

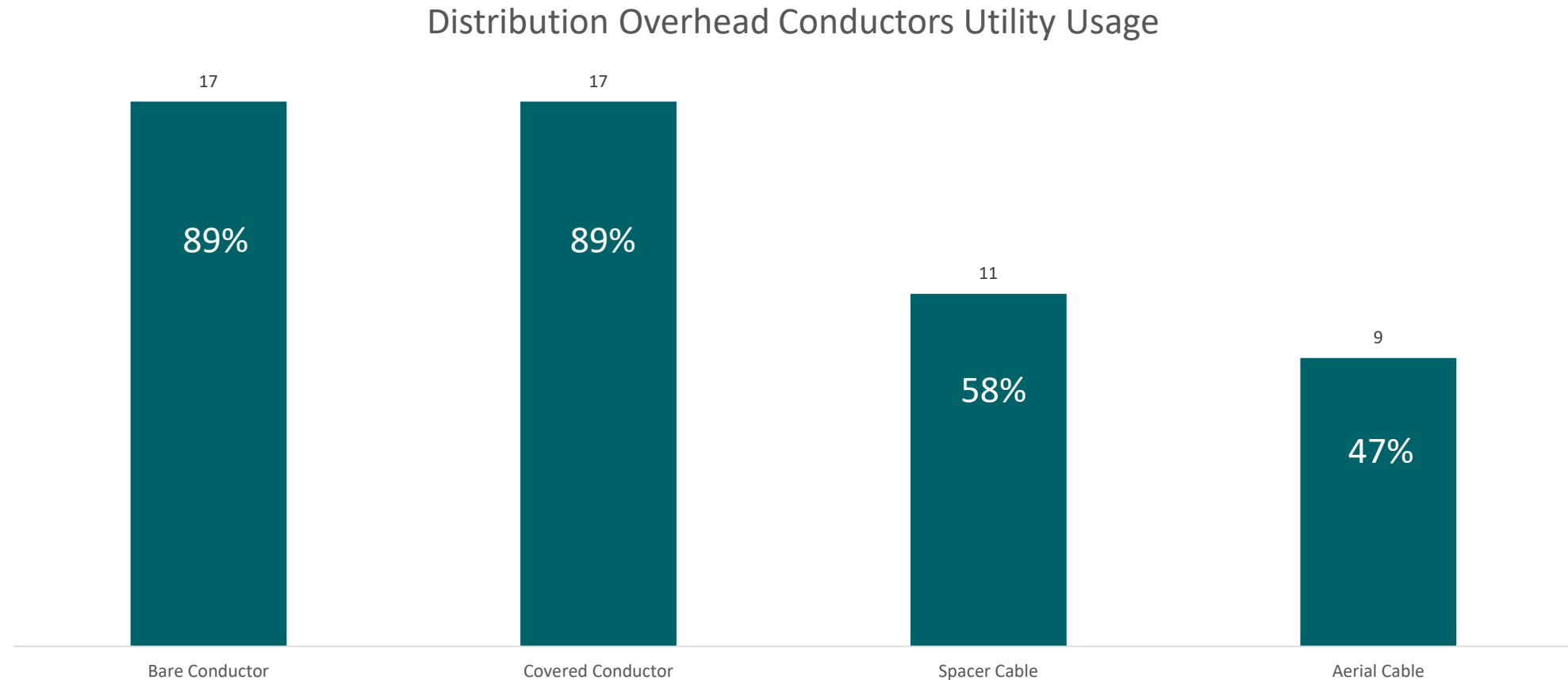
Covered Conductor Benchmarking Survey Results

Joint IOU CC Effectiveness Workstream

Participants

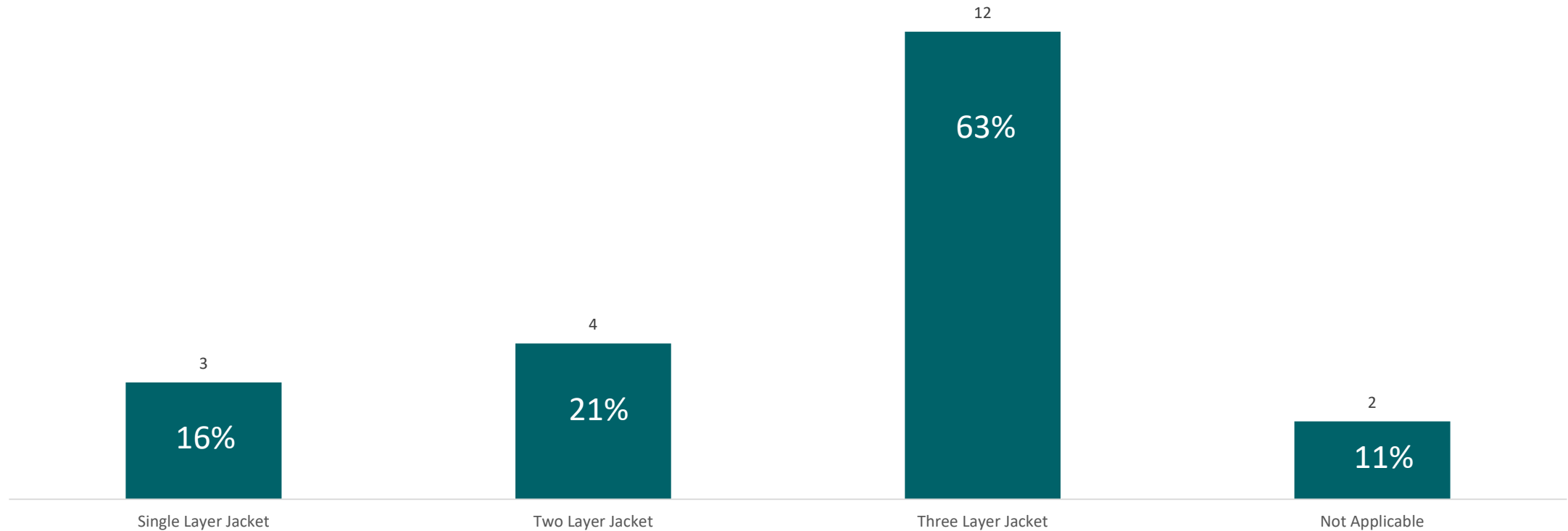
1. American Electric Power
2. Ausnet Services
3. Bear Valley Electric Service, Inc.
4. Duke Energy
5. Essential Energy
6. Eversource Energy (CT)
7. Korean Electric Power Corporation
8. Liberty
9. National Grid
10. Pacific Gas and Electric Company
11. PacifiCorp
12. Portland General
13. Powercor
14. Puget Sound Energy
15. San Diego Gas & Electric
16. Southern California Edison
17. TasNetworks
18. Tokyo Electric Power Company
19. Xcel Energy

What types of overhead conductors does the utility utilize in its distribution system?



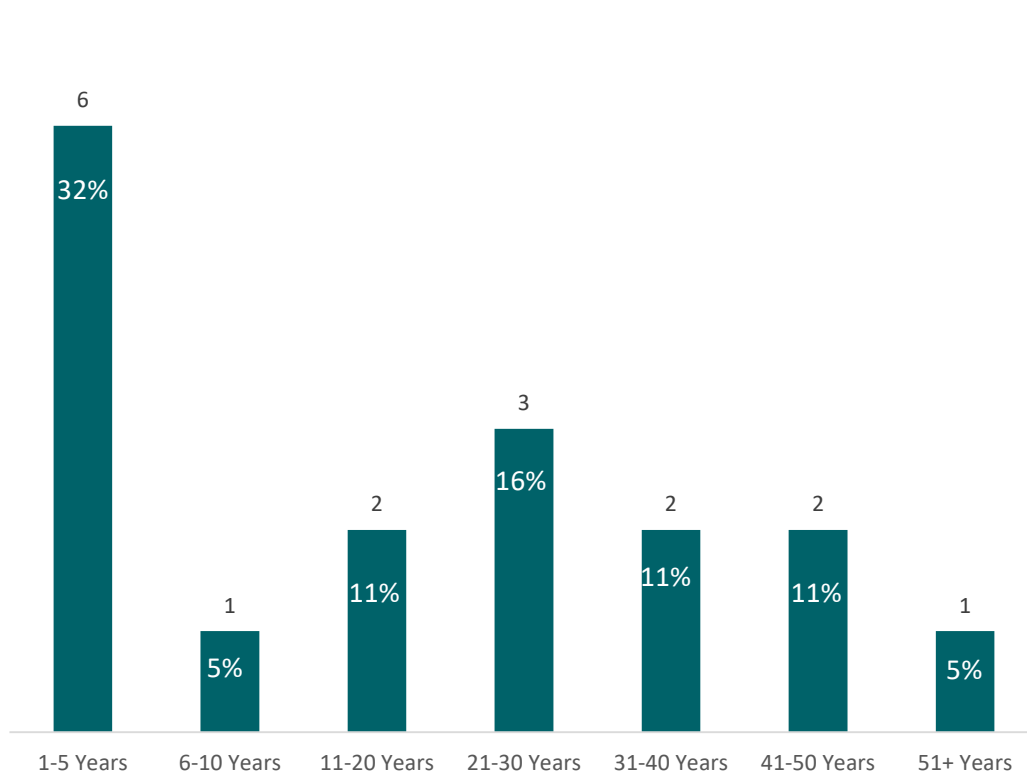
What type of covered conductor design does the utility utilize?

Covered Conductor Jacket Design

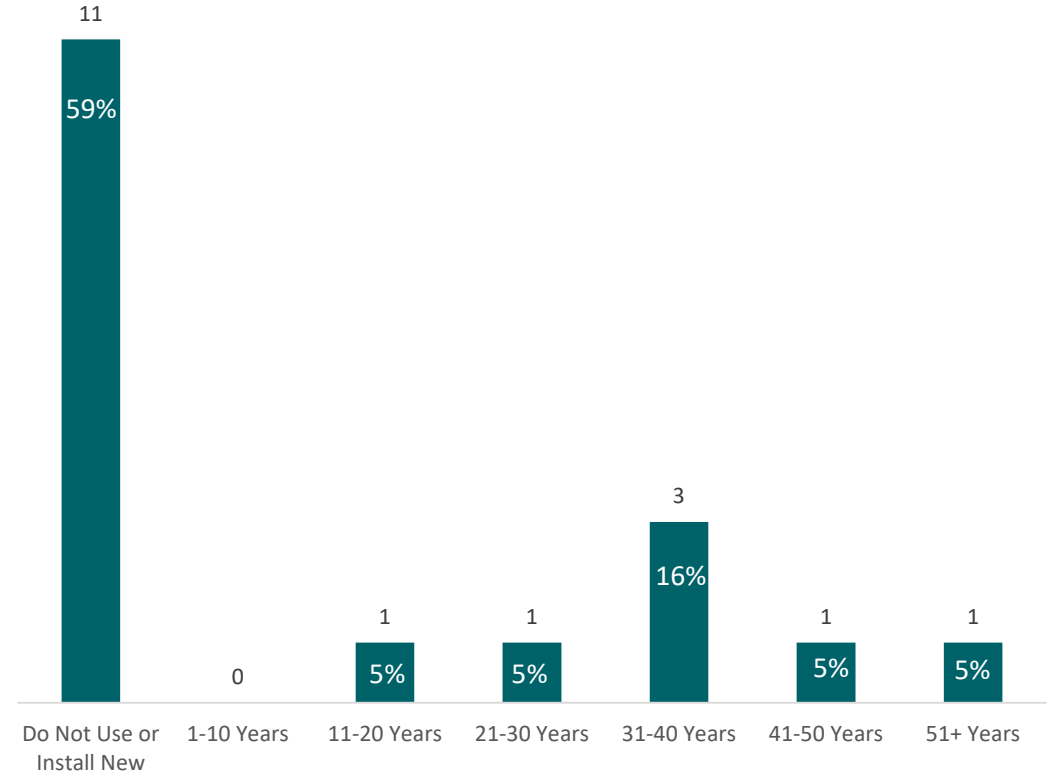


Years of Covered Conductor and Aerial Bundled Cable Usage

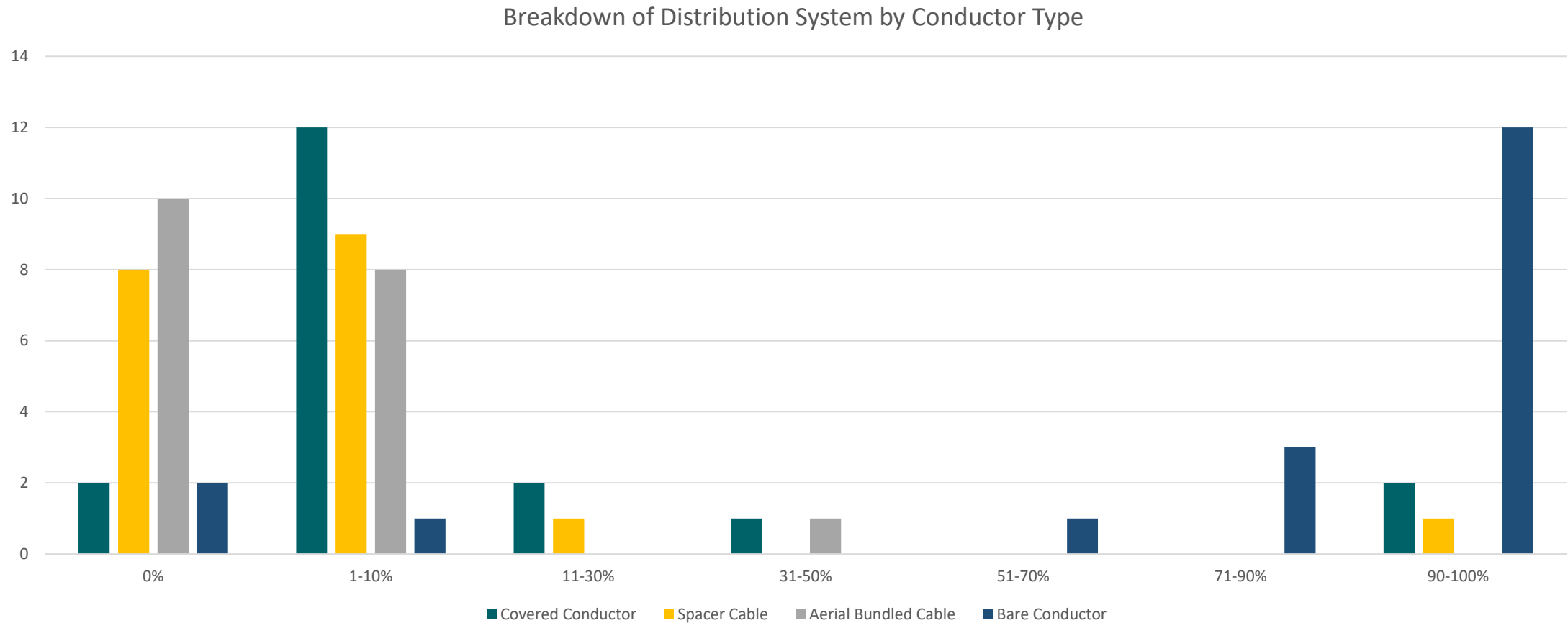
Years of Covered Conductor Use: Open Crossarm and Spacer Configuration



Years of Aerial Bundled Cable Usage



What percent of the primary distribution system is covered conductor vs. spacer cable vs. ABC vs. bare conductor?



Circuit Miles of Covered Conductor, Spacer Cable, and ABC Installed

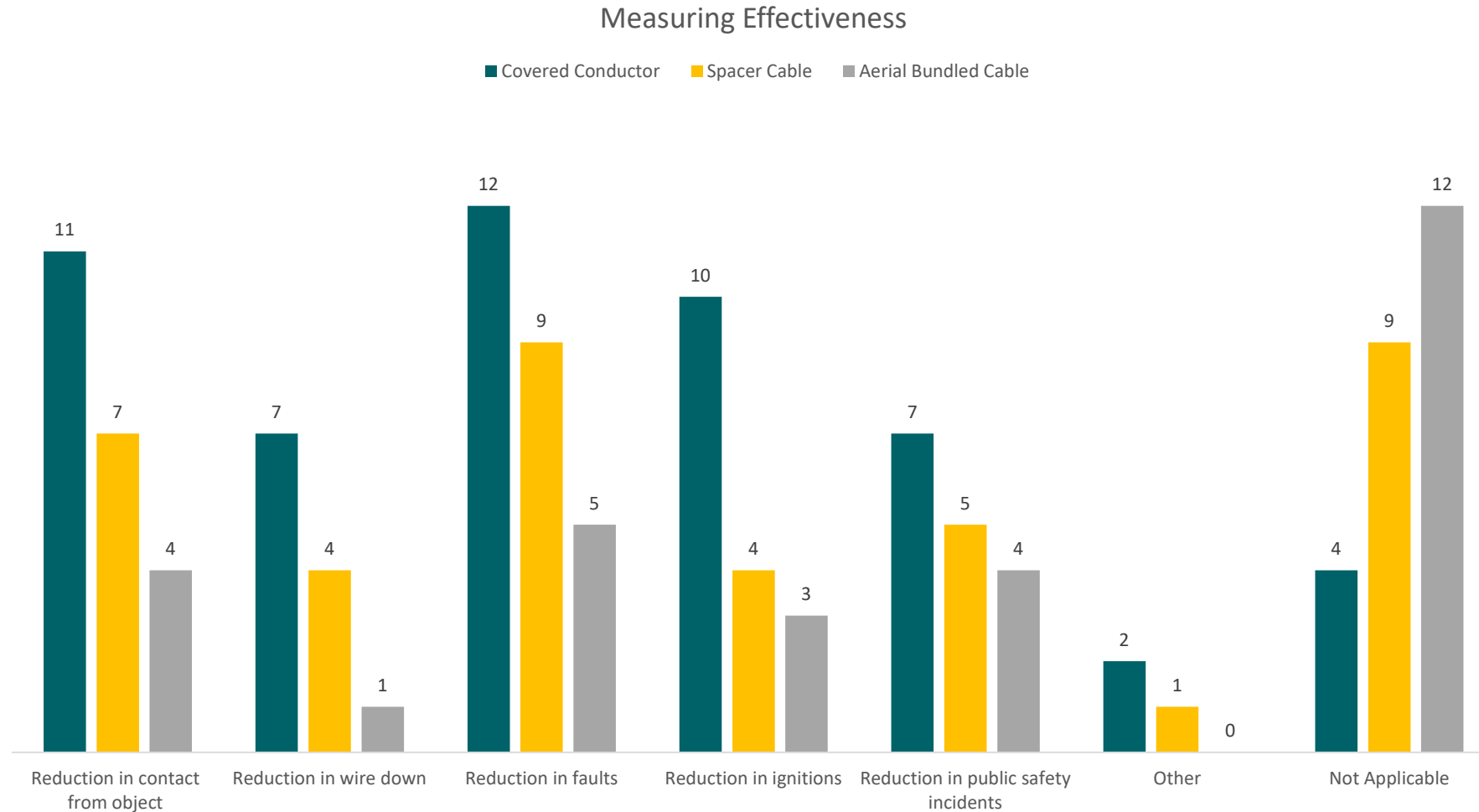
Utility	Covered Conductor Circuit Miles	Spacer Cable Circuit Miles	Aerial Bundled Cable Circuit Miles
American Electric Power	156	137	0
AusNet Services	5	25	125
Bear Valley Electric Service, Inc.	22	0	0
Duke Energy	0	0	0
Essential Energy	2,500	0	1500
Eversource Energy (CT)	8,000	520	200
Korean Electric Power Corporation ¹		120,485	
Liberty	5	2	0
National Grid	4,000	3,000	1,000
Pacific Gas and Electric Company	820	0	3
PacifiCorp	0	60	0
Portland General	243	9	0
Powercor	6	1	60
Puget Sound Energy	1,500	1	0
San Diego Gas & Electric	22	2	0
Southern California Edison	2,187	0	64
TasNetworks	2	0	10
Tokyo Electric Power Company ²	267,190		16,156
Xcel Energy	0	50	0

1. Korean Electric Power Corporation uses Covered Conductor and Aerial Bundled Cable. Value represents total circuit miles of Covered Conductor and Aerial Bundled Cable. Circuit mile data is based on information provided from previous benchmarking
2. Tokyo Electric Power Corporation uses Covered Conductor and Spacer Cable. Value represents total circuit miles of Covered Conductor and Spacer Cable.

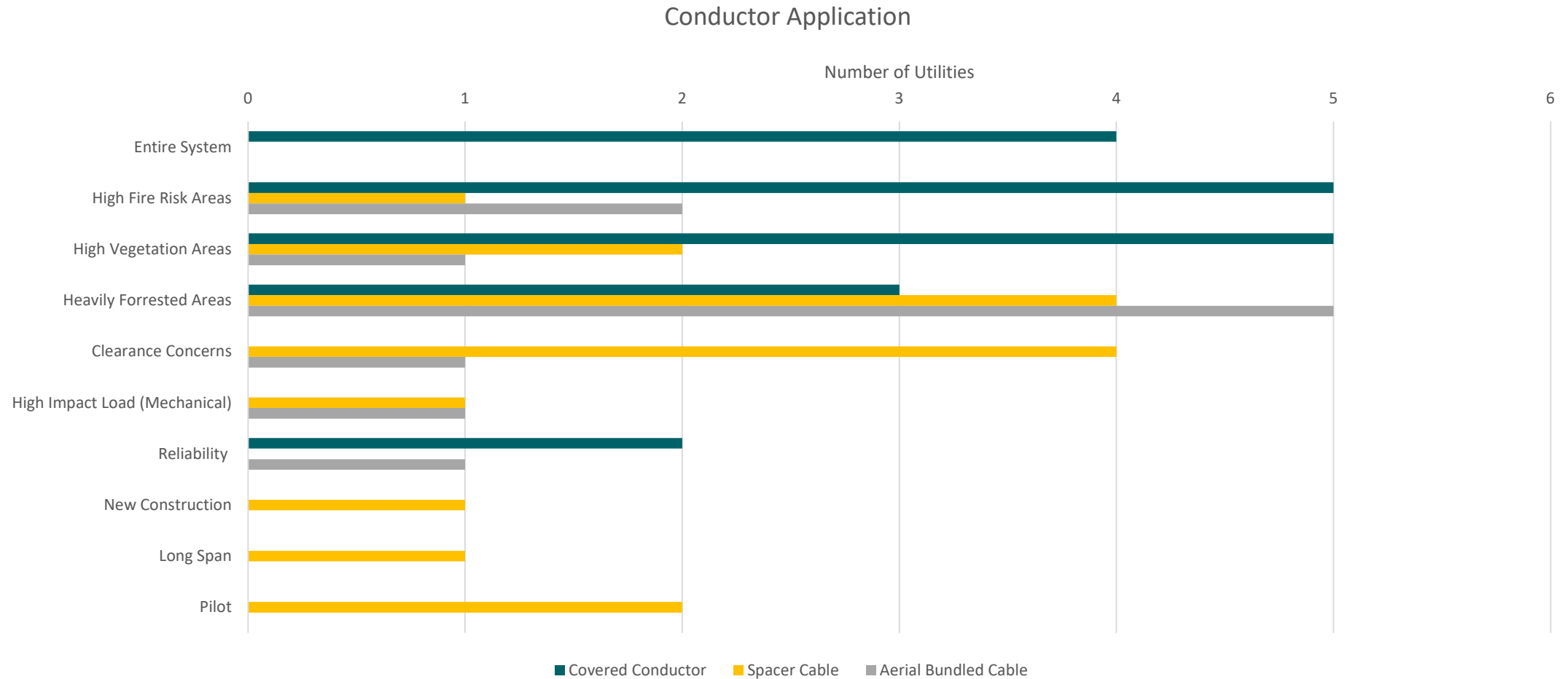
Outage and Ignition Tracking

Utility ¹	Track Outage Counts for Bare vs. CC?	Has use of CC, Spacer Cable, or ABC reduced faults?	Track ignition Counts for Bare vs. CC?	Has use of CC, Spacer Cable, or ABC reduced ignitions/ignition drivers?	If no ignition reduction, why?
American Electric Power	No	Yes	No	Yes	
AusNet Services	No	Yes	No	Yes	
Bear Valley Electric Service, Inc.	Yes	Yes	Yes	No	No prior ignitions
Duke Energy	NA	NA	NA	NA	Does not use CC
Essential Energy	Yes	Yes	Yes	Yes	
Eversource Energy (CT)	Yes	Yes	No	No	Data not tracked
Korean Electric Power Corporation	Yes	Yes	No	Yes	
Liberty	No	No	No	No	Data not tracked
National Grid	Yes	Yes	No	No	Data not tracked
Pacific Gas and Electric Company	No	Yes	No	No	Data not tracked
PacifiCorp	Yes	Yes	Yes	Yes	
Portland General	No	Yes	No	No	Data not tracked
Powercor	No	No	No	Yes	
Puget Sound Energy	No	Yes	No	No	Data not tracked
San Diego Gas & Electric	Yes	Yes	Yes	Yes	
Southern California Edison	Yes	Yes	Yes	Yes	
TasNetworks	No	Yes	Yes	Yes	
Tokyo Electric Power Company	No	Yes	No	Yes	
Xcel Energy	No	Yes	No	No	Data not tracked

Measuring Effectiveness of Covered Conductor, Spacer Cable, and ABC

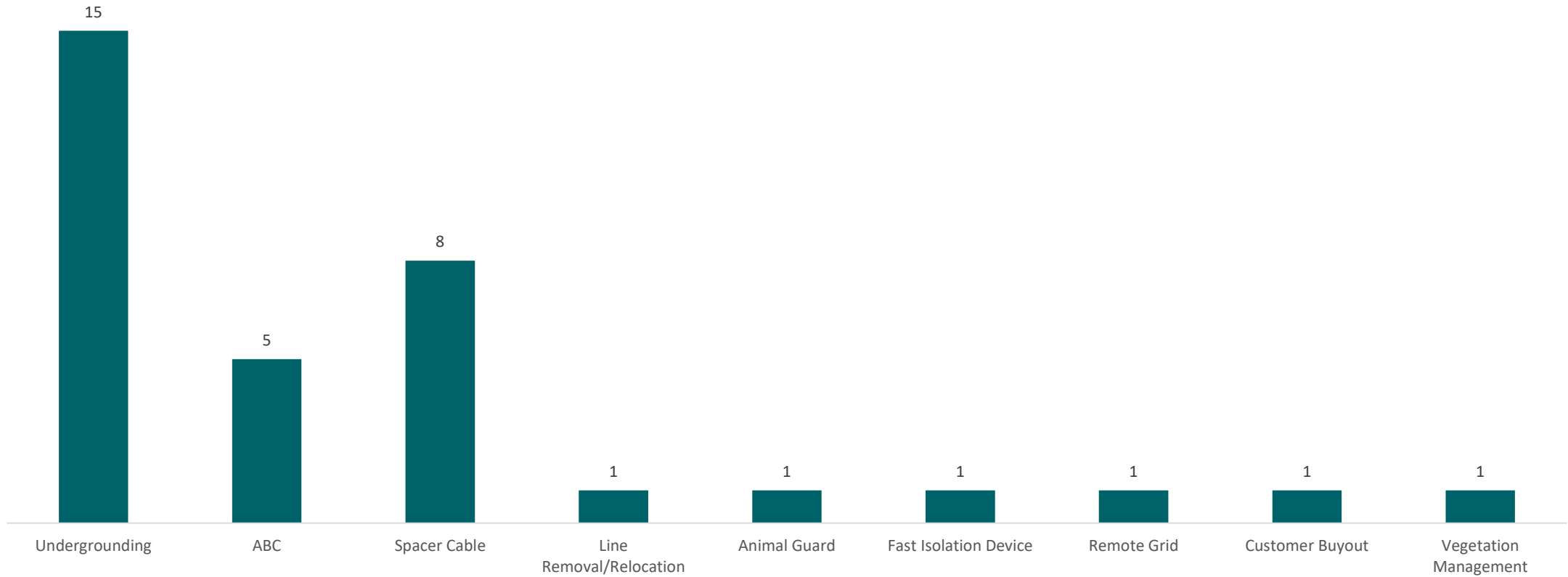


Covered Conductor, Spacer Cable, and Aerial Bundled Cable Application



Alternatives

Alternatives to Covered Conductor



Protection

- **Existing** fault detection methodologies

- Overcurrent protection
 - Circuit breaker & Relay
 - Fuses
 - Reclosers
 - TripSavers
- SCADA connected devices
- Smart Meters
- High voltage DC pulse with directional tracking
- High impedance fault detection
- Distribution automation system monitoring
- Distance to fault algorithm

- **Potential** fault detection methodologies

- Early Fault/Failure Detection
- Distribution Fault Anticipation
- Open Phase Detection
- High impedance fault detection
- Sensitive Ground Fault
- Rapid Earth Fault Current Limiter
- Downed Conductor Detection
- LR controllers
- Fault indicators
- Sensing insulators
- Zero phase voltage measurement
- AMI meter loss of voltage detection
- Working with vendors to develop communication aided protection to detect faulted or broken CC
- Inspection

Patrol Protocols

- Patrol conductors after storm before energization
 - Require visual observation
 - Same as bare conductor
- Drone usage

Other Comments

Utility	Comment
SDG&E	Primarily using covered conductor, but have the option for spacer cable.
PacifiCorp	Spacer cable has been highly effective
Liberty	Piloting on a case-by-case basis, targeting highest-risk areas, based on Risk-Based Decision model.
Duke Energy	<p>Installed covered conductor and spacer cable on our system in the past. There is a miniscule amount on our system. Our current construction standards do not call for covered or spacer cable installation for the following reasons:</p> <ol style="list-style-type: none">1) Require additional installation procedures and maintenance compared to bare conductors.2) Require proper Installation to prevent BIL and deterioration failures.3) Designed to prevent intermittent vegetation contact. Should NOT be used for sustained contact of vegetation.4) Must coincide with continual Vegetation Maintenance.
Xcel Energy	Using a strengthened neutral shield wire to protect crossarm construction from tree impacts.
TEPCO	<ul style="list-style-type: none">• Use of bare wires for MV line is prohibited in Japan. For MV line, covered electric wires are basically used.• Spacer cables used when it is necessary to move the electric wire position away or change routes between utility poles.• Aerial bundled cables are used when connecting the MV line of the third route on the utility pole.
Portland General	<ul style="list-style-type: none">• Developing the application strategy to mitigate wildfire in high-risk zones using these conductor types. Until now, these systems were primarily used for reliability purposes.