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Pacific Gas and Electric_Current and Potential Areas of Research on Climate Change for the Electricity and Natural Gas Systems

Additional submitted attachment is included below.

Pacific Gas and Electric Company

Valerie J. Winn
Chief
State Agency Relations

77 Beale Street, B10C
San Francisco, CA 94105

(415) 973-3839
(415) 973-7226 Fax
valerie.winn@pge.com

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California Energy Commission
Dockets Office MS-4
Re: Docket No. 17-EPIC-01
1516 Ninth Street Sacramento, CA 95814-5512

Re: PG&E Comments on CEC Staff Workshop – Current and Potential Areas of Research on Climate Change for the Electricity and Natural Gas Systems

I. INTRODUCTION

Pacific Gas and Electric Company (PG&E) appreciates the opportunity to provide information to the California Energy Commission (CEC) on PG&E's active energy–related climate research. PG&E also respectfully suggests potential areas of climate research for the electricity system for inclusion in the CEC's 2018–2020 Triennial Electric Program Investment Charge (EPIC) Investment Plan and opportunities for collaboration and sharing of information amongst stakeholders. PG&E supports the efforts of the CEC to explore strategies to make the electricity and natural gas sectors more resilient to climate impacts and PG&E is pleased to continue its close collaboration with the CEC on projects that deliver actionable results to address climate vulnerability, resilience, and to ensure the efficient use of customer monies and maximize "deployability" of research results to the grid.

Key points of PG&E's comments are:

- Numerous PG&E research projects are currently underway and key learnings are summarized;
- Future research should build from these learnings and augment, not duplicate, efforts; and
- A continued focus on making the research actionable for utilities, developing scenario planning tools, and identifying interdependencies of climate change impacts on the utility systems will be beneficial.

II. PG&E HAS NUMEROUS CLIMATE ADAPTATION RESEARCH PROJECTS UNDERWAY

PG&E is currently conducting a variety of research and demonstration projects to further its understanding of the impacts of climate change on the utility system.[1] A high-level summary of the projects, by major area of impact, and expected outcomes/results are summarized below.

A. Developing a Framework to Analyze and Report on the Impacts of Climate Change for the Utility and for Affected Communities

Development of tools to explain the impact of climate change is fundamental to understanding the challenges that need to be addressed. Two initiatives to develop such tools are described below.

1. Resiliency metrics and analytical frameworks. One challenge for energy providers such as PG&E is the current lack of climate resilience metrics and analytical frameworks. To address this challenge, PG&E is partnering with the Electric Power Research Institute (EPRI) and several other energy providers on a multi-year research project to collaboratively review and assess metrics and analysis tools for electric sector resiliency.

The results of this research will inform PG&E's ongoing efforts to assess the costs and benefits of different resilience strategies and enhance the company's framework for managing climate risks across the business.

2. Better Together Resilient Communities Grant Program. Through this new program, PG&E will invest $1 million over five years—or $200,000 per year—in shareholder-funded grants to support local initiatives to build greater climate resilience throughout Northern and Central California. The grant results will be made publicly available to help communities better understand, plan for and respond to climate change risks and encourage partnerships.

In 2017, PG&E is requesting grant proposals that will build healthy and resilient forests and watersheds to help communities prevent and prepare for increasing wildfire risk. PG&E will select the grants through a competitive process and the program will feature a different climate risk each year using the following criteria:

[1] Additional information is available in PG&E's Climate Change Vulnerability Assessment and Resilience Strategies report, which can be found at http://www.pgecurrents.com/wp-content/uploads/2016/12/PGE_climate_resilience_report.pdf

- Demonstrated partnership
- Replicability
- Assistance to disadvantaged communities
- Measurable impact

For more information on this program, please go to: www.pge.com/resiliencegrants.

B. Tree Mortality, Wildfires, and Superstorms

Development of tools that could help utilities target programs for affected areas and enhance how the state responds to the impacts of climate change is crucial as we work to reduce the impact of climate change on affected communities. Two of these initiatives are described below.

1. Collaborating to predict future tree mortality. PG&E continues to look for new tools to improve its proactive response to tree mortality and associated wildfire risks. This includes working with researchers at Humboldt State University and the University of Virginia to build a model to predict locations of future tree mortality across PG&E's service area through 2020. The results will be available as a five-year predictive map to help assess forest health and the risk of wildfire. This information can be used operationally to allow PG&E to plan for the necessary resources to mitigate dead trees that could impact PG&E assets. This will allow better planning and prioritization of work to mitigate tree mortality issues. To develop the model and predictions, researchers considered factors such as historic data on tree mortality, drought impacted areas, forest type and climate data. This project has been completed; PG&E is now reviewing the project findings and plans to share the research results with others, as appropriate.

2. Economic impacts of a Superstorm on the Bay Area. PG&E participated in the Bay Area Council Economic Institute's "Surviving the Storm" report, which examined the economic impact of a Superstorm and associated flooding on the Bay Area economy.[2] Published in 2015, the report found that a Superstorm and the associated flooding could have a $10.4 billion impact on the San Francisco Bay Area economy. Included in the report is PG&E's estimate that disruption to several Bay Area substations (see page 35 of the report) could result in an economic impact to customers of up to $125 million.

C. Sea Level Rise and Subsidence

The impacts of sea level rise, as well as drought, on PG&E's assets, need to be better understood. Efforts to accomplish this are described below.

[2] http://documents.bayareacouncil.org/survivingthestorm.pdf

1. Assessing natural gas pipeline vulnerability to sea level rise. PG&E is working with the research community to explore the physical vulnerabilities of California's natural gas system due to climate change so that the company can prepare for and implement the actions needed to adapt to those changes.

PG&E partnered with the University of California, Berkeley's Center for Catastrophic Risk Management on a CEC-funded study to assess the potential impacts of sea level rise and extreme flooding on the company's natural gas transmission system. The study, entitled *Assessment of Bay Area Natural Gas Pipeline Vulnerability to Climate Change,*[3] used a worst case future scenario of 1.41 meters (4.6 feet) of sea level rise coupled with a 100-year storm event and focused on the San Francisco Bay Area, Sacramento-San Joaquin Delta, and Coastal California. Researchers used geographic information systems (GIS) and a state-of-the-art hydrodynamic model to simulate the location and depth of potential inundation under a realistic extreme storm event coupled with sea level rise.

The results of this study will inform PG&E's ongoing efforts to better understand, plan for, and respond to future climate change risks to its natural gas transmission infrastructure.

2. Assessing natural gas pipeline vulnerability to subsidence. California's Central Valley has experienced land subsidence as a result of groundwater withdrawal associated with the drought. It has been a significant challenge to understand the potential impacts of subsidence to infrastructure such as roads, railways, bridges, and pipelines. In the region south of El Nido, the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory documented approximately two feet of subsidence between 2007 and 2011 and an additional foot of subsidence between 2014 and 2015.

Given these findings, PG&E conducted a third-party led pilot project to better understand the potential impact of subsidence on its natural gas transmission pipeline (Line 186) near El Nido and enable the company to identify appropriate pipeline integrity management measures. The analytic modeling of the subsidence in the El Nido region for Line 186, both accumulated to date and predicted in the future, indicated that the subsidence poses a low risk and that the pipeline is fit for service.

Moving forward, PG&E will continue working to better understand the effects of subsidence through pipe analysis and modeling efforts, resulting in the development of risk-informed monitoring strategies.

[3] http://www.energy.ca.gov/2017publications/CEC-500-2017-008/CEC-500-2017-008.pdf

D. Improving Forecasting and Management Tools

1. Collaborative research to improve hydroelectric system forecasting and management. Climate scientists predict that climate change will result in significant reductions in snowpack in parts of the Sierra Nevada Mountains and altered precipitation patterns. To better understand precipitation patterns and potential impacts on PG&E's hydroelectric generation, the company is partnering with the University of California, Berkeley and the California Department of Water Resources on a multi-year research project involving PG&E's North Fork Feather River hydroelectric facilities.

Using CEC funding, the research team is installing a next-generation hydrographic data network that integrates satellite remote sensing data with ground-based measurements. This will enable PG&E to better measure and monitor snowpack, climate, soil moisture and other factors to improve monitoring and predictive tools, reduce uncertainty in water forecasts, and adapt to climate change.

2. High Resolution Forecasting: PG&E Operational Mesoscale Modeling System (POMMS). This model provides predictions out to 84 hours in the future and generates products including weather forecasts and fire danger. Through the EPIC, the POMMS high-resolution weather model was created which drives the National Fire Danger Rating System and determines daily PG&E Fire Index Ratings. It also incorporates Red Flag Warnings from the National Weather Service and provides day-ahead fire danger ratings for improved planning for PG&E.[4]

3. SolSource: Managing the grid under variable weather conditions. Also developed through EPIC, this project estimates past and predicts future solar irradiance at 3-kilometer/60-minute resolution, extending out seven days. This weather information is then leveraged to estimate and forecast behind-the-meter solar generation anywhere from a customer-by-customer level, all the way up to the PG&E service area as a whole. This vastly improves real-time understanding of weather impact to behind-the-meter generation in both time and space. This initiative informs PG&E operations and has opportunity to be used in customer-facing services.[5]

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[4] The final project report can be found here: https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/PGE-EPIC-Project-1.05.pdf

[5] See final project report at: https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/PGE-EPIC-Project-1.05.pdf

E. Developing and Testing new Grid Innovation and Integration Tools

Adding flexibility to the grid introduces another tool for utilities to manage climate impacts to the system. A few programs underway are described below.

1. Innovative demand response pilot. During heat events, PG&E's demand response programs can help relieve pressure on the grid and save customers money with incentives to reduce their energy use or shift it to another time. As an innovative pilot, PG&E and automaker BMW teamed up on a smart charging project to test the potential for electric vehicle batteries to provide valuable services to the energy grid. The successful pilot program could help ensure that the growing electric vehicle charging load is managed efficiently on the grid and provides value to vehicle owners who can be flexible with their charging.

2. Vehicle-to-grid operational integration. Next-generation electric hybrid trucks have the potential to provide PG&E with exportable power during an emergency or routine maintenance. Through the EPIC program, PG&E explored the potential for plug-in hybrid vehicle technology to generate utility-grade power, supporting distribution circuits during planned or unplanned outage events. As part of this project, PG&E developed nominally 120 kilowatt exportable power capabilities from these trucks, and created the protocols necessary to safely connect the trucks to the appropriate grid connection points. Post project, PG&E will continue to evaluate the portfolio of fleet vehicles (higher and lower weight classes) to broaden the range of available power ratings demonstrated by the project.[6]

3. Collaborating on low-carbon community microgrids. In an effort to build community resilience, enhance public safety and address a changing climate, several localities are exploring the potential for community microgrids in collaboration with PG&E and other partners. "Community" microgrids are those designed to ensure that specified loads can remain powered up during a broader grid outage to ensure that critical services can be provided to a broad range of constituents. PG&E is helping to identify how these systems integrate into the broader energy grid and achieve community goals.

Blue Lake Rancheria, a Native American reservation in Humboldt County, is building a low-carbon community microgrid as part of their quest to conserve energy, reduce greenhouse gas emissions and enhance emergency preparedness. Funded in part through a CEC grant, the microgrid will provide the tribe and local citizens with life, health and safety support in the event of an emergency and may serve as a model for other communities looking to prioritize both economic vitality and climate change reduction.

[6] See final project report at: https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/PGE-EPIC-Project-1.16.pdf

PG&E is also providing technical support to the San Francisco Department of the Environment on a project to assess potential microgrid locations within the city. In the event of an earthquake or other natural disaster, a microgrid could power public facilities where people assemble and receive critical services, including schools, recreation centers and libraries. In addition to identifying potential locations, the project is considering approaches for integrating solar and energy storage for enhanced sustainability.

Finally, PG&E is working with the City of Berkeley as it considers a community microgrid pilot project in the downtown area. In support of its recently published Resilience Strategy, Berkeley is exploring the potential for a community microgrid—with its new Center Street Garage at the heart of the system. The project would advance the city's use of local, clean energy for community resilience and help adapt to a changing climate.

III. FUTURE RESEARCH PROJECTS SHOULD ENSURE THE UTILITY CAN TAKE ACTION, AID IN SCENARIO PLANNING, AND ANALYZE INTERDEPENDENCIES OF CLIMATE IMPACTS

To build upon the success of existing and planned research and to ensure that customers funding the research receive the highest value for their investments, PG&E respectfully suggests efforts in three areas would yield the greatest benefit at this time. Those areas are: 1) taking steps to make science more actionable; 2) focusing on scenario planning; and 3) working to better understand the interdependencies across critical systems. Specific suggestions are provided below.

A. MAKING SCIENCE MORE ACTIONABLE

Sharing research and building awareness of research being performed in California – and nationally and internationally – is an important tool for minimizing any duplication and to maximizing the benefits and application of work underway. Enhancing engagement between the California regulatory agencies like the CPUC and/or the CEC, researchers, and end users could ensure that state-funded research is providing answers to priority questions for end users. One way to accomplish this could be for the CPUC and/or the CEC to host a series of consultation sessions with end-users and researchers to help refine questions being asked in current research projects. This would allow researchers to build more awareness about the research underway and facilitate opportunities for researchers to engage directly with utilities and other end users in a structured way during the research process.

B. SCENARIO PLANNING

The following areas of research would support PG&E's efforts to better understand and plan for climate resilience and support its Enterprise Risk program:

1. Interactive climate change impacts. Research is needed to better assess combined/ multiplicative impacts of climate change on utilities. Examining each impact individually is an important initial step, but it is likely that these impacts will occur in combination with one another. A better understanding of how these impacts interact with one another is desirable and suggested areas would include: 1) Drought conditions in combination with increased temperatures and wildfire risk; 2) sea level rise and stronger storms; and 3) changing precipitation patterns and hydropower generation.

Utilities also face increased risk to infrastructure from land subsidence that occurs as a result of increased groundwater extraction during extreme drought conditions. As land subsidence continues to be a risk, particularly in the Central Valley, these impacts need to be examined in context with increased flooding risk. Research is needed to assess how utility infrastructure may be at risk from flooding as land elevation decreases.

2. Understanding heatwaves and impacts on electric generation, transmission, and distribution. California's Fourth Climate Assessment includes important research on urban heat islands. However, utilities also need to understand the impacts of increasing temperatures and heatwaves across the state, not just in urban settings. A better understanding of the impacts of rising temperatures and heatwaves on electric generation, customer energy usage, transmission and distribution – including areas of the state that traditionally have not needed air conditioning in the summer – would be valuable in planning future infrastructure investments and assessing how to manage electricity demand and reliability with increasing temperatures/heatwaves across PG&E's service territory.

3. Understanding potential impacts to California's hydropower system. Cost/benefit analyses can provide valuable insight into how to best use limited resources to address climate change. Some areas where such analyses are needed are below.

a. Cost-benefit analysis of infrastructure changes/investments:
Continued and improved analysis of forecasted snowpack and seasonal precipitation to better manage California's hydropower system are crucial. Some suggested areas for analysis could include the impact of atmospheric rivers, more frequent droughts, higher snowlines, and how this will impact water storage and supply for hydropower generation. Research can assess whether reservoir capacities should be increased and/or dam heights raised to manage annual patterns with more rain/atmospheric rivers rather than snowpack, and the associated costs and benefits.

b. Cost-benefit analysis of managing/recharging groundwater:
Northern California's volcanic aquifer systems are very important to California's hydropower system and also provide cold water for salmon (among many other

uses). Research is needed to assess how California can best manage recharging these volcanic aquifer systems so that hydropower operations can continue without significant decline during successive years of drought. In some relatively low elevation watersheds such as the upper North Fork Feather River, more precipitation falling as rain rather than snow may result in less groundwater recharge for these relatively shallow volcanic aquifer systems. Research can assess the costs/benefits of various potential management techniques for headwater recharge.

c. Beneficial uses of dead trees to reduce wildfire risk: After years of drought, and with the increase in wildfire risk, a cost/benefit analysis of how best to manage, remove, and utilize dead trees and biomass from the forests would help focus the state's efforts in this area.

C. INTERDEPENDENCIES

Along with scenario planning and understanding the combined impacts of climate changes on the system, utilities need to better understand "upstream" impacts to critical systems on which they rely, including the regional gas and electric systems, suppliers, and water and telecommunications networks. Understanding and managing these interdependencies can assist PG&E in its planning to continue service to customers during and after major incidents. Other areas for research include:

1. Supply Chain. Another element to better understanding the interdependencies across systems is to also consider how climate change affects utility supply chains. Questions include how electric/natural gas utility operations may be affected by upstream supply chain disruptions caused by climate change impacts. Research can explore the potential impacts of climate change on utility suppliers, the level of preparedness by critical suppliers to address those impacts, and how the potential impacts can be assessed to ensure that critical products and services remain available. Another area is determining what supply chain contingency plans should be in place to ensure ongoing operations when facing different types of climate impacts.

2. Interdependencies and cascading impacts for sectors dependent on resilient electricity and natural gas supply. Utilities must prepare to increase the resilience of infrastructure, operations, employees and customers. Disruption of energy delivery because of climate impacts could have cascading and interdependent impacts on many important sectors, including but not limited to: health system impacts, transportation impacts, and economic impacts. Research can explore what roles utilities, governments, other private sector entities, NGOs, and others can play in understanding these interdependencies and contributing to/building the resilience of the entire system.

3. Including potential climate change impacts in utility demand forecasting. Currently forecasted climate change impacts may not be included in current energy demand forecasting processes with the CAISO and the CEC. Studying and including climate change impacts in these regulatory processes for the entire state would be of use to utilities.

4. Dislocation/relocation of populations in the state. Research is needed to better understand how populations may relocate over the long-term as climate change impacts increase. Population displacement will have many environmental justice components, and may also impacts customer demand and load for energy infrastructure.

IV. CONCLUSION

PG&E appreciates the opportunity to provide this update to the CEC on PG&E's current research projects and to provide comment on areas of beneficial research. We look forward to future collaboration with the CEC on advancing research on these important topics. Please contact me if you have any questions or wish to discuss matters further.

Sincerely,

/s/

Valerie J. Winn