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Impacts of Wildfire on Electric Grid Reliability

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Senator Murkowski, Senator Manchin, and members of the Senate Energy and Natural Resources Committee, thank you for honoring me with the opportunity to appear before you to speak about the issue of wildfire and grid reliability. I have worked on issues related to wildfire and electric utilities since the Napa-Sonoma wildfires of 2017, served on California's Commission on Catastrophic Wildfire Cost and Recovery, created by state legislation after the 2017 fires, and continue to work with my energy and environmental colleagues at Stanford, at other academic institutions, and with the executive and legislative branches in California to better understand and respond to the enormous challenges presented by wildfire in California and the West. As such, I am heartened by the attention being paid to this issue by the Energy and Natural Resources Committee at such a busy time for the Senate.

There are real, present threats to the bulk transmission system presented by wildfire and, at least in the California context, these threats raise significant questions regarding how and if elements of the bulk transmission system that cross high wildfire threat areas should be operated during increasingly common, and increasingly dangerous late fall dry, high wind events.

As real as these threats are, they are probably not the greatest threat to customer reliability presented by wildfire. The primary threat primarily originates in the distribution system where on multiple occasions, interactions between vegetation and low voltage distribution lines have led to wildfire and more recently, in order to avoid wildfire, the widespread use of Public Safety Power Shutoffs (PSPS). I reside 15 minutes from San Francisco and 30 minutes from the heart of the financial district and the Pacific Gas & Electric headquarters. Nevertheless, I spent more than 6 days without power during October due to PSPS. This is not just an issue for rural or remote parts of California. It impacts literally millions of people in the state.

The use of PSPS has both prevented wildfire and caused widespread disruption to families and businesses, especially in Northern California. PSPS events, though they do dramatically improve safety, are likely very costly to the health of the economy, especially in smaller communities. My best estimate, using the Interruption Cost Estimator (ICE) tool developed by Lawrence Berkeley Laboratory (LBL) indicates that Pacific Gas &

Electric (PG&E) PSPS events in 2019 cost customers more than \$10 billion – that’s 0.3% of gross state product or 10% of overall economic growth this year in California. These impacts were highly focused on communities located in high wildfire risk areas of the state. It’s worth noting that we need better tools to estimate costs of these planned power outages of extended duration – and that there is an urgent need for LBL and others secure funding to collect the data required and to develop and calibrate better tools for valuing economic impacts of PSPS and like events to electricity customers. Knowing the value of lost load during these events is critical to valuing both grid and customer-sided investments that are ultimately directed towards improving the reliability of energy services.

All that being said, I will limit my remarks today to the impact of wildfire on the bulk transmission system as that is the domain most squarely within the jurisdiction of this committee and the federal government. I’m happy to answer questions regarding the response of the investor and publicly owned utilities and their regulators in California to the risks posed by their distribution systems. As a Wildfire Commissioner this year, I had the opportunity to hear and learn about the experiences of many different utilities from across the state.

Failure of transmission components during high winds is not a new phenomenon in California. Indeed, the wildfire that spelled the birth of modern approaches to managing utility caused wildfire risk – the 2007 Witch Fire in San Diego County, was ignited when a San Diego Gas & Electric 69kv tie line, a transmission component between two substations, failed during a late fall Santa Ana wind event. More recently, the Camp Fire was ignited when a C clip failed under high winds at a 115kv line in Butte County in late 2018. This year, failure of a jumper on a 230kv line near the Geysers geothermal power plant appears to have caused the Kincaid Fire. While the Kincaid Fire was superbly managed by CalFire and CalOES, it very nearly resulted in property losses at least as large as the Tubbs and Camp Fires. In addition, the ignition points of at least two Southern California fires – the Saddleridge and the Maria Fire – are directly beneath or adjacent to Southern California Edison (SCE) high voltage lines and ignited during red flag conditions or when lines were reenergized after a PSPS. I would emphasize that the causes of the 2019 fires are still very much under investigation but that at this point, bulk transmission infrastructure appears to have been an important cause of wildfire this year.

Prior to this year, preemptive deenergization of transmission assets during high wind events for safety was not a part of either SCE’s or PG&E’s PSPS protocols. After the Camp Fire, PG&E began deenergizing the older, relatively lower voltage components of its transmission system during PSPS events. These 115 and 60kv lines were similar in design, and of similar vintage, to the Caribou-Palermo line, whose failure caused the Camp Fire. In general, these lines date from the pre-WWII buildout of the PG&E system. Many, including the Caribou-Palermo line, were acquired by PG&E as it consolidated ownership of the Northern California grid in the first four decades of the 20th century.

Higher voltage lines that were mostly built by PG&E and SCE as California’s population and economy boomed in the 1950’s through the 1970’s have not typically been subject to deenergization during PSPS events. These lines are typically of 200kv and above, connect

many existing large power plants to the backbone system and play key roles in maintaining bulk power system reliability. But in the aftermath of system failures at both PG&E and SCE towers that are relatively new and also subject to more intensive inspection, questions exist with respect to the safety of the bulk transmission system. In particular, PG&E has stated publicly that the tower suspected as the cause of the Kincaid fire was inspected on multiple occasions over the past two years. We still don't know why the jumper that apparently ignited the Kincaid Fire was able to pass multiple inspections and yet fail in high winds. We know even less about whether safety issues related to the electrical system caused any of the fires in SCE territory this year. SCE has indicated that they do not believe that their lines were a cause.

In the near term, it would seem prudent, based on recent experience to at least consider including all but the highest voltage lines in PSPS protocols when they traverse high fire threat areas. That has potentially significant systemic implications even beyond the PSPS events that we experienced this year. It's notable that this year, PG&E had to deenergize non-hazardous areas in order to maintain grid stability on only a few occasions. One would expect this grid stability driven deenergization to increase in frequency and number of impacted customers if >200kv lines become subject to PSPS. Also, given the requirement to inspect before energizing lines, bringing the system back up after a PSPS might be substantially more complex if higher voltage lines cannot be trusted.

In the meantime, the California Public Utility Commission (CPUC) Safety and Enforcement Division and the Investor Owned Utilities (IOUs) need to and are engaging in urgent examination of inspection and testing protocols for these critical components of the bulk transmission system to make sure that they are capable of operating safely during conditions that are increasingly common in the late fall in California. If inspections aren't producing the information the IOUs or the CPUC need to evaluate safety, then we need to first fix inspection regimes and then reinspect infrastructure to make necessary repairs and improvements. This learning should be shared with utilities across the west that are increasingly likely to confront high fire threat conditions either in summer or fall.

The transmission system failures during red flag events, and the evidence that has emerged about aging infrastructure in California – at least some of which is well past its expected operating lifetime – raises important questions about how to approach bulk power system maintenance and operations moving forward in areas that face significant wildfire threats. Traditionally, some risk of mechanical failure was acceptable from these systems because these failures tended to occur during wet winter storms. In that context, a fault might lead to arcing and an outage but was unlikely to cause a major fire.

Today, in California, the failure mode grid managers worry most about is mechanical failure when it is windy but, dry, and fuel conditions reflect the absence of measurable precipitation for the prior 4 to 6 months. These conditions are highly intolerant of any failure of the bulk transmission system to operate properly. A single spark has the potential to destroy entire communities at a cost of many lives and tens of billions in losses. This change in the consequences of failure means that tolerance for failure has to be much lower than the cost-effective approaches developed during the 20th century.

Moreover, the best available science on the weather and climate conditions that lead to this new risk indicates that these conditions are likely to worsen over the next several decades. Recent work also indicates that wildfire risk elevated far above historic norms, like the risks encountered in California over the last few fire seasons, will be more frequent in coming years in more areas of the western United States. I would emphasize that this science is still developing. But it tends to indicate the loss of the “shoulder” of the wet season in the West, which occurs from September to December. This will mean extension of fire season later into the fall, when wind speeds tend to be higher even as fuel conditions are more extreme. Neither our transmission system or our distribution system was built with this condition in mind.

All this likely means that utilities in California, and in the West more broadly, need to start assessing where their transmission infrastructure is located relative to wildfire risk, and thinking differently regarding maintenance and operation of transmission infrastructure that is located in high fire threat areas. In California, San Diego Gas & Electric, the utility whose equipment caused the Witch Fire in 2007, has been a leader in developing and deploying new situational awareness technologies that provide information to grid operators regarding weather conditions from the tops of transmission towers in high risk areas. PG&E and SCE have also implemented similar practices since 2017. But recent experience with older components of the PG&E system indicates that even elements of the system that were considered robust to high wind events are potentially vulnerable. Enhanced measurement of system characteristics to identify early warning signs of potential failure will be important to cost-effectively addressing the risks created by the combination of aging electric transmission infrastructure and wildfire threats supercharged by climate change.

As California utilities makes these investments, it will be important to consider cost effectiveness. California has numerous policy objectives for its electricity system – from achieving ambitious renewable and decarbonization targets to adding new sources of load in the transport and buildings sectors. These goals also require significant capital investment all of which must ultimately be paid for in rates. Rates in California are already quite high compared to national averages (average residential electricity bills are still relatively low). Judicious management of capital spend will be essential to maintaining affordability both for low income residential customers and for energy intensive commercial and industrial customers.

Keeping electricity affordable even as the state’s utilities compensate victims, harden their grid and achieve these policy goals is challenging but achievable. Meeting that challenge will require the state’s regulators to stay focused on cost-effectiveness of risk buy-down in the bulk transmission system (and the distribution system) and to keep an open mind to a suite of solutions that may reduce or avoid the need to site, harden or operate transmission lines in high threat areas. Undergrounding may be cost-effective in certain limited contexts. Microgrids, batteries and backup generation may be more cost-effective than hardening transmission lines that traverse high threat areas to serve smaller communities. Even if it were possible, we cannot likely afford to build a totally failure proof grid. We need to keep all options in the tool box as we seek to achieve outcome-based goals of no fatalities from utility caused wildfire and structure loss counts more like

2019 than 2018, 2017 or 2015. And we need to develop analytical methods to evaluate cost-effectiveness across a greater suite of wildfire risk mitigation approaches.

These affordability challenges are even more formidable given the financial distress that has been caused by liabilities due to PG&E-caused wildfires and more generally the perception that the California utilities are extremely high risk. This perception is due to the combination of high wildfire risk, high property value at risk, a liability doctrine known as inverse condemnation that states that utilities are strictly liable for all damages that are caused by their system, and uncertainty regarding the ability of utilities to recover these costs in rates.

The legislature and Governors Brown and Newsom have worked hard to reduce the real and perceived financial risks to utilities, their ratepayers, and the victims of fires through a series of new and modified statutes. The initial approach was to suggest legislated changes to the interpretation of inverse condemnation. This failed to gain momentum for a variety of reasons in 2018. But the Governor and lawmakers perceived and ultimately enacted, AB 1054 in 2019, a law that creates a new insurance pooling mechanism – known as the Wildfire Fund – which provides \$21 billion in claims paying capacity to cover 3rd party claims against investor owned utilities from wildfire. Contributions to the fund are being made in equal parts by ratepayers and shareholders of the utilities. The fund will cover all settled claims and sets clear limits on the repayment obligation of a utility to the fund if imprudent conduct causes a fire. Passage of AB 1054 was highly significant in both clearing a path for PG&E to exit bankruptcy and also in avoiding imminent credit rating downgrades to non-investment grade for both SCE and SDG&E in July of 2019.

Passage of AB 1054 significantly reduced uncertainty about financial consequences of utility caused wildfires in California, but in the end, California needs to reduce both the number of ignitions and the severity of fires once ignition occurs if we are to truly solve this problem. Allocating costs is not enough. We need to work hard to reduce them. Reducing the odds of catastrophe will require smart and targeted investment in the bulk transmission system and in the distribution system. It will require much more sophisticated approaches to measurement and quantification of variations in system performance of the high and low voltage electricity system so that problems can be identified and fixed before disaster strikes. And it will require collaboration between local property owners, local state and federal governments, and wildland fire fighters, in beginning the process of reducing fuel loads both in communities, to reduce fatalities and structure loss, and in wildlands to reduce acreage and habitat loss to wildland fire.

The lessons learned in California over the past several years of catastrophe and in future as we work to avoid its recurrence can be fruitful for other western states as the wildfire threat – from the electric transmission and distribution system and from other causes – increases due to climate change.