Mitigation Plan includes a description of natural hazards and the effects of climate change on those hazards which are consistent with this Annex. However, the impacts of increased severe weather patterns on the electrical distribution network are already being felt by electrical consumers across Minnesota.

As noted in the "Economic Benefits of Increasing Electric Grid Resilience to Weather Outages" published by the Executive Office of the President[vii] - Severe weather is the single leading cause of power outages in the United States. Outages caused by severe weather such as thunderstorms, hurricanes and blizzards account for 58 percent of outages observed since 2002 and 87 percent of outages affecting 50,000 or more customers (U.S. DOE, Form OE-417). Furthermore, according to the National Climate Assessment, the incidence and severity of extreme weather will continue to increase due to climate change. This increase in severe weather may have a profound impact on rural electric cooperatives across the State.

Mitigation Goals and Strategies

The development of an Annex to the Minnesota Hazard Mitigation Plan specific for rural electric cooperatives is to create a vision for preventing future disasters, establish a common set of mitigation goals across state, prioritize actions, and evaluate the success of such actions.

In addition to meeting the State's mitigation goals of (1) enhancing the State's capacity to make Minnesota more resilient to the effects of all hazards and (2) building and supporting local capacity and commitment to increase resiliency to all hazards. The state will continue to work with cooperatives to:

- Increase awareness of risks and utility infrastructure vulnerabilities to natural hazards
- Establish hazard mitigation goals

- Identify strategies to help implement mitigation measures
- Establish priorities for the use of cooperative and public resources to mitigate hazards
- Enable cooperatives, as sub-applicants, to seek hazard mitigation funding from the Federal Emergency Management Agency
- Improve recovery efforts related to natural disasters
- Minimize public safety concerns and power supply disruptions to persons served by electric cooperatives.

Mitigation Strategies

Electric cooperatives provided input into the development of site specific mitigation strategies and are included in the mitigation strategy table. In addition to these site specific strategies, through conversations with cooperatives, meetings and research of best practices, HSEM developed a list of mitigation strategies that could be applied to all electrical cooperatives through the support of this plan. The table identifies the anticipated hazard of concern, a mitigation measure/solution, an estimated cost, priority ranking, a projected timetable and a cooperative responsible for the strategy.

Table 8 Mitigation Strategies

Hazards of Concern	Mitigation Measures	Estimated Cost	Project Location	Responsible Party	Priority Ranking (H, M, L)	Projected Timetable
High winds, ice storms, blizzard, and tornadoes	Convert overhead lines to underground lines in areas that have been subject to repetitive damage.	$10,000 to $10 million	Sate-wide	Cooperatives responsible for distribution lines being converted	H	Ongoing
Flooding	Remove (acquisition of property) critical infrastructure from 100 and 500 year flood zones	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
Flooding	Remove (relocation) critical infrastructure from 100 and 500 year flood zones	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	L	Ongoing
Flooding	Dry flood-proofing of non-residential critical facilities that are subject to flood damage or within the 100, 500 year flood zones	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
Flooding	Elevate critical facilities to remove from flood hazard areas	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	M	Ongoing

Flooding	Protect critical facilities through minor localized flood reduction projects	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	M	Ongoing
High winds and tornadoes	Construct new safe rooms or retrofit existing structures in critical facilities protecting employees and critical infrastructure from damaging winds and tornadoes	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds and tornadoes	Construct community new safe rooms or retrofit existing structures in critical facilities protecting employees, neighboring residents, and critical infrastructure from damaging winds and tornadoes	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
Erosion	Protect critical infrastructure by installing soil stabilization systems in areas prone to erosion	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds, tornadoes, flooding, erosion, wildfire, winter storms, ice storms	Implement unproven mitigation techniques, technologies, methods, procedures or products that will aid electric cooperatives in becoming more disaster resilient	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	M	Ongoing
High winds, tornadoes, flooding, erosion, wildfire, winter storms, ice storms	Implement hazard identification or mapping and related equipment for the implementation of mitigation activities	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds, tornadoes, flooding, erosion, wildfire, winter storms, ice storms	Implement GIS software, hardware, and data acquisition whose primary aim is mitigation	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing

Wildfire	Protect critical facilities through the use of defensible space, structural protection through ignition-resistant construction activities, and hazardous fuels reduction activities.	$10,000 to $10 million	Sate-wide	Cooperatives responsible for critical infrastructure	H	Ongoing
High winds, ice storms, blizzard, and tornadoes	Anoka Substation Circuits 3 & 4 Project -- Convert 1.2 miles of double circuit overhead distribution to one circuit overhead and one circuit underground. Line has history of wind-related outages. It presently shares structures with its alternate feed (double-circuit). Project would enhance system reliability by providing redundancy. Circuits serve 1,890 consumers.	$460,000	Anoka	Connexus Energy	H	2015
High winds, ice storms, blizzard, and tornadoes	Coopers Corner Substation Circuit 6 Project -- Convert approximately 0.7 miles of single phase overhead line located in back lot lines in a heavily wooded area with difficult access to underground and relocating the facilities along the roadway. This line has experienced multiple outages and very long restoration times in recent years.	$40,000	Anoka	Connexus Energy	H	2014
High winds, ice storms, blizzard, and tornadoes	Anoka Substation Circuits 5 & 6 Project -- Convert 0.7 miles of double circuit overhead distribution to one circuit overhead and one circuit underground. Line presently shares structures with its alternate feed (double-circuit). Project would enhance system reliability by providing redundancy. Circuits serve 1,025 consumers.	$250,000	Anoka	Connexus Energy	M	2015
High winds, ice storms, blizzard, and tornadoes	Forest Lake Circuit 4 Project -- Establish a metered tie point with Xcel Energy. This overhead feeder is a nine mile long radial with about three miles in private property with limited access and a freeway crossing. Having a tie point will provide an alternate feed to most of the loads served by this line in the event of a system disturbance.	$200,000	Forest Lake	Connexus Energy	M	2015
High winds, ice storms, blizzard, and tornadoes	May Circuit 1 Project --Establish a metered tie point with Xcel Energy. This overhead feeder is a five mile long radial. Having a tie point will provide an alternate feed to most of the loads served by this line in the event of a system disturbance.	$200,000		Connexus Energy	M	2015

High winds, ice storms, blizzard, and tornadoes	Circle Pines Substation Circuits 4 & 5 Project -- Convert 0.5 miles of double circuit overhead distribution line to one underground and one overhead feeder. Line has history of weather-related outages, is challenging to restore due to its double-circuit construction, and is under-capacity. Project would enhance system reliability. Circuits serve 1,150 consumers.	$192,000	Circle Pines	Connexus Energy	M	2015
High winds, ice storms, blizzard, and tornadoes	Bowers Drive Project -- Convert 0.75 miles overhead radial line to a looped underground tap. The area around this line is heavily wooded. This line has experienced several outages as a result of high winds. Due to the nature of the route, access is difficult during these conditions and restoration time is well above average.	$125,000	Anoka	Connexus Energy	M	2015
High Winds	Convert 7.5 miles of three-phase overhead distribution line to three-phase underground line. This line was hit hard in a July 2012 wind storm and this is a critical feeder line for businesses and organizations in the Cass Lake area.	$1,360,000	Hubbard County and Cass County	Beltrami Electric Cooperative, Inc.	High	2015
High winds, ice storms, tornados	Project AL-A/B upgrade of 3-phase main feeder of Alden Substation Circuit 1 with 3-phase 4/0 aluminum underground. Parts of line are 65+ years old. Line is part of the backbone of the system and will improve system performance during normal maintenance and emergency situations. Circuit is a backup to Bancroft and Freeborn Substations and serves 132 homes and 900kW peak load.	$393,250	Freeborn County Alden Substation Circuit 1	Freeborn Mower Cooperative Services	High	2014
High winds, ice storms, tornados	Project CO-2—convert 2.0 miles of 6A CWC single phase overhead distribution with 3-phase 4/0 aluminum underground to improve reliability on feeder to 60 homes. Will allow back-feeding from other substation.	$132,000	Freeborn County Corning Substation Circuit 2NE	Freeborn Mower Cooperative Services	High	2014
High winds, ice storms, tornados	Project CO-3—convert 2.3 miles of 8A and 6A CWC with 3-phase 4/0 aluminum underground to provide better service and reliability to local manufacturer. Will allow back-feeding from other substation.	$151,800	Freeborn County Corning Substation Circuit 2NE	Freeborn Mower Cooperative Services	High	2014

High winds, ice storms, tornados	Project CO-C—convert 4.3 miles of 8A CSC with new single phase 1/0 aluminum underground line. This will include a short tie-line across 890 Ave South of Oakland to provide loop. This line is the main line through the area and will enable load transfers and improve system reliability during maintenance and emergency situations.	$141,900	Freeborn County Corning Substation Oakland Twp.	Freeborn Mower Cooperative Services	High	2015
High Winds, tornados, Ice storms	Project CO-D—convert 3-phase 1/0 ACSR feed of main Circuit 5S with new 3-phase 4/0 aluminum underground line. Line is part of the backbone of the system and a new feed main will improve system performance along with improving reliability to 145 members with 550 kW peak load. This will provide additional capacity for the backup to the Lerdal Substation.	$286,000	Freeborn County Corning Substation	Freeborn Mower Cooperative Services	High	2015
High winds, ice storms & Excessive Heat	Tie Project--convert 2.8 miles of single phase #6A CWC overhead line to new three phase 4/0 Al. underground line. Lines serve 110 consumers and an entire campground.	$217,560	Goodhue County – Hay Creek Twp. Sect 19 & 20	Goodhue County Cooperative Electric Association	High	2014
High Winds, Ice Storms	The Project – Convert 3 miles of single phase #8A CWC overhead to 1/0 Al. underground line. Line serves 30 consumers on remote end of system that becomes difficult to access in storm conditions.	$104,400	Goodhue County – Vasa Twp. Sect 4, 5, & 6	Goodhue County Cooperative Electric Association	High	2015
High Winds, Ice Storms	The Project – Convert 8 miles of single phase overhead distribution line to underground – area is highly vulnerable to wind and snow/ice storms; service to 50 consumers, majority are farms with livestock	$270,000	Goodhue and Steele Counties – Kenyon and Richland Twp.	Goodhue County Cooperative Electric Association	High	2015
High Winds, Ice Storms, Heavy Snow	Convert approx. 2.3 miles of single phase overhead distribution to single phase underground distribution. Enhancement will limit overhead exposure on the upstream recloser and provide a tie for another single phase line.	$82,800	Nobles County	Nobles Cooperative Electric	High	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 1.5 miles of 1 phase radial overhead to underground to limit overhead exposure.	$54,000	Nobles County	Nobles Cooperative Electric	High	2015

High Winds, Ice Storms, Heavy Snow	Convert approximately 3 miles of single phase overhead to underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another line.	$108,000	Nobles County	Nobles Cooperative Electric	High	2015
High Winds, Ice Storms, Heavy Snow	Convert approximately 2 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another two lines.	$72,000	Nobles County	Nobles Cooperative Electric	High	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 1 mile of two phase overhead line to two phase underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another line.	$53,400	Nobles County	Nobles Cooperative Electric	High	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements This line is used as a tie to another line.	$180,000	Nobles County	Nobles Cooperative Electric	High	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 1.5 miles of single phase overhead to single phase underground. Add approximately 0.25 miles to back up an additional line. Enhancement will limit overhead exposure to the elements This existing line is used as a tie to another line.	$64,800	Nobles County	Nobles Cooperative Electric	High	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 2.5 miles of radial overhead single phase line to single phase underground line. Add approximately 0.5 miles to create a tie to another line. Enhancement will limit overhead exposure to the elements	$108,000	Nobles County	Nobles Cooperative Electric	High	2017
High Winds, Ice Storms, Heavy Snow	Tie Project—Convert approximately 2 miles of single phase overhead to single phase underground. Add approximately 0.25 miles to provide backup for an additional line. Enhancement will limit overhead exposure to the elements. This line is used as a as a tie to another 2 lines.	$82,800	Nobles County	Nobles Cooperative Electric	High	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 0.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements.	$18,000	Murray County	Nobles Cooperative Electric	High	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 2 miles of 2 phase overhead to 2 phase underground. Enhancement will limit overhead exposure to the elements.	$106,800	Jackson County	Federated Rural Electric Association	High	2015
High Winds, Ice Storms, Heavy Snow	Convert approximately 5 miles of 3 phase overhead to 3 phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a main feeder as well as a tie between substations.	$398,500	Jackson County	Federated Rural Electric Association	High	2015

High Winds, Ice Storms, Heavy Snow	Convert approximately 2 miles of 2 phase overhead to 2 phase underground. Enhancement will limit overhead exposure to the elements.	$106,800	Jackson County	Federated Rural Electric Association	High	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 4.5 miles of single phase overhead to single phase underground. Add approximately 1 mile to as back up to Talcott Lake. Enhancement will limit overhead exposure to the elements.	$180,000		Federated Rural Electric Association	High	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 5 miles of 3 phase overhead to 3 phase underground. Enhancement will limit overhead exposure to the elements.	$398,500	Jackson County	Federated Rural Electric Association	High	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 10 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to two other lines.	$360,000	Jackson County	Federated Rural Electric Association	High	2015
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 4.75 miles of single phase overhead to single phase underground. Add approximately 0.5 miles to create a tie. Enhancement will limit overhead exposure to the elements.	$190,800	Jackson County	Federated Rural Electric Association	High	2016
High Winds, Ice Storms, Heavy Snow	Convert approximately 6.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to another line and serves the town of Bergen.	$234,000	Jackson County	Federated Rural Electric Association	High	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 3.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to another line.	$126,000	Jackson County	Federated Rural Electric Association	High	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 2.5 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements.	$90,000	Jackson County	Federated Rural Electric Association	High	2017
High Winds, Ice Storms, Heavy Snow	Convert approximately 4 miles of 3 phase overhead to 3 phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a main feeder as well as a tie between substations	$318,800	Jackson County	Federated Rural Electric Association	High	2017
High Winds, Ice Storms, Heavy Snow	Tie Project--Convert approximately 6 miles of single phase overhead to single phase underground. Add approximately 1 mile to create a tie to two additional lines. Enhancement will limit overhead exposure to the elements.	$252,000	Jackson County	Federated Rural Electric Association	High	2016

High Winds, Ice Storms, Heavy Snow	Convert approximately 6 miles of single phase overhead to single phase underground. Enhancement will limit overhead exposure to the elements. This line is used as a tie to another line.	$216,000	Jackson County	Federated Rural Electric Association	High	2016
High Winds, Heavy Snow Events, Tornados and Ice Storms	Tie Project – install 0.75 miles on new 3 phase underground distribution. Addition would provide an underground tie between two three phase circuits that serve parts of the City of Medford and the City of Owatonna. Existing three phase circuits are located in private right of way which can extend outage restoration durations. Existing circuits serve 700 consumers including a high school.	$75,000	Steele County, Medford Twp.	Steele-Waseca Cooperative Electric	High	2015
High Winds, Heavy Snow Events, Tornados and Ice Storms	Overhead to Underground Conversion Project – covert 3.5 miles of three phase overhead distribution circuit to three phase underground distribution circuit. Area of the existing distribution line is in a heavily treed private right of way area. This distribution line is a section of a tie line between two substations. Number of consumers that would benefit - 360.	$325,000	Rice County, Bridgewater Twp.	Steele-Waseca Cooperative Electric	High	2016
High Winds, Ice Storms, Lightning and Tornadoes	Tie Project – convert 5.75 miles of single phase overhead distribution line to three phase underground distribution line. This conversion will allow for the ability to tie two circuits together that are now long radials, (8+ miles). The circuits serve 150 agriculturally based consumers.	$450,000	Dodge County, Claremont, Concord, Ellington and Wasioja Twp.	Steele-Waseca Cooperative Electric	Medium	2015
High Winds, Blizzards, Ice Storms, Tornadoes, Floods, Heavy Snow Events, Lightning Storms	Technology - Update SCADA system in 17 distribution substations to allow for transfer of substation information to crews in the field, not just dispatchers in the offices. Also enables further SCADA applications such as automation at major points on a distribution circuit down line of a substation. These substations serve 9,850 consumers.	$350,000	Parts of Blue Earth, Dodge, Faribault, Freeborn, Goodhue, Le Sueur, Rice, Steele and Waseca Counties	Steele-Waseca Cooperative Electric	High	2014-2016

Red River Line Crossing	Replace existing structures in the flood plain with steel structures to reduce ice floe damage during spring flooding. This will reduce outage time.	$50,000	Various Locations	Minnkota Power Cooperative, Inc.	M	2015
Blink Outage Mitigation	Add a breaker at Sand Hill to reduce the number of miles of line exposed to faults and mitigate extended outages and blink outages.	$350,000	Sand Hill, MN	Minnkota Power Cooperative, Inc.	H	2015
Line Outages	Service disruption in the Oslo/Thief River Falls area has increased after construction of a 115 kV line in 1999. The addition of a breaker at Oslo will improve service by reducing outages.	$1,100,000	Oslo, MN	Minnkota Power Cooperative, Inc.	H	2014
Power Quality	Expand the existing Hallock substation to provide for the addition of three breakers needed to improve service to the surrounding area. Blink outages have negatively impacted a large commercial customer as well as residential customers in that vicinity.	$920,000	Hallock, MN	Minnkota Power Cooperative, Inc.	H	2014
Provide Alternate Service	Construction of a transmission line that will provide looped service to the area around Hawley, MN. At this time radial lines support the load and extended outages have occurred due to the fact that there is no alternate feed. A looped transmission line will improve the quality of service and reduce outage times.	$3,400,000	Audubon, Christensen, Hawley,	Minnkota Power Cooperative, Inc.	H	2014-2015
High winds, ice storms and floods	Convert 2miles of east/west overhead 3 phase lines to underground. Approximately 270 customers are served, including the City of Hendrum and Norman County West Elementary School and several businesses	$100,000	Norman County, Hendrum Twp.	Red River Valley Co-op	High	2014/2015
High winds and ice storms	Convert 5 miles of overhead 3 phase line to underground. Approximately 100 customers are served by this line.	$450,000	Polk County, Bygland Twp.	Red River Valley Co-op	High	2014/2015

High winds, ice storms and floods	Convert 3 miles of overhead 2 phase line to 3 phase underground line. Approximately 30 customers are served by this line including a transmitter tower owned by the FFA that is considered to be critical infrastructure for a large airport – Hector International in Fargo, ND	$228,000	Clay County, Kragness Twp.	Red River Valley Co-op	High	2014/2015

Survey Results and Analysis

HSEM conducted a survey of Minnesota rural electric cooperatives and their perceptions, past experiences, and concerns regarding natural hazards affects to their utility systems. The survey asked 25 questions ranging from concern that service will be interrupted by natural hazards to how often cooperatives coordinate and plan with local response personnel. The survey was completed by 40% of distribution cooperatives across the state.

Survey highlights include:

- 89% of survey responses "extremely concerned" that services provided by the rural electric cooperative will be interrupted or otherwise impacted by a natural hazard.
- 83% of survey responses "extremely concerned" that the electrical infrastructure will be impacted by a natural hazard.
- 77% of survey respondents have conducted a hazard analysis and risk assessment in the past 10 years (50% in the past five years)
- The top natural hazards that have "affected/damaged critical infrastructure in the cooperative service area" – flooding, windstorms, tornados, and winter storms
- The top potential high impact from natural hazards to critical electrical infrastructure was identified as windstorm, tornado, and winter storms
- Almost 50% of survey respondents identified that the cooperative has a high capability to respond to the same natural hazards (windstorms, tornados, and winter storms) that were identified as potential high impact.
- 94% of survey respondents identified substations, distribution lines, and transmission lines as highly critical to the electrical infrastructure, with transformers, human capital and vehicles also identified as highly critical (89%, 78%, 72% respectively)
- 100% of survey respondents have taken mitigation action steps to reduce vulnerability
- Underground burial projects, vegetative management, and pole replacement are the three top potential mitigation actions that survey respondents identified as high potential to be completed
- 73% of survey respondents have participated in local, regional, or state-level emergency planning (28% identified "possibly, but not certain")
- Only 39% have participated in in local, regional, or state-level emergency response exercises (22% identified "possibly, but not certain")
- 73% have participated in local, regional, or state-level emergency response activities during actual natural hazard events (11% identified "possibly, but not certain")
- 63% have worked with local emergency managers to identify mitigation measures
- 75% of respondents identified that they needed additional mitigation information for windstorms and winter storms.

Incorporated Plans, Studies, Reports, and Technical Data

Minnesota Hazard Mitigation Plan (2011 & 2014)

Minnesota Rural Electric Association Emergency Work Plan

Extreme Ice Thickness from Freezing Rain[viii]

Severe Storms in the Midwest[ix]

Electrical Transmission and Distribution Mitigation: Loss Avoidance Study (FEMA, 2008)

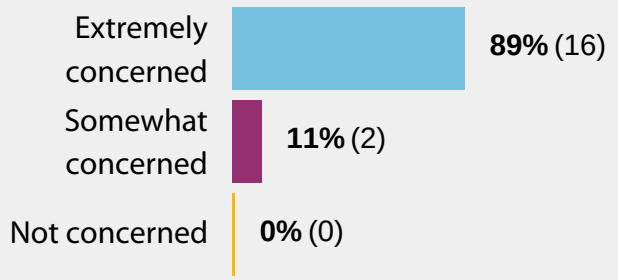
Economic Benefits of Increasing Electric Grid Resilience to Weather Outages - published by the Executive Office of the President

Survey Results

On the following pages

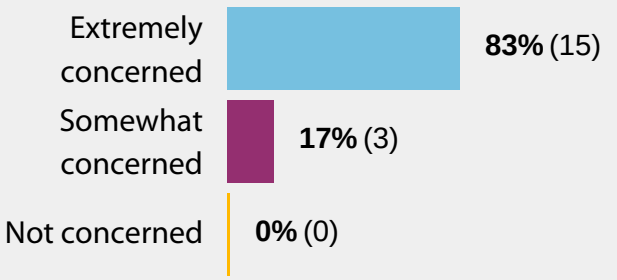
[i] NRECA – U.S. Electrical Utility Overview - http://www.nreca.coop/about-electric-cooperatives/co-op-facts-figures/u-s-co-ops-by-the-numbers/
[ii] http://www.nreca.coop/about-electric-cooperatives/history-of-electric-co-ops/
[iii] Minnesota Rural Electric Association - http://www.mrea.org/about-electric-cooperatives/
[iv] Minnesota Rural Electric Association - http://www.mrea.org/about-electric-cooperatives/
[v] Minnesota Rural Electric Association - http://www.mrea.org/about-electric-cooperatives/
[vi] Data from Minnesota Rural Electric Association on cooperative member statistics.
[vii] Economic Benefits of Increasing Electric Grid Resilience to Weather Outages. Executive Office of the President, 2013. http://energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf
[viii] Kathleen Jones, "Extreme ice thickness from freezing rain (Report for Federal Emergency Management Agency and National Institute of Building Sciences", 28 May 2004.
[ix] Kunkel, K. E., and S.A. Changnon, 2009: Severe Storms in the Midwestern USA. Chapter 20, Understanding Climate Change, Indiana Univ. Press, 225-235.

How concerned are you that services provided by the rural electric cooperative will be interrupted or otherwise impacted by a natural hazard?



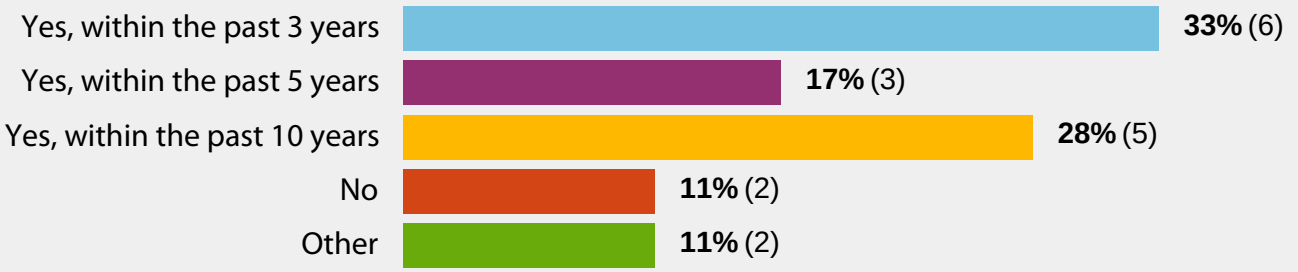
* 18 total responses, 100% of submissions

How concerned are you about the possibility of the rural electric cooperative critical electrical infrastructure being impacted by a natural hazard?



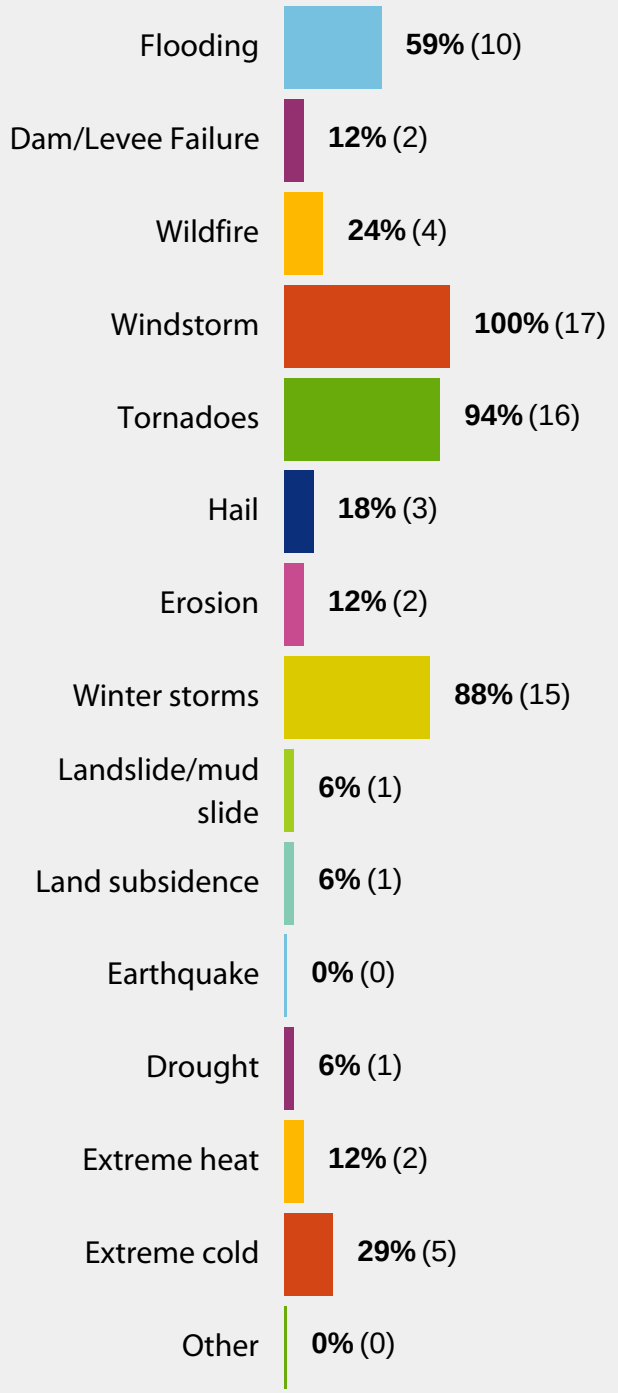
* 18 total responses, 100% of submissions

Has the rural electric cooperative conducted a hazard analysis and risk assessment?



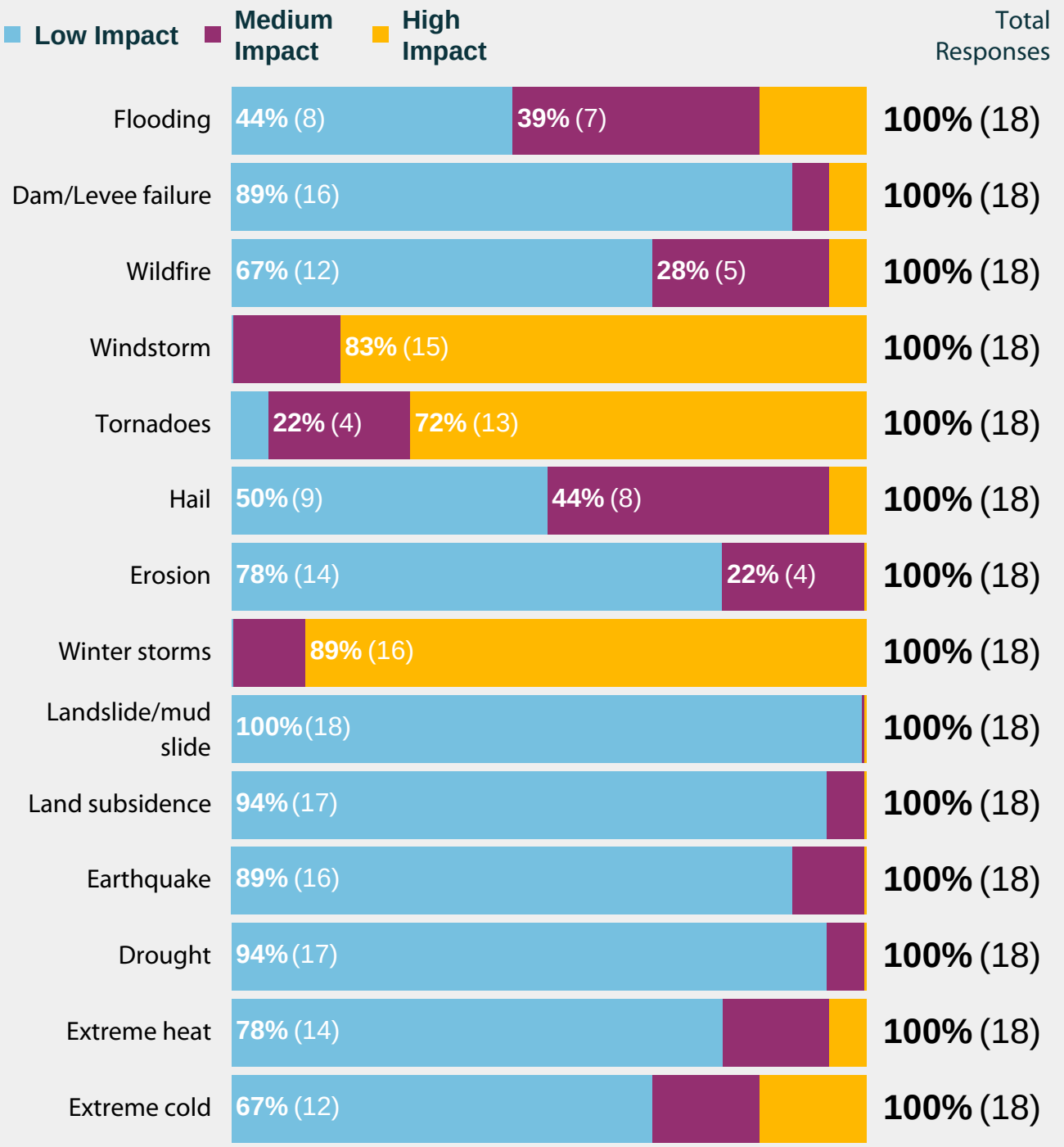
* 18 total responses, 100% of submissions

Which of the following natural hazards adversely affected/damaged critical electrical infrastructure in the cooperative service area? (check all that apply)

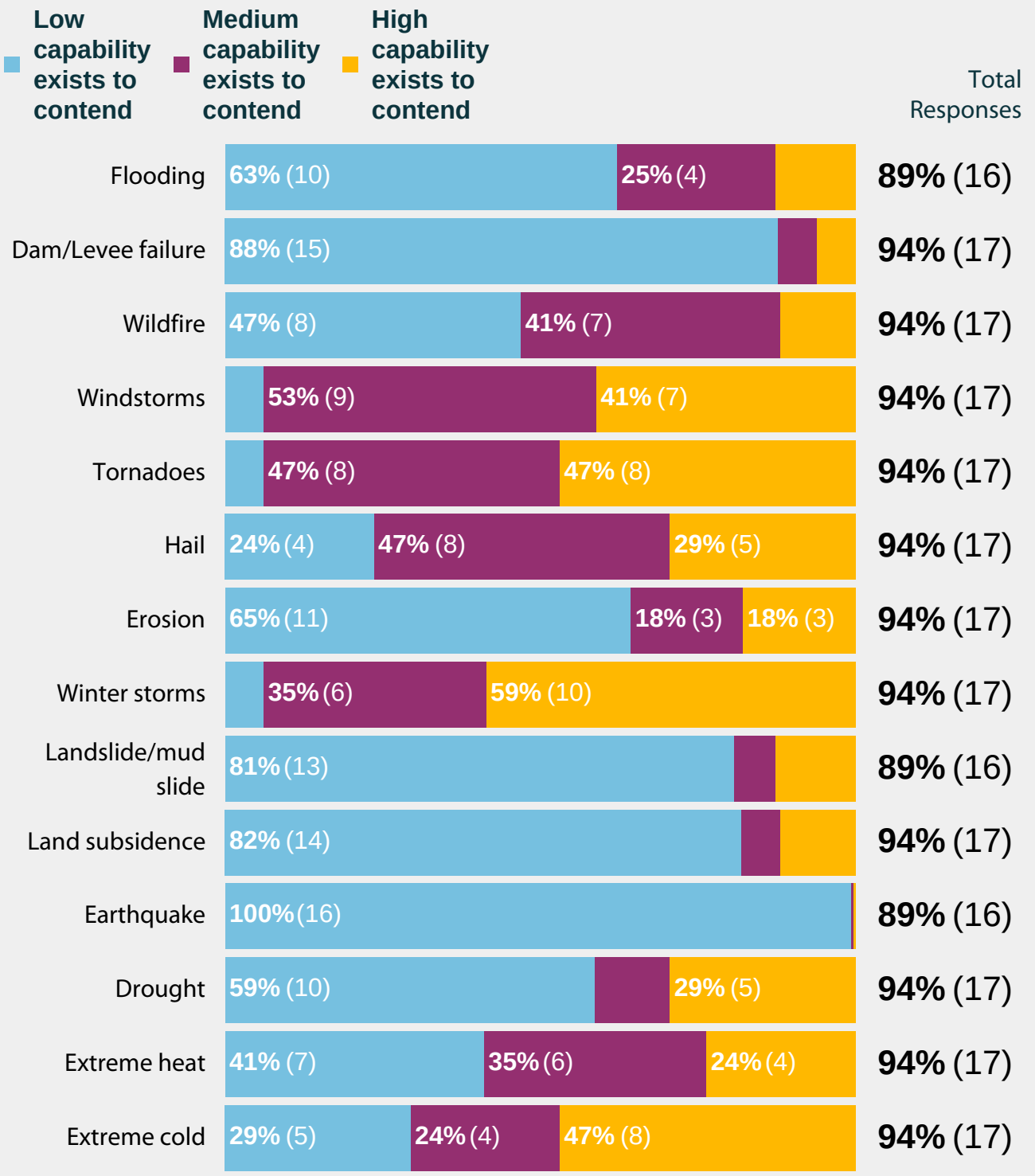


* 17 total responses, 94% of submissions

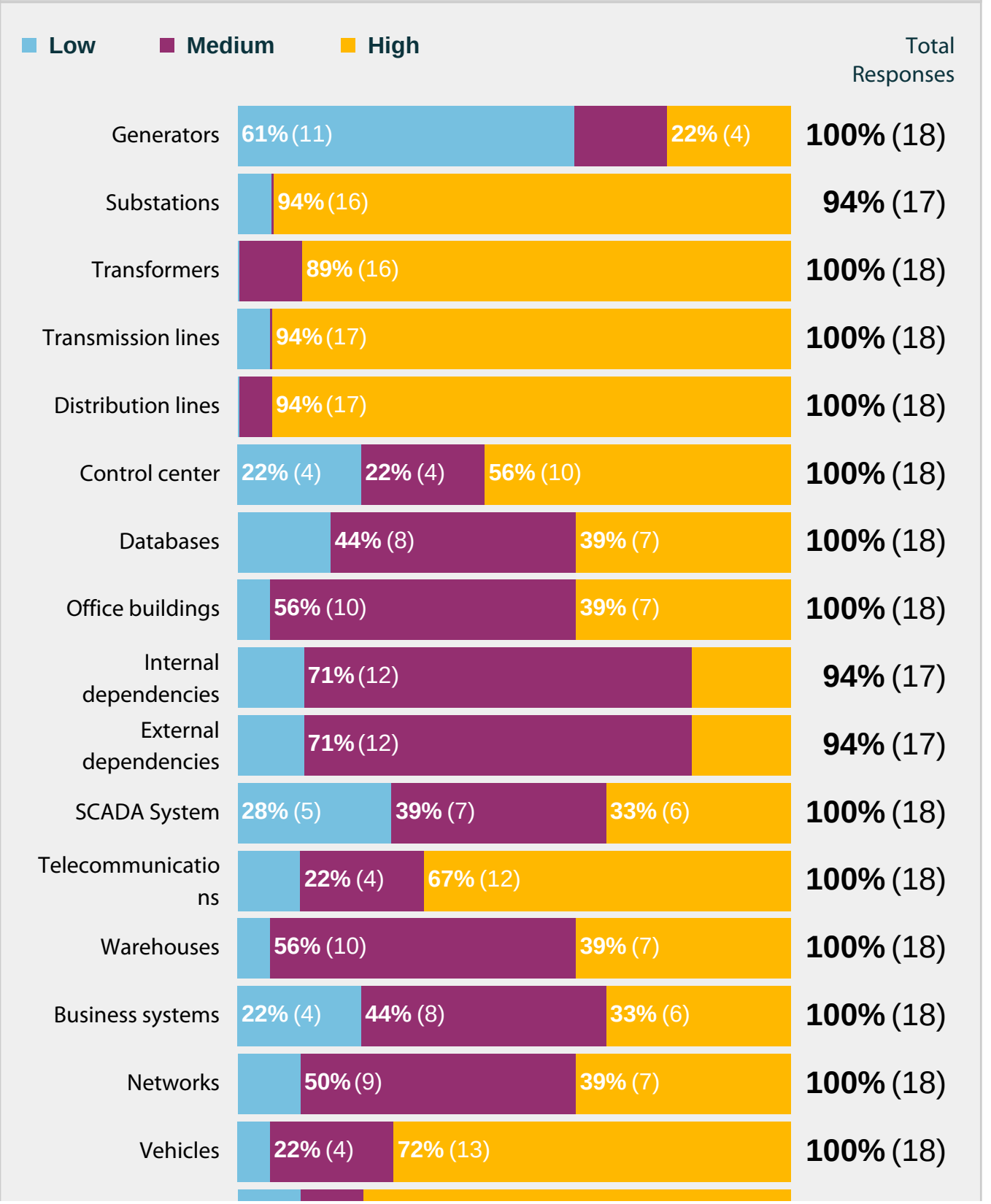
What is the potential impact of natural hazards to critical electric infrastructure in the cooperative service area? Please rate the degree of impact by hazards as: Low impact, Medium impact, or High

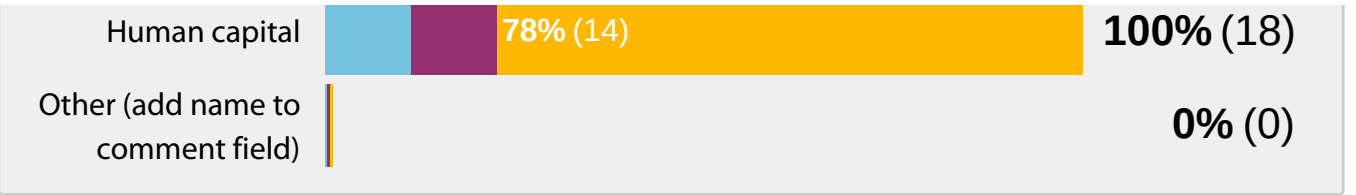


What level of local capability exists to contend with the hazard in your cooperative service area? Please rate the capability for each hazard.

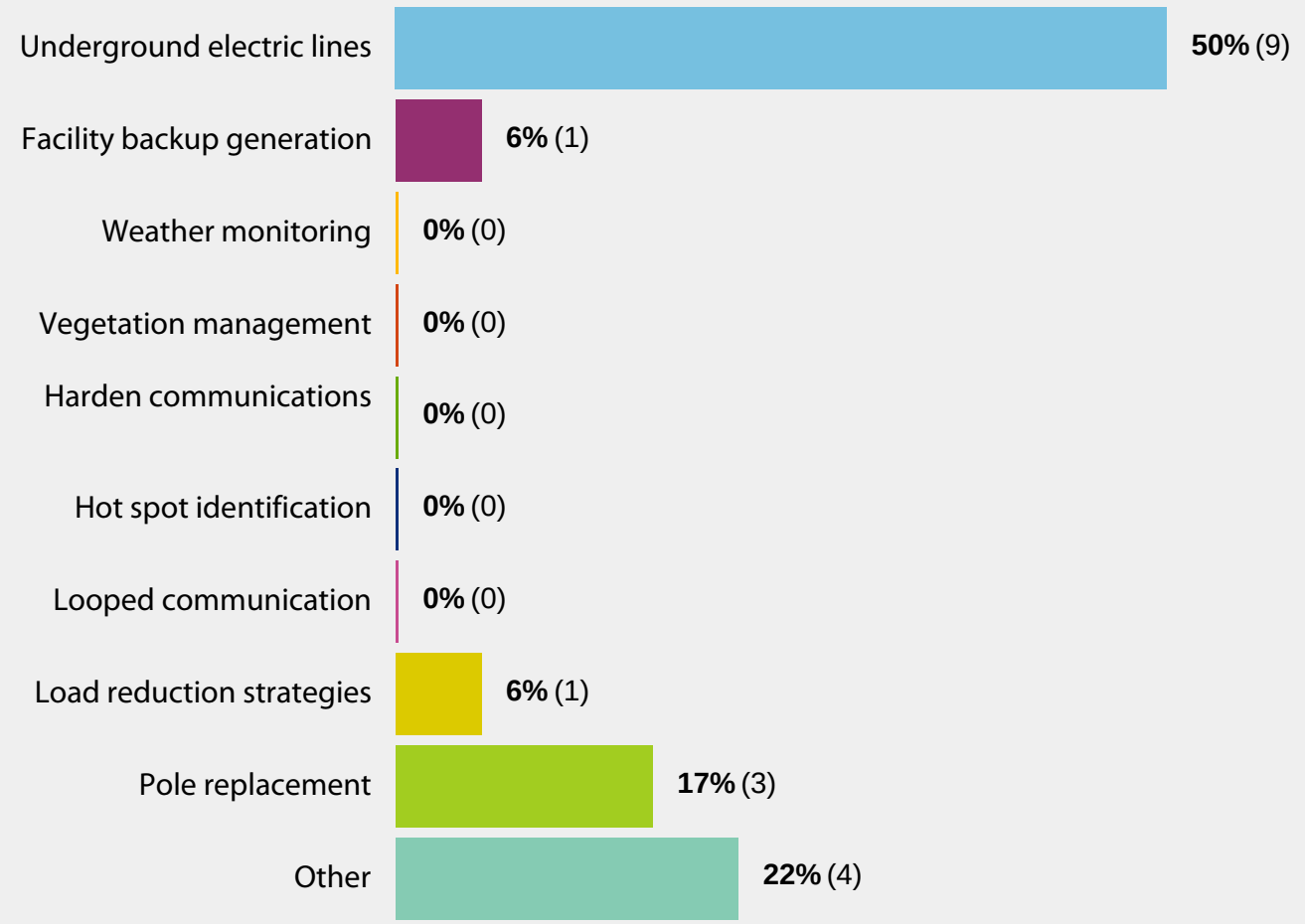


Please review the following list of potential critical assets to the electric infrastructure. Please rate the criticality of each type of infrastructure to the overall system: Low, Medium, High



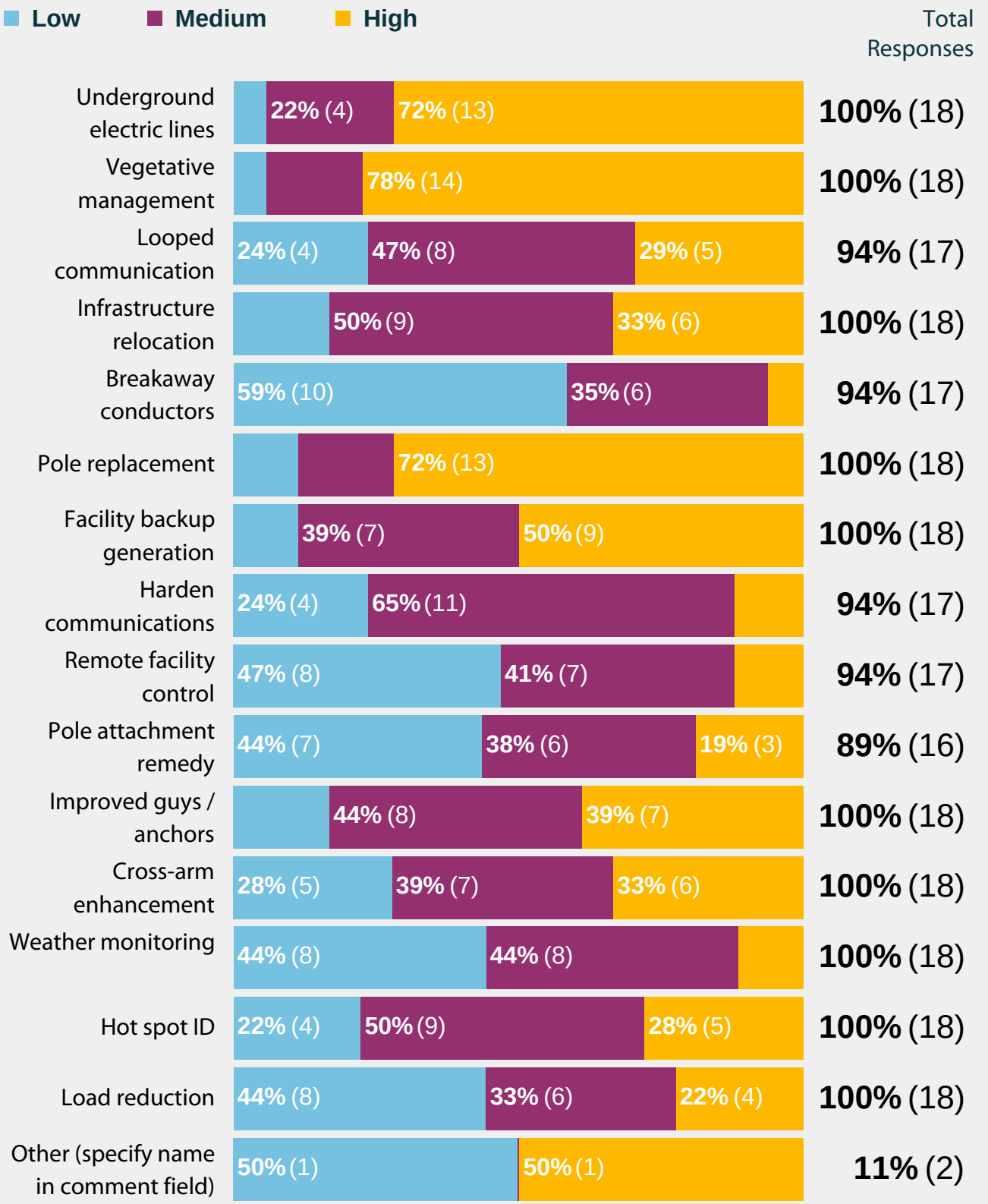


Has the electric cooperative taken mitigation action(s) to make critical electric infrastructure more resistant to natural hazards? Please check all that apply. Add other items to the comment field.

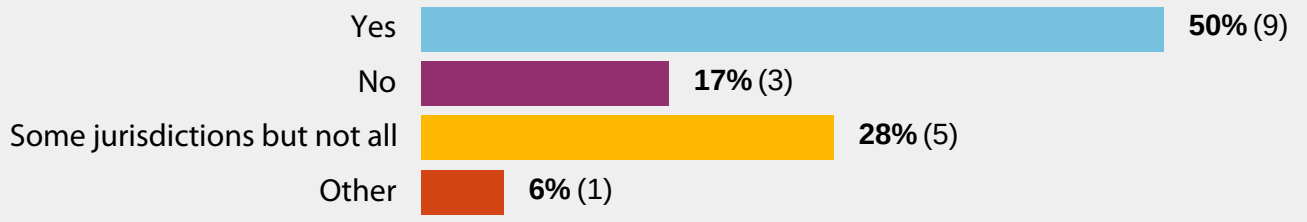


* 18 total responses, 100% of submissions

Please review the potential mitigation actions for rural electric cooperatives to reduce impacts of natural hazards on service or critical infrastructure. Please rate by: Low, Medium, or High

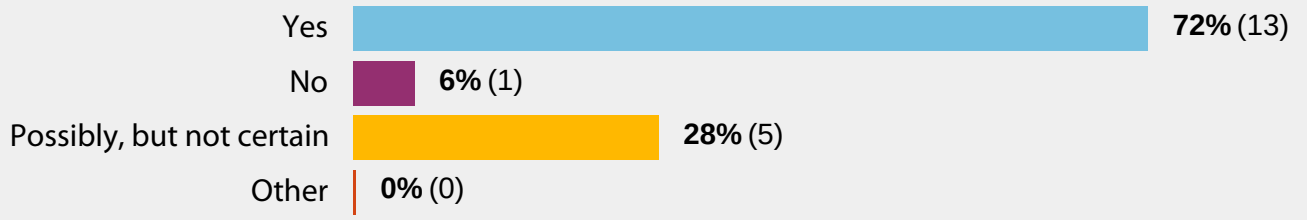


Has your organization been involved with local pre-disaster mitigation planning in the local jurisdiction(s) representing the cooperative service area?



* 18 total responses, 100% of submissions

Has the rural electric cooperative participated in local, regional, or state-level emergency response planning?

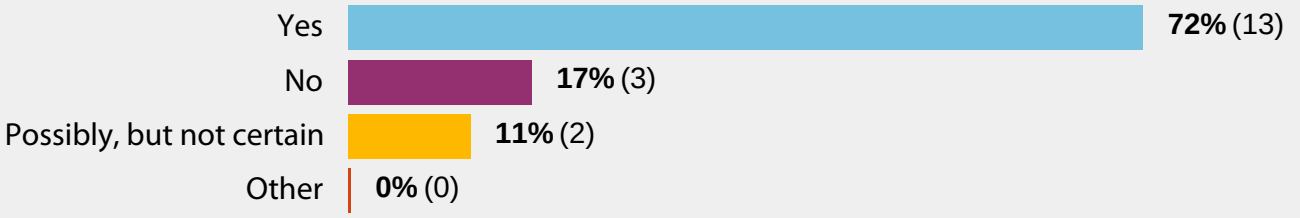


* 18 total responses, 100% of submissions

Has the rural electric cooperative participated in local, regional, or state-level emergency response exercises?

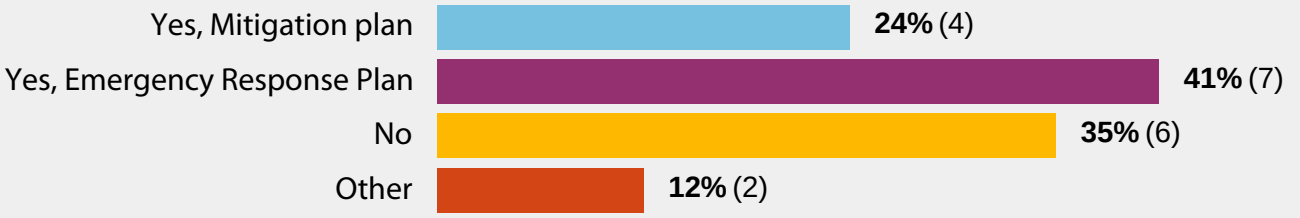
* 18 total responses, 100% of submissions

Has the rural electric cooperative participated in local, regional, or state-level emergency response activities during actual natural hazard events?



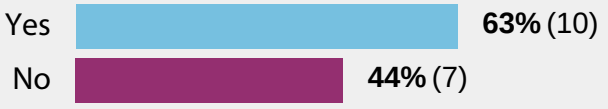
* 18 total responses, 100% of submissions

Do you have a copy of the local hazard mitigation plan and/or emergency response plan from the jurisdiction(s) representing the rural electric cooperative service area?



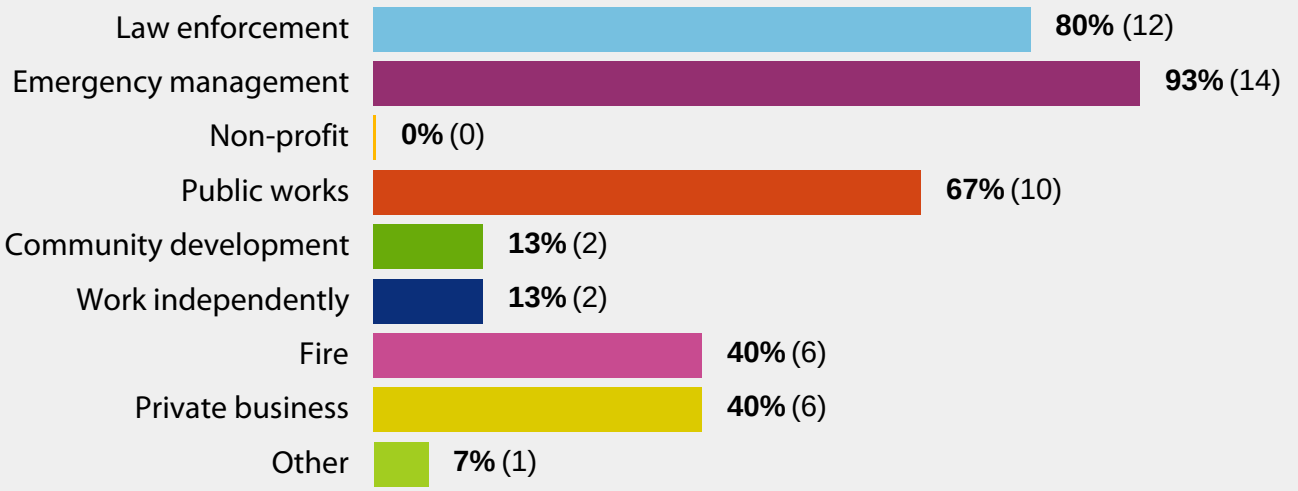
* 17 total responses, 94% of submissions

Have you worked with your local emergency managers in identifying or developing mitigation measures to reduce the impact of natural disasters on critical electric infrastructure?



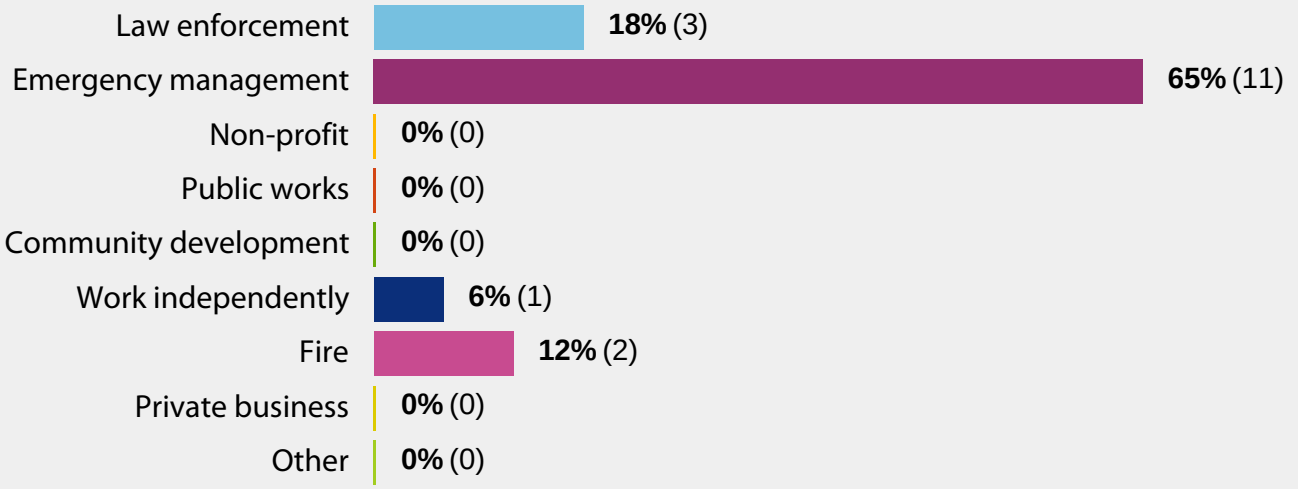
* 16 total responses, 89% of submissions

Which entities does your rural electric cooperative work with for disaster mitigation, preparedness, response, or recovery? (Choose all that apply)



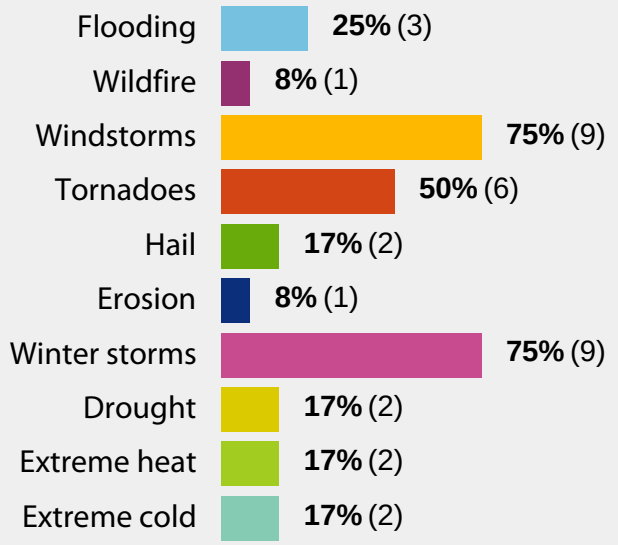
* 15 total responses, 83% of submissions

Which entity does your rural electric cooperative work with most frequently for disaster mitigation, preparedness, response, or recovery? (Choose only one)



* 17 total responses, 94% of submissions

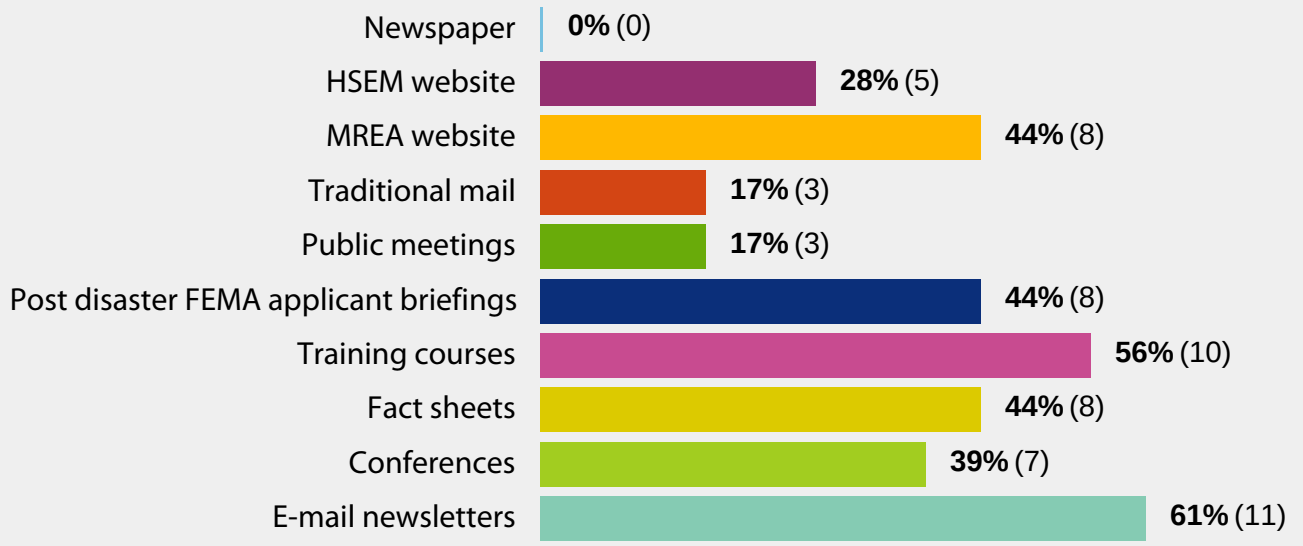
Do you need additional mitigation information for any of the natural hazards identified below? (Check all that apply)



3 additional choices not shown

* 12 total responses, 67% of submissions

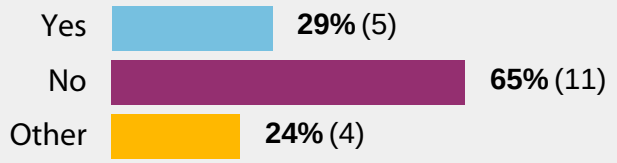
What is the most effective method to receive information on making rural electric cooperatives more resistant to natural hazards? (Check all that apply)



1 additional choice not shown

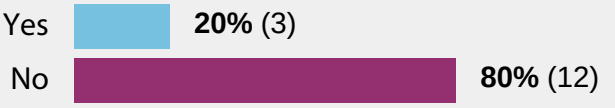
* 18 total responses, 100% of submissions

Do you have any suggestions for other ways that the State or local jurisdictions could make natural hazard information more available to your organization?



* 17 total responses, 94% of submissions

Are there any other issues regarding the reduction of risk and loss associated with natural hazards and rural electric cooperatives that you think are important?



* 15 total responses, 83% of submissions