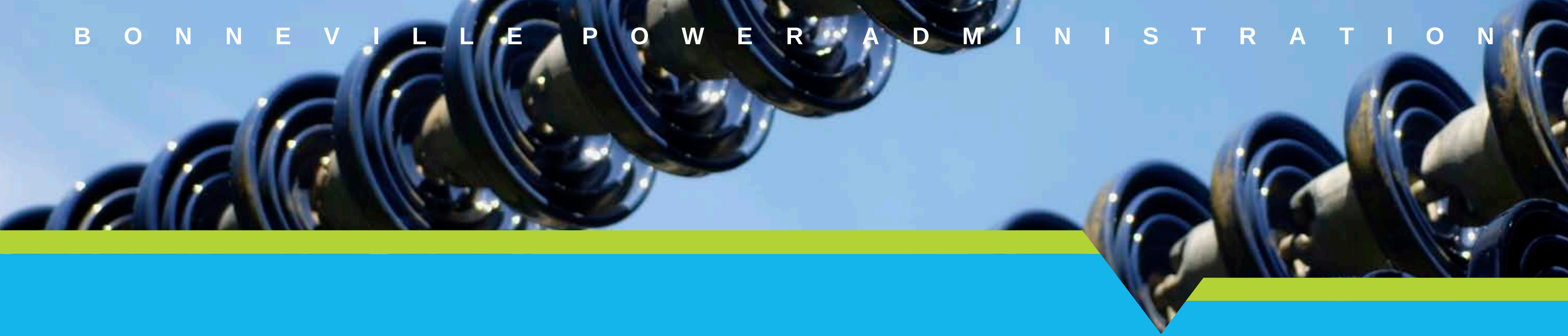
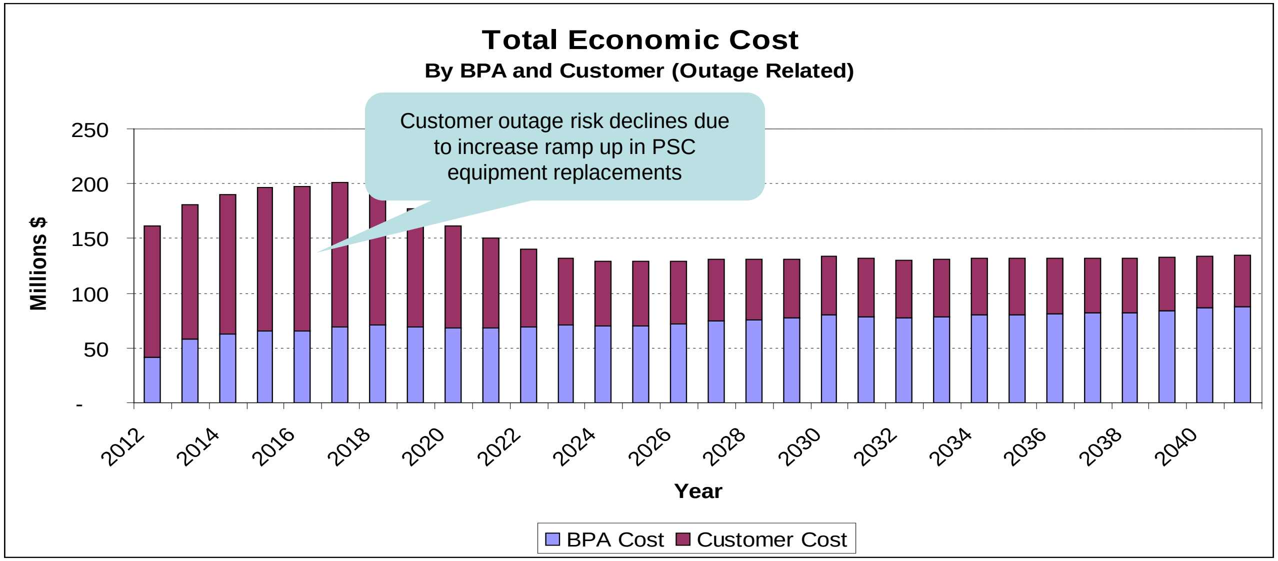


PSC/Telecommunications Asset Strategy

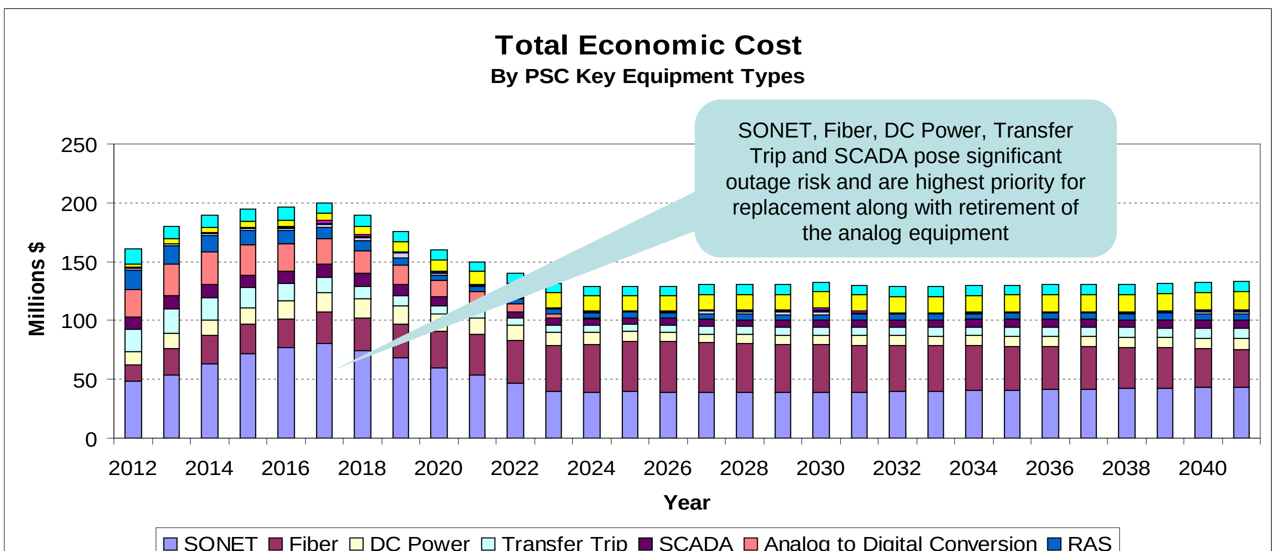
Customer Value Loss Methodology

Capital Investment Review
Follow-up conference call
Workshop on capital project prioritization
April 30, 2012

Different Views of Total Economic Cost



- There are two primary sources of cost being evaluated: BPA direct cost and avoided outage cost



- The methodology provides insight into the contribution that different equipment types make on Total Economic Cost

Definitions Used

- **Transmission outage**
  - ***Reliability risk:*** Failure of transmission equipment (emergency) or discovery of a problem that needs immediate attention (forced) that results in an unplanned transmission outage. System operators are able to control the outage and prevent the spreading beyond the area immediately impacted.
  - ***Cascading:*** The uncontrolled successive failure of system elements triggered by an incident at any location within the Interconnection. Cascading results in widespread electric service interruption that cannot be restrained from sequentially spreading beyond an area predetermined by appropriate studies.

- **Customer outage** – Residential, commercial, industrial and other end-use electric customer loss of electric service as a result of an electric system outage.

- **Customer value loss** - the estimated amount that customers receiving electricity with firm contracts would be willing to pay to avoid a disruption in their electricity service.

PSC/telecom equipment failures can have adverse impacts on transmission grid operations

- ✓ Most PSC/Telecom equipment types pose little or no risk to reliable operation of the transmission grid should they fail.
- ✓ Nine of the 24 PSC/Telecom equipment types do pose significant risk to reliable transmission system operation
- ✓ These nine types were assessed for probability of failure and impact on system operations by SME's

  - ***RAS (Remedial Action Scheme)***
  - TT (Transfer Trip)
  - SCADA (supervisory control and data acquisition)
  - DATS (Dial Automatic Telephone System)
  - VHF (Radio Frequency)
  - Fiber Optic Cable
  - Analog to Digital interfaces
  - DC Power
  - SONET

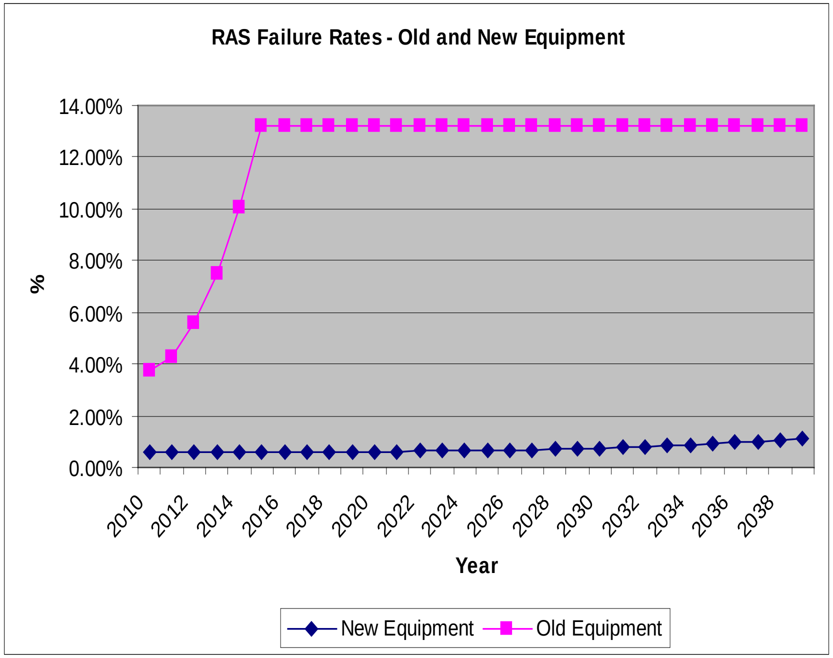
RAS equipment is used as an example to explain the methodology for calculating non-BPA cost (outage cost), but the approach is generally the same for all 9 equipment types

RAS Equipment Failure Curves
Old and New Equipment

- Assessed based on actual history of RAS failures over past five years
    - New equipment type (Forward installations)
    - Old equipment type (Prior installations)

- In 2010 there were approximately 666 RAS units of equipment on BPA's system. It is expected that this population will increase at a rate of 1.8% per year and reach almost 1200 units by 2039

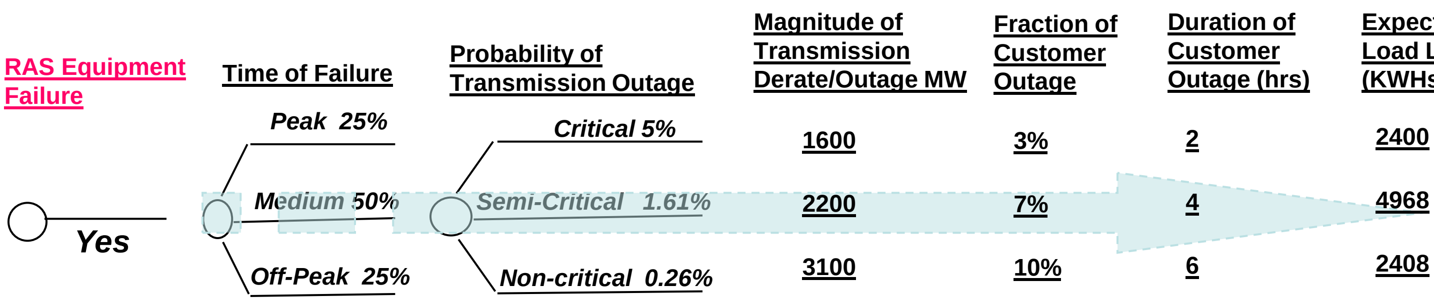
- Failure rates were assessed based on current number of failures and a forecast of maximum number of failures and the time to get there (new and old equipment type).



If "old" RAS are still on the system in 2017, we expect that 1 in 8 will fail every year. If all of these have been replaced with "new", we expect less than 1 in 100 will fail each year.

Methodology for assessing "Reliability Risk"

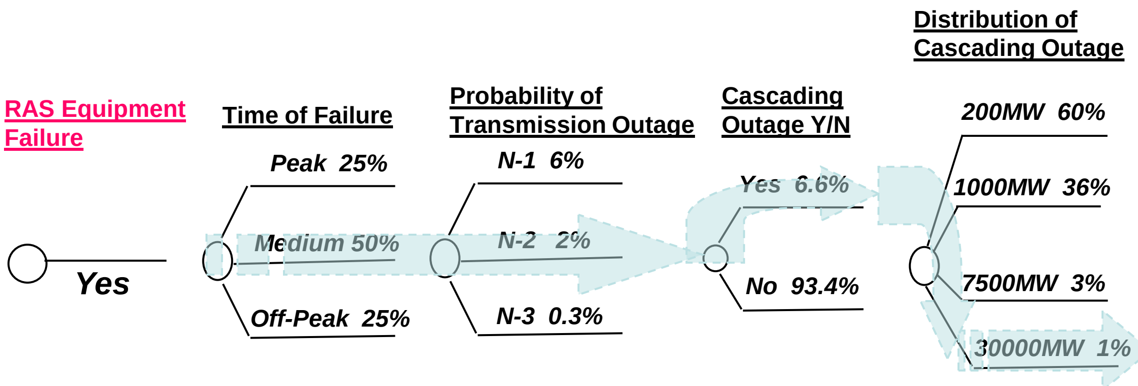
Failures of PSC/Telecommunications equipment can have adverse impacts on transmission system operation. SME's from BPA Transmission Operations assessed the magnitude of outage (MW), fraction of customer outage, the likelihood of an outage, and restoration time (Hours) for nine PSC equipment types. RAS equipment failure is used below to show how the probabilities and assessed impacts are used to calculate expected customer value loss.



Expected customer value loss is estimated to be $85,630 per RAS failure

	Time of Failure	Probability of Transmission Outage	Magnitude of Transmission Derate/Outage MW	Fraction Customer Outage	Restoration Time (Hours)	Expected Load Loss (KWH)	Average Customer Value ($ per KWH)	Expected Load Loss * Average Value $/kwh (Thousands $) per failure
Given Critical Peak	25%	6.00%	2500	4%	3	4,500	$ 3.21	$ 14.44
Given Critical Medium	50%	5.00%	1600	3%	2	2,400	$ 3.21	$ 7.70
Given Critical Off-peak	25%	4.00%	1000	3%	2	600	$ 3.21	$ 1.93
Given Semi-Critical Peak	25%	1.94%	3500	8%	5	6,796	$ 3.21	$ 21.81
Given Semi-Critical Medium	50%	1.61%	2200	7%	4	4,968	$ 3.21	$ 15.94
Given Semi-Critical Off-peak	25%	1.28%	1400	7%	4	1,250	$ 3.21	$ 4.01
Given Non-Critical Peak	25%	0.31%	5000	12%	7	3,209	$ 3.21	$ 10.30
Given Non-Critical Medium	50%	0.26%	3100	10%	6	2,408	$ 3.21	$ 7.73
Given Non-Critical Off-peak	25%	0.18%	2000	10%	6	551	$ 3.21	$ 1.77
NOTE: SME assessments are highlighted in light blue						**26,681**		**$ 85.63**

Methodology for assessing “Cascading Outage”



Size of Outage	Joint Probability of Cascading Outage, given a RAS failure	Customer Value Loss, given a cascading outage ($M)
200MW	0.0396%	$2.5
1000MW	0.0238%	$12.8
7500MW	0.0020%	$962.0
30000MW	0.0007%	$3,800.0

Each of the above probabilities are assumed to be independent. The joint probability is therefore the product of the various individual probabilities.

Overall probability of 30k MW outage given a **RAS** failure is (Time of Failure X Probability of Transmission Outage X Cascading Outage (Y/N) X Size of Cascading Outage) =
0.5% X 2%X% 6.6%X1% = **0.0007%**

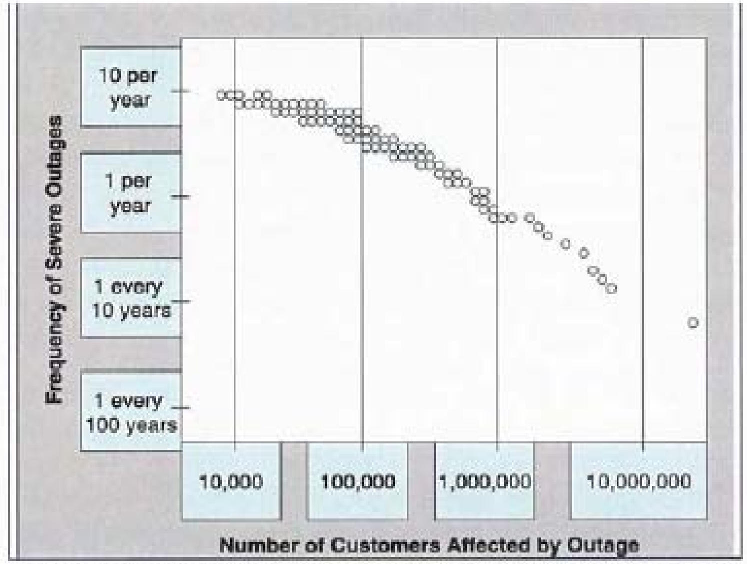
This is one path, of many thousands, that calculates the probability that a RAS failure could lead to a cascading outage and subsequent loss of significant load

Customer value loss for customer outages of this size range as little as $2.5 million to as high as $3.8 billion. For each forecasted RAS failure, the expected customer value loss is the joint probability of the event happening (0.0007%) times the customer value loss of the event ($3.8 billion) which is equal to approximately $25,000 per equipment failure.

Methodology for assessing “Cascading Transmission Outage Risk”

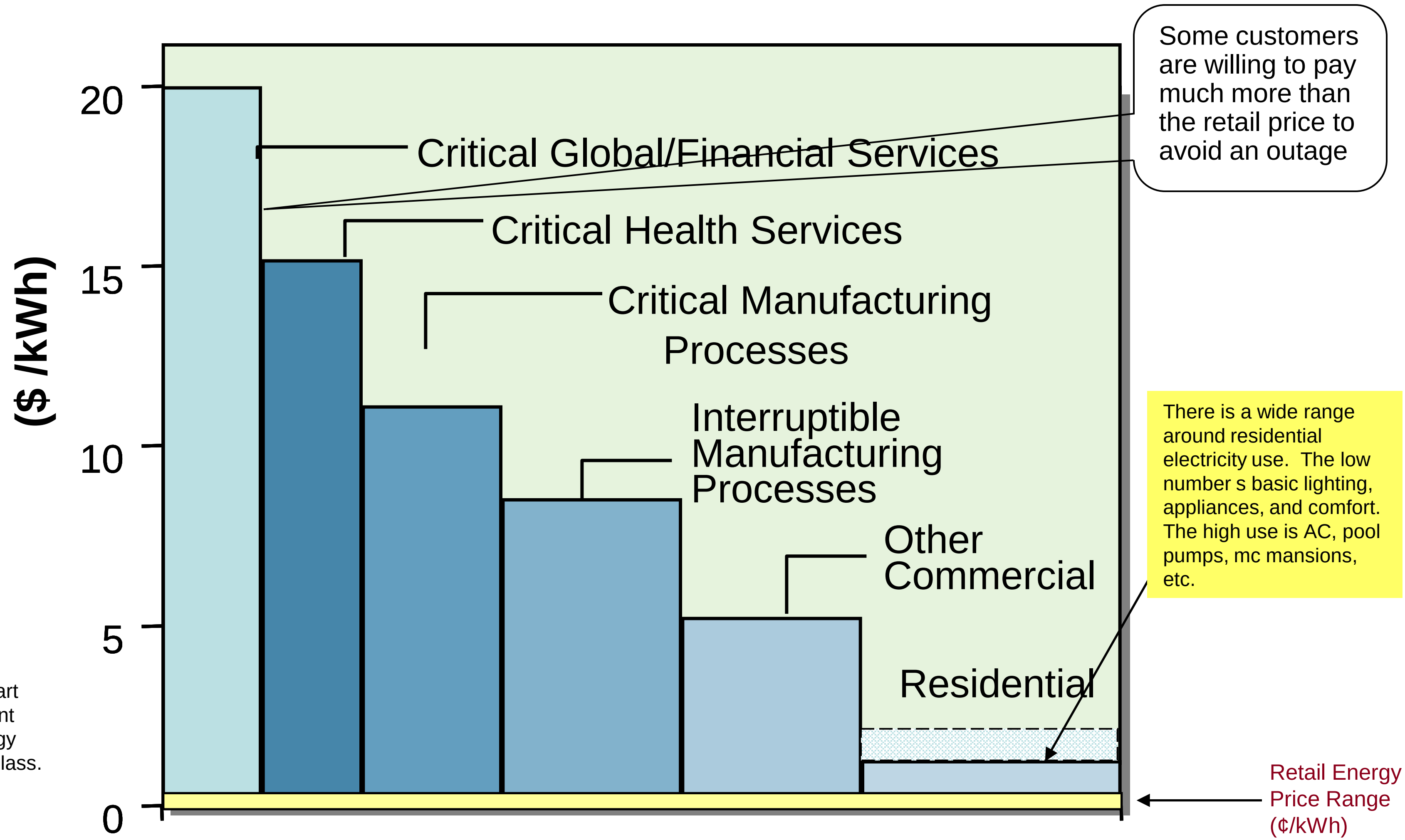
North American Power Outage Study – Actual outages from 1984 to 1997 were studied to understand likelihood and consequences of large scale outages

- The chart the actual scale and frequency of power system outages in North America, showing that an outage affecting 1,000,000 customers can be expected to occur about once a year.
- A large-scale outage affecting 500,000 customers occurs every other year in the Western Inter-connection, and is supported by this chart.
- For large cities, a major outage typically has customer costs valued as low as $1.0 billion to $3.5 billion or higher, depending on size and scope of outage.



Note: The bubbles represent individual outages in North America between 1984 and 1997.
Source: Adapted from John Doyle, California Institute of Technology, “Complexity and Robustness,” 1999. Data from NERC.

Customer surveys indicate that electricity has much greater value than the actual cost



Representative Outage Costs by Sector

Widths of chart bars represent relative energy use for that class.

Assumptions on Customer Value $/KWH

- Assumes mix of customers impacted by the outage is the same as the mix for the region.
- Average customer value loss is weighted based on the customer mix for the region and customer type energy load in kW.