

CALIFORNIA EARTHQUAKE EARLY WARNING
ADVISORY BOARD
NOVEMBER 30TH, 2017 MEETING



***Cal* OES**
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES



CALIFORNIA EARTHQUAKE EARLY WARNING ADVISORY BOARD

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CALIFORNIA EARTHQUAKE EARLY WARNING ADVISORY BOARD

MEETING PUBLIC NOTICE



Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

California Earthquake Early Warning Advisory Board

Public Notice/Agenda

November 30, 2017

2:00 PM – PDT

Meeting Site:

Governor's Office of Emergency Services
3650 Schriever Avenue
Mather, CA 95655
Multipurpose Room 1 and 2

Date of Notice: November 20, 2017

NOTICE IS HEREBY GIVEN that the California Earthquake Early Warning Advisory Board will meet at the Governor's Office of Emergency Services Multipurpose Room 1 and 2 as set forth below. The Bagley-Keene Open Meeting Act applies to meetings of the California Earthquake Early Warning Advisory Board, which are open to the public. Public participation, comments and questions are welcome for each agenda item. Agenda items may be taken out of order.

Item	Agenda Topic
I	Welcome – Call to Order – Introductions
II	California Program Update
III	Finance and Investment
IV	System Operations
V	Research and Development
VI	Training and Education
VII	Public Comment*
VIII	Adjourn

* Public comment will be taken before any official actions.



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PUBLIC COMMENT: If the committee determines that there is not enough time to hear from all those wishing to present comments, the committee will select among those wishing to testify to ensure representation of a range of viewpoints and interests. Those providing public comment may choose to supplement their testimony with written statements that will be made part of the official public meeting record.

SUGGESTIONS FOR SUBMISSION OF WRITTEN MATERIALS: It is requested that written materials be submitted to the California Earthquake Early Warning Advisory Board Executive Officer prior to the meeting. If this is not possible, it is requested that at least 30 copies be submitted to the California Earthquake Early Warning Advisory Board Executive Officer. This material will be distributed to the California Earthquake Early Warning Advisory Board members.

ACCESS TO THE HEARING: The meeting is accessible to those with access and functional needs. A person who needs an access and functional needs-related accommodation or modification in order to participate in the meeting may make a request by contacting Tina Walker at (916) 845-8428 or sending a written request to the Governor's Office of Emergency Services at 3650 Schriever Avenue, Mather, CA 95655. Providing your request at least five (5) business days before the meeting will help ensure availability of the requested accommodation.

For further information, please contact:

General Information:

Tina Walker, Program Manager and Advisory Board Executive Officer, California Earthquake Early Warning Program at (916) 845-8970 or via email at Tina.Walker@caloes.ca.gov

Media Information:

Brad Alexander, Public Information Officer, at (916) 845-8455 or via email at Brad.Alexander@caloes.ca.gov.



CALIFORNIA EARTHQUAKE EARLY WARNING ADVISORY BOARD

PREVIOUS MEETING MINUTES

California Earthquake Early Warning Advisory Board Meeting Minutes

California State Capitol, Room 2040
Sacramento, CA
June 22, 2017

Members Present:

Mark Ghilarducci, Director of the Governor's Office of Emergency Services
David Bunn, designee of John Laird, Secretary of the California Natural Resources Agency
Samantha Lui, designee of Diana S. Dooley, Secretary of the California Health and Human Services Agency
Stephanie Dougherty, designee of Brian Kelly, Secretary of the California State Transportation Agency
Alexis Podesta, Secretary of the California Business, Consumer Services and Housing Agency
Barry Anderson, Vice President of Pacific Gas and Electric Company, Electric Distribution
Anne Kronenburg, Executive Director of the San Francisco Department of Emergency Management (Senate Appointment)
Gary Leonard, designee of Janet Napolitano, President of the University of California
Tom Kennedy, designee of Timothy White, California State University Chancellor

Staff Present:

Tina Curry, California Earthquake Early Warning, Governor's Office of Emergency Services
Ryan Arba, California Earthquake Early Warning, Governor's Office of Emergency Services
Tina Walker, Executive Officer from Governor's Office of Emergency Services
Emily Holland, California Earthquake Early Warning, Governor's Office of Emergency Services
Dana Ferry, California Earthquake Early Warning, Governor's Office of Emergency Services
Art Botterell, California Earthquake Early Warning, Governor's Office of Emergency Services
Jessica Sicard, California Earthquake Early Warning, Governor's Office of Emergency Services

I. Welcome / Call to Order / Introductions

- Director Ghilarducci called the meeting to order.
- Tina Walker conducted the roll call and the proposed agenda was adopted.
- Director Ghilarducci introduced the Advisory Board members and made opening remarks.

II. Brief History of Earthquake Early Warning

- Tina Curry, Deputy Director of Planning, Preparation and Prevention, of the Governor's Office of Emergency Services, presented a summary of legislative and budget actions leading to this point that focused on earthquake early warning.



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She also presented on previous efforts by a steering committee that developed the framework and a multi-sector benefit study.

- Doug Given, Project Chief, United States Geological Survey, presented a brief history of the Shake Alert prototype system; explanation of science required to make it function; and a West Coast system build out update.
- **Questions/Discussion from the Advisory Board:**
 - Mr. Anderson mentioned that initial earthquake paths are not understood and then asked if it's the same for aftershocks. Doug Given responded by explaining that aftershocks are more predictable in timing than location.
 - Mr. Anderson expressed interest in the effectiveness of earthquake early warning to give warning in advance of aftershocks. Mr. Given responded that the system may be limited in giving early warning for aftershocks due to internet connectivity and reliability.
 - Secretary Podesta asked if there is a threshold in which someone would receive a notification from an earthquake early warning system. Mr. Given responded by saying it has yet to be determined but will be determined by the Advisory Board, based on social science.
 - Director Bunn asked if the EEW system detects small earthquakes, for instance 3.0, and if those would be enough to test the system. Mr. Given stated that the system is capable of detecting smaller earthquakes but could be less accurate for larger earthquakes if tuned for small.
 - Ms. Kronenberg inquired if the strategy for cell phone warnings follows the model set by Japan, with regards to the long waiting period for cellphone implementation. Mr. Given responded that we are moving towards a system that is consistent with EGWS, an international standard for rapid notification, but that there is still a 3-5 year timeline before implementation in handsets in the United States. Director Ghilarducci mentioned that the development of First Net and conversations with the cell phone industry indicated that this time line could be expedited.
 - Ms. Kronenberg stated she is interested in any research relating to public reception of emergency alerts. Kate Long, Earthquake Program Lead for Cal OES, responded by saying that the Joint Committee on Education, Training, and Outreach developed recommendations for best practices based on social science. Additionally, Cal OES is in contract with Dr. Michele Wood at CSU Fullerton to complete a literature review and gap analysis.
 - Director Bunn expressed a concern for lack of cell phone service, specifically in rural areas and asked about a gap analysis of earthquake zones that might be at risk. Director Ghilarducci shared that broadband and cellular coverage is another topic that will need to be examined by the Advisory Board in the future along with regional roll outs and tests in certain markets.



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III. California Program Update

- Ryan Arba, Earthquake, Volcano and Tsunami Branch Chief, Governor's Office of Emergency Services, presented an update on the California earthquake early warning Program including the current and planned investments of existing funding.

IV. Discussion for the Vision for the Advisory Board

- Ms. Curry provided an introduction to the discussion that highlighted the importance of the Advisory Board to the state and in the eyes of the legislature.
- Director Ghilarducci outlined expected initial and maintenance funding needs, as well as highlighting considerations and decisions that will be needed moving forward.
- Mr. Anderson stated that this project includes many moving parts and that the Advisory Board appears to have resources, including land access and subject matter expertise, to provide creative solutions.
- Mr. Kennedy stated that there may be a wealth of existing and in progress research at a variety of campuses within the state. Additionally, the campuses could be good test beds for ShakeAlert and undevelopable CSU land could serve as sensor locations. Director Ghilarducci responded that it would be beneficial for the system operators to present sensor installation requirements and a map indicating the sensor locations and lands owned under the control of Advisory Board members.
- Ms. Kronenberg asked if we know the cost of full public rollout and maintenance fees. Ms. Curry responded by saying the business plan will help us realize anticipated costs. Director Ghilarducci followed up by saying there are a few ways to accelerate the project, one example being the California Geologic Survey repurposing sensors to enhance earthquake early warning.
- Mr. Kennedy proposed consolidating the academic research that is in progress.
- Ms. Lui expressed an interest in a presentation of best practices for public notifications and warning thresholds.
- Director Ghilarducci asked if the board members need any additional items. Mr. Anderson requested the executive summary of the *California Earthquake Early Warning System Benefit Study*.

V. Public comment

- Patrick Welch, Legislative Aide to Senator Jerry Hill, made general comments on Senator Hill's behalf about the outlook for Earthquake Early Warning and support to continue federal funding.

VI. Adjournment



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California Program Update



Ongoing Considerations

discussed during the last meeting

- Sensor build out – site access, permitting and regulatory flexibility
- Deployment schedule – community engagement and public/industry input
- Financing strategy
- Development and/or review early warning technology standards





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California Early Earthquake Warning Limited Public Rollout Phases

- Academic research
- Beta testing
- Pilot projects
- Limited public roll out
- Full public roll out

Approach

- Meet minimum qualifications
- Highlight and expand current successful pilot projects
- Make signal available to broadest user base



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Opportunities

- Institutions/audible alerts: announce EEW over loudspeaker in gathering areas (i.e., schools, hospitals, offices, etc.)
- Institutions/automated applications: slow trains, stop elevators, etc.
- Individual alerts: send message to mobile phones, "internet of things," etc.

Discussion

- Which industries/alert types should California focus on?
- How should Cal OES approach institutions to help spread use of EEW alert?



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Finance and Investment Update



Business Plan Update

Presented to the California Earthquake Early Warning
Advisory Board

November 30, 2017

Presented by
Matthew Newman and Katrina Connolly



Overview

- Business plan update
 - preliminary budget
 - financing plan
 - timeline
 - risk assessment
- Key strategic issues
- Advisory Board action items
- Discussion

Introduction

- The business plan for the California Early Earthquake Warning Program (CEEWP) is still under development
 - As a result, the business plan is preliminary at this point
- Steps required prior to submission of business plan to Legislature in February 2018
 - Gather feedback today from the Advisory Board
 - Collect additional data and information on costs, financing strategy, and risks
 - Refine the business plan
 - Present the revised business plan to the Advisory Board and CalOES and incorporate additional feedback
 - Submit the final plan to the State Legislature in February 2018



CALIFORNIA EARTHQUAKE EARLY WARNING ADVISORY BOARD

Budget Estimate for Capital/One-time Costs

- Most of the 1,115 seismic stations planned for CEEWS have been upgraded, constructed, or funded. However, funding is still needed for
 - 282 seismic stations
 - 164 GPS stations
 - 56 primary and secondary telemetry nodes
- Estimates of the cost to complete these remaining stations and nodes were developed in consultation with UC Berkeley, Caltech, and USGS
- In addition to capital costs, estimates for one-time costs for outreach and education were developed based on
 - Comparable costs for other statewide public campaigns in California
 - E.g., H1N1 Flu Prevention, Save Our Water, and Flex Alert

Preliminary Estimate of Unfunded CEEWP Capital and One-Time Costs

CEEWP Component	Capital/One-Time Costs (Millions)
Seismic Stations	\$16
GPS Stations	\$2
Backbone Telemetry	\$11
Outreach and Education	\$6
Total	\$35



CEEWP Ongoing Costs

- Station maintenance
 - Personnel, permit fees/renewal, travel, supplies & equipment
- Central site operations
 - Personnel & equipment
- Telemetry
 - Data transmission costs
- Outreach and education
 - CalOES staff to develop and manage outreach strategy and materials
 - Technical user support (e.g., regional hands-on team, Help Desk, online support)
 - Ongoing research and media buys for public campaign
- Research and Development
 - CalOES costs to develop improved ways to deliver the signal to users
- Program Management
 - CalOES staff to manage CEEWP

Method for Estimating CEEWP Ongoing Costs

- Data inputs were provided by the partners (CGS, USGS, UCB, and Caltech) based on experience operating the California Integrated Seismic Network (CISN)
- Anticipated changes necessary to adapt a research network for use in earthquake early warning were included where possible
 - Diversified and redundant real-time telemetry
 - Additional personnel for maintaining stations and data quality
 - Regular equipment replacement and upgrades
- Estimates presented reflect incremental costs net of ongoing funding provided by CISN or USGS
- Actual costs could be higher or lower than estimated
 - In addition to uncertainty surrounding some cost estimates, programmatic decisions with respect to desired level of system resiliency and accuracy or extent of public awareness and education initiatives can influence costs



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Preliminary Estimate of Annual Unfunded Ongoing Costs

CEEWP Component	Ongoing Costs* (Millions)
Seismic Stations, Central Sites, First Mile Telemetry	\$11.6
GPS	\$1.0
Backbone Telemetry	\$2.7
CalOES Outreach and Education	\$3.4
CalOES Research and Development	\$0.3
CalOES Program Management	\$0.4
Debt Service†	\$1.5
Total	\$20.9

*Some costs, such as outreach and education, may decline in the future as the public learns about the system.

†Debt service assumed for \$20 million of capital costs at 4% over 20 years.

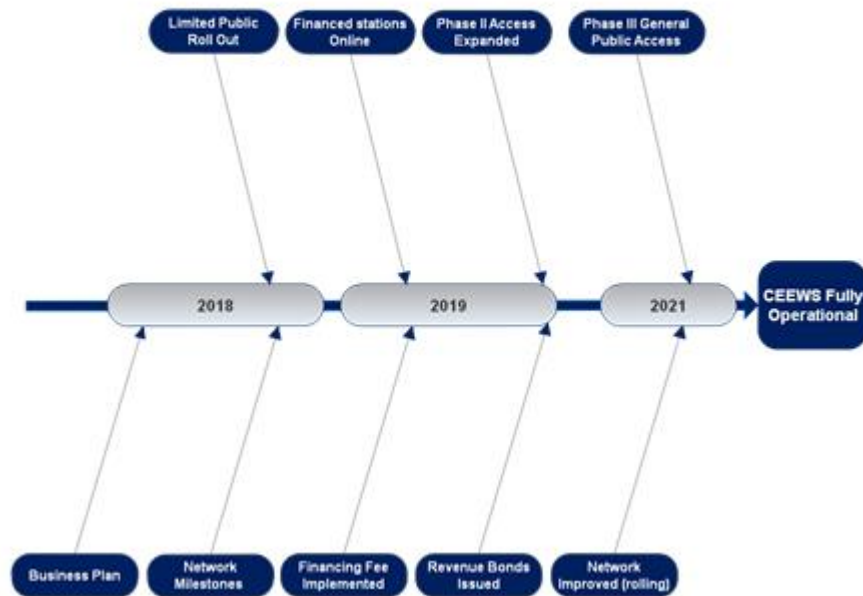
Financing Strategy

- A successful financing strategy will
 - Accommodate one-time/capital costs
 - Be able to repay any debt service if capital costs are financed
 - Provide a dedicated, stable funding source that can cover ongoing costs
 - Grow over time with inflation and other changes in ongoing program costs
 - Ensure accountability for expenditure of state funds
 - Include a funding source with a nexus to users/beneficiaries of the system
- We considered multiple options to finance both one-time and ongoing costs, including
 - a surcharge on income tax returns, use of the state general fund, charges imposed on utilities and regulated transportation providers, a charge on providers of earthquake early warning services or technology, FEMA funds, and foundation funding and grants
- Proposed approach
 - The most promising financing strategy appears to be a tax or fee on cell phone bills combined with a revenue bond to finance one-time/capital costs (if needed)



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Timeline



Risk Assessment

Risk	Mitigation Strategy
Large earthquake occurs, but signal has not been made available	Aggressively pursue business plan timeline
Slow pace of expanding access to alert undermines political will for funding	Plan and meet benchmarks for expanding access
Lack of participation due to lack of user willingness to invest in EEW	Increase outreach, education, and publicity
Strong interest in accessing signal from ineligible users during limited public roll out phase	Work with USGS to expand signal access to excluded groups
User demand exceeds administrative capacity resulting in difficulty accessing and using signal	Develop plan to expand access in response to strong demand; invest in technical support and help desk resources
False/missed/delayed alerts dilute confidence in system or interrupt costly machine processes and services	Clearly inform users of system limitations and continue to support USGS in refining system performance



Risk Assessment Continued

Risk	Mitigation Strategy
Middlemen reduce data quality and dilute confidence in system	Enforce contractual terms to prevent misuse
Cyber security fails to protect CEEWS from cyber threat	Invest in ongoing security upgrades
Technology for real time cell phone alerts is delayed	Work with providers to accelerate timeline; adjust public awareness campaign timing as needed
CEQA permitting process stalls progress	Continue to work on global CEQA solution
Funding based on estimate proves to be inadequate to support CEEWP	Work to cut costs and find additional funding sources
People do not respond to alert	Refine and enhance outreach and education

Key Strategic Issues

- Identification of most appropriate revenue source for financing ongoing system costs/legislative approval for revenue source
- Clear delineation of roles and responsibilities among OES and USGS
 - Accountability for use of state funds
 - Responsibility for release and dissemination of early warning signal
 - Messaging around signal
 - Users included in limited public roll out
 - Timing of release to users after limited public roll out



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Action Items for Advisory Board

- Continue to support CalOES focus on strategic planning
- Help to ensure a plan is in place at the time of the limited public roll out for extending signal access to users outside of the pilot framework
- Assist CalOES and Legislature in determining if adequate progress is being made toward full deployment of system such that continued expenditure of state funds is warranted
- Review the budget, financing plan, timeline, and risk assessment to ensure consistency with Advisory Board goals and priorities

Blue Sky Consulting Group Workplan

- Get feedback from Advisory Board based on today's presentation
- Continue to collect information and refine estimates and strategies
- Present revised draft of business plan to Advisory Board before February 2018
- Submit final draft to the State Legislature by February 2018



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Questions?

System Operations Update



Dana Ferry, System Operations Project Manager
CA Governor's Office of Emergency Services
CA Earthquake Early Warning Advisory Board
November 30, 2017



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Collaboration



- Identified 4 CSU and 8 UC properties as locations for potential seismic stations
- Ryan Arba - Executive Facilities Officers (EFO) meeting in Monterey Bay Sept. 28, 2017

Region	Station Name	Campus	Distance	Comments
NC	NS045	CSU, Monterey Bay	5 Km	Possible but there is also a UC preserve. Need to site scout.
NC	UG165	CSU, Fresno	5 Km	A definite possibility.
NC	NS008	Sonoma State University - Gallatin Preserve	10 Km	A definite possibility.
SC	NS545	San Diego State University - Mt Laguna Observatory	5 Km	Requested by USGS. Land owned by BLM but SDSU leases the building.
NC	NS045_new	Fort Ord/UC Preserve	5 Km	
NC	NS094	Grouse Ridge Logging Area/UC Preserve	5 Km	
NC	NS147	Kearney REC/UC	5 Km	
NC	UG167	UC Merced	5 Km	
NC	NS146	Flatwood/UC Preserve	5 Km	
NC	NS082	Intermountain REC/UC	5 Km	
NC	NS051	Landis Big Hill REC/UC	5 Km	
NC	NS171	WestSide REC/UC	5 Km	



**Total System Operations
2017-19 Workplan
Proposed Sensor Sites**
140 Upgrades
43 New
183 Total

SFY 2017-19 Budget:
\$6,483,690

Expended: \$17,164





CALIFORNIA EARTHQUAKE EARLY WARNING ADVISORY BOARD

Work Plan Overview

	Year 1				Year 2				Total
	9/30/17	12/31/17	3/31/18	6/30/18	9/30/18	12/31/18	3/31/19	6/30/19	183/8
USGS	Plan/Logistics			15/2	15	20	20	Close-out	70/2
CGS	Plan	10/6	10	10	15	15	10	Close-out	70/6
UC Berkeley	Plan	4	7	8	5	5	5	Close-out	33
Caltech	Plan	-	3	3	4	-	-	Close-out	10

*completed



CEEWS Sensor Build Out Totals

(October 2017)

Currently # of Stations Contributing: **559**

Completed/Undergoing Data Quality Controlled: **56**

Planned Installation Over Next 2 years

CalOES Funded: **183**

USGS Funded: **34**

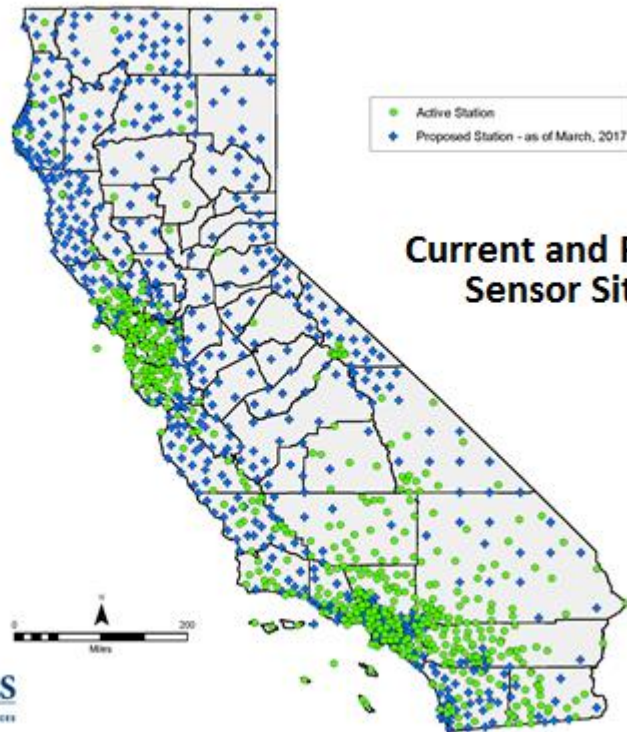
Total Contributing by 2019: **830**

Remaining Stations Needed: **~282**





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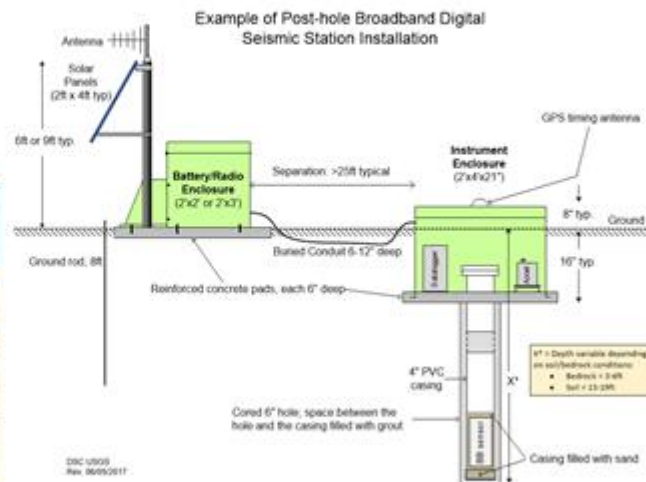


**Current and Future
Sensor Sites**



Seismic Sensors

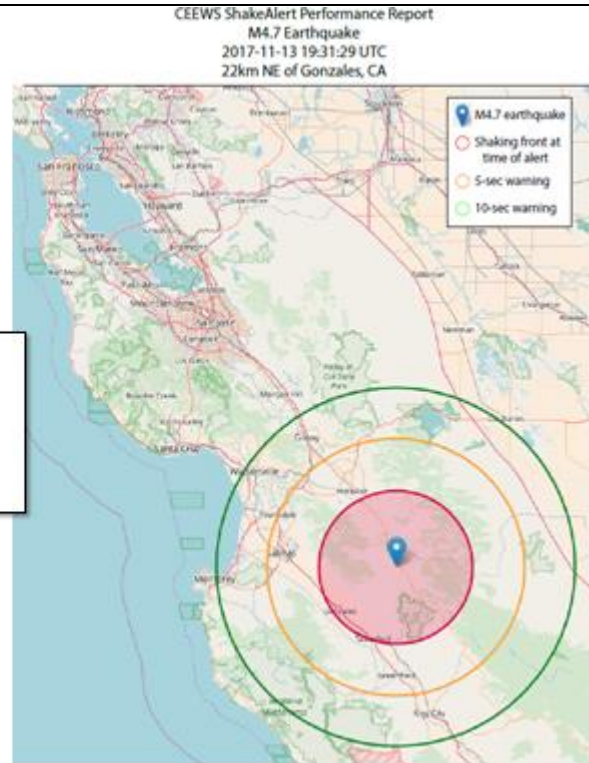
*Seismic sensor set-ups
vary based on the
landscape, geological
features, telemetry
capabilities and
equipment performance.*





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CEEWS Performance Report October 10, 2017 San Jose 4.1



CISN

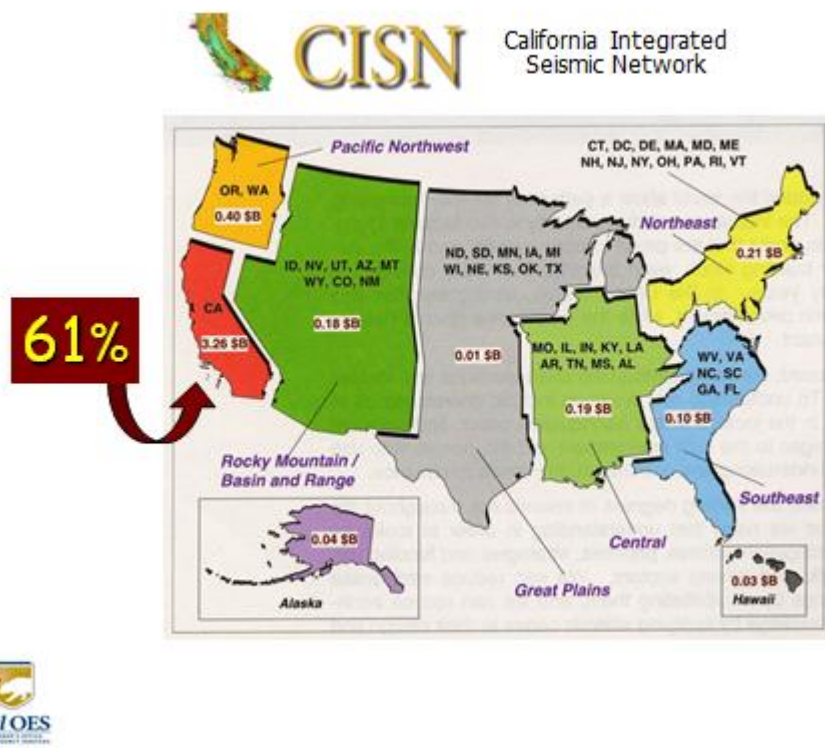
California Integrated
Seismic Network

*"Civilization exists by Geologic
consent – Subject to change
without notice." -- Durant*





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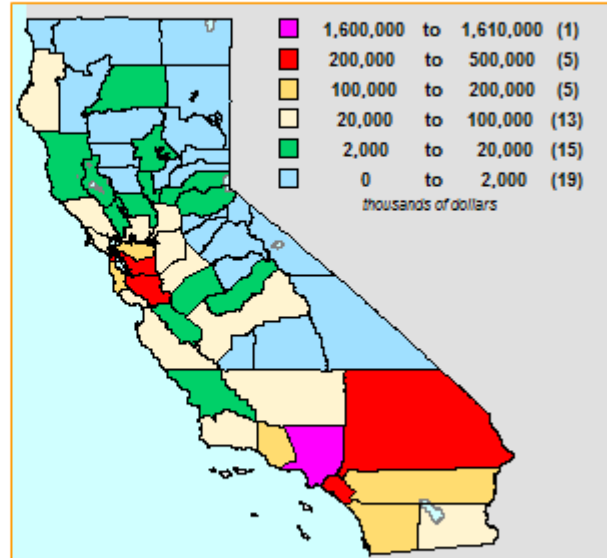


CISN

California Integrated
Seismic Network

Expected Total Annual Loss by County

The seismic hazard values from the PSHA map can be combined with the inventory of structures in California and analyses of the vulnerability of those structures to seismic shaking to calculate projected earthquake losses



Core members

- USGS (Pasadena & Menlo Park)
- Caltech
- UC Berkeley
- Calif. Geological Survey (CGS)
- Cal OES

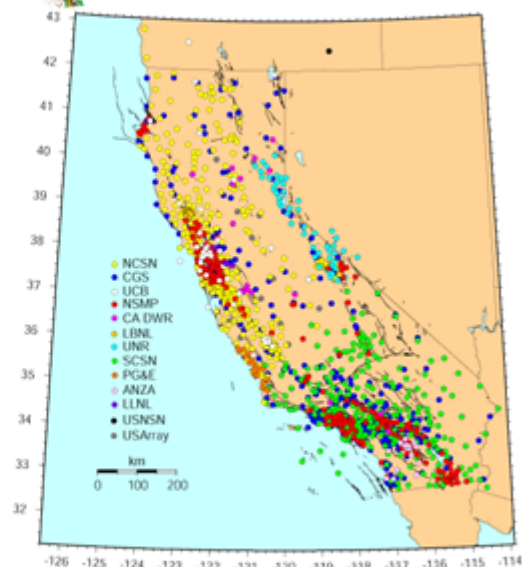
Participating members (real-time data contributors)

- UC San Diego
- UC Santa Barbara
- University of Nevada Reno
- Calif. Dept. of Water Resources
- Lawrence Livermore National Labs
- PG&E
- EarthScope - US Array/PBO
- CalEnergy
- Calpine
- CICESE
- And more...



CISN

California Integrated
Seismic Network





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CISN

Management Structure



CGS



USGS



OES



Caltech



UC Berkeley



CISN

California Integrated Seismic Network

The CISN has three management centers:

Southern California : Caltech/USGS Pasadena

Northern California : UC Berkeley/USGS Menlo Park

Engineering Strong Motion Data Center:
CGS/USGS National Strong Motion Program

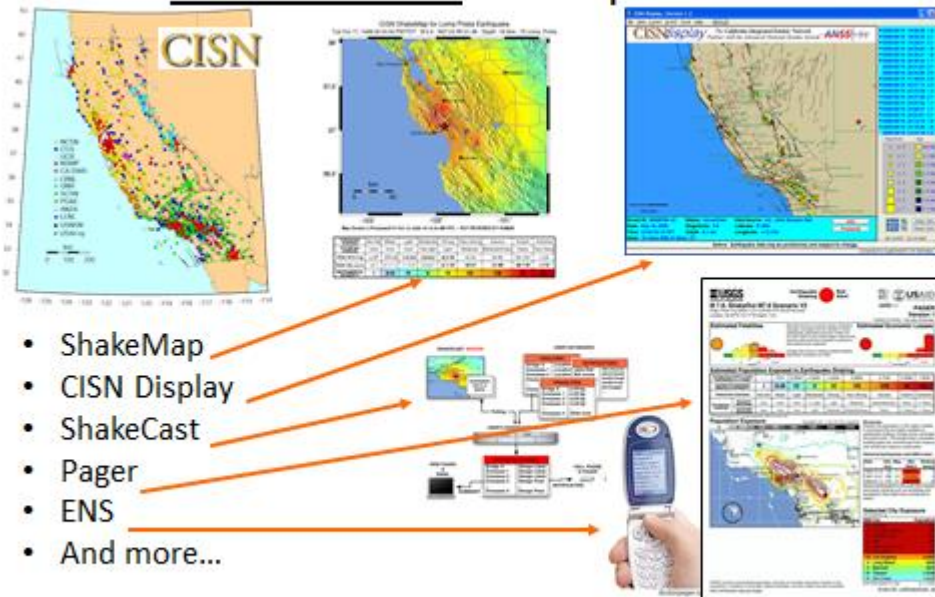
The Northern and Southern California Earthquake Management Centers operate as twin statewide earthquake processing centers, serving information on current earthquake activities, while the Engineering Strong Motion Data Center is responsible for producing engineering data products and distributing them to the engineering community.





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CISN Post-seismic Earthquake Products

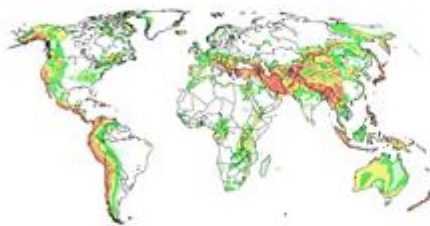




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Earthquake early warning around the globe

focus: Mexico

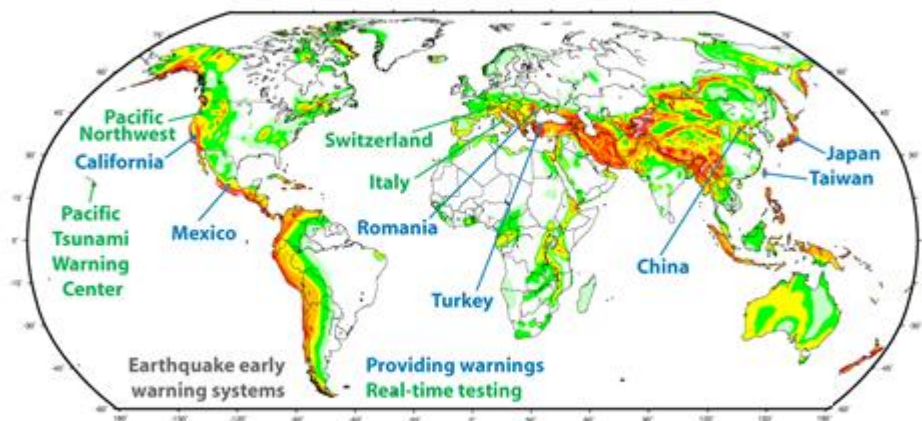


Richard Allen

Professor, Director



Earthquake early warning around the globe





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Earthquake early warning in Mexico City



Earthquake early warning in Mexico City



EERI Reconnaissance Team

Richard M. Allen – UC Berkeley

Elizabeth Cochran – USGS

Thomas Huggins – Massey University

Scott Miles – University of Washington

Diego Otegui – University of Delaware

Mexico City visit: October 2nd-6th, 2017

Talked with CIRES (EEW alert generator), C5 (warning sirens), UNAM seismologists

business owners, private warning companies, and members of the public



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SASMEX: Mexico's EEW system

Goal: Issue alert for all earthquakes that might be felt in Mexico City



EEW alerts in Mexico City



12,000 sirens across Mexico City



Dedicated radio receivers and sirens—few hundred



Modified NOAA weather radios—tens of thousands?



September 2017 – busy month

Sep 6 th ??pm	Technician triggered sirens across Mexico City
Sep 7 th 11:50pm	M8.1 over 700 km from Mexico City ~2 minutes of warning Shaking widely felt, little damage

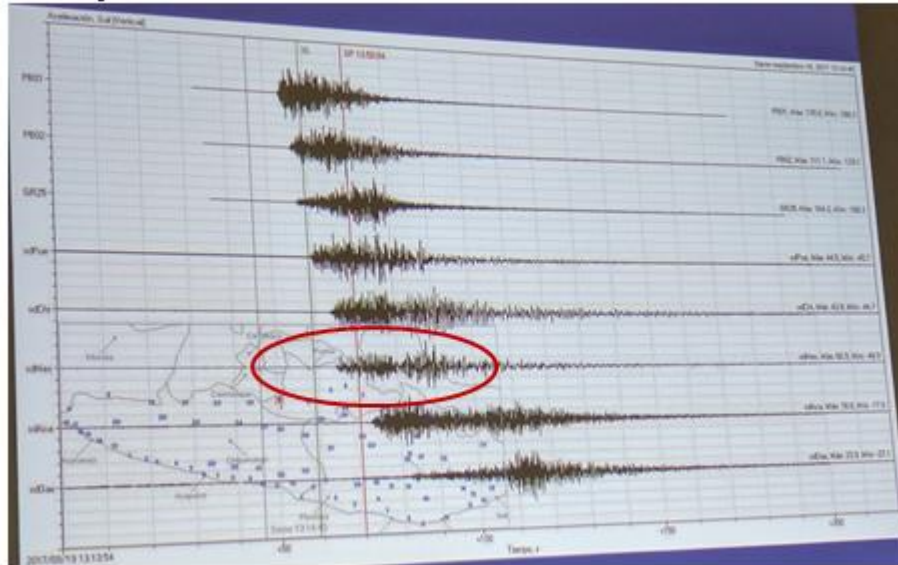
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Sep 19 th 11am	Annual earthquake drill – sirens sound
Sep 19 th 1:15pm	M7.1 120 km from Mexico City Sirens sound few seconds <i>after</i> shaking felt Damaged and collapsed building across the city



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September 19th 2017 – M7.1



September 2017 – busy month

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Sep 19 th 11am	Annual earthquake drill – sirens sound
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Sep 23 rd 7:53am	M6.4 over 700 km from Mexico City ~2 minutes of warning Very few felt shaking



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Sep 23 rd 7:53am	M6.4 over 700 km from Mexico City ~2 minutes of warning Very few felt shaking

Five alerts:

- Main event: Alert few seconds after shaking felt
- Two alerts with *little damage and little shaking*
- One false + one drill

So what do people think of EEW?

The system is “valuable”

People do gripe:

- Have to “go outside in the rain when the alert sounds”
- “evacuated in the night but did not feel shaking”
- “the alert sounded after they started to feel shaking”

But go on to say

the system is “valuable” “necessary”
even “stupendous”

They recognize there are technical limitations
...and accept them



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"False" alerts

Public definition: an alert but no earthquake

...the earthquake does not have to be felt by an individual

and "false alerts are just drills"

CFO of "BBB" based in headquarters:

"Could have a drill/alert every couple of months"

"Would loose about 30 min worktime
but improve awareness and response"

This means there is a

greater tolerance

for false events than missed events

The right message

Earthquake!

More complex message cannot be comprehended

...and are technically more challenging

magnitude vs. intensity – public does not understand

time-till-shaking

– may delay or confuse response

– may be wrong, e.g. strong P-wave shaking

Multiple types and sources of alerts only amplifies confusion



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The right message **Earthquake!**

...immediately followed by additional information

People want to know what happened...



"there was an earthquake even though I did not feel it"

...mitigates potential frustration about "false" alerts

Seismic culture – EEW helps

EEW increases earthquake awareness



People ...think about earthquakes
...think about impacts
...think about response
...think about preparedness

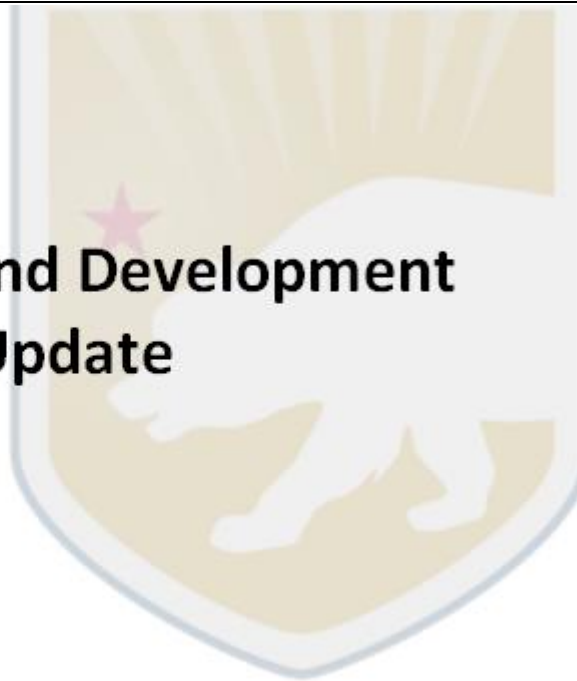


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Five recommendations for EEW around the world

1. EEW is seen as being valuable
...despite technical limitation, non-perfect performance
and mixed messages about protective actions
Gives us confidence about accelerated deployment elsewhere
2. Initial alert should be as simple as possible: "earthquake"
to prompt immediate protective actions
3. Follow-up information critical in the seconds/minutes after alert
social media is a key channel for communicating this information
4. Warning information from all sources should be consistent
to prevent confusion
5. EEW is only as good as the likelihood that effective action is taken
EEW development must be paired with disaster preparedness research,
education, planning and policy

Research and Development Update





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Maximizing CEEWS Performance

- Minimizing delays throughout the alerting chain
- Exploring rapid alert delivery over:
 - Public Television “datacasting” (APTS)
 - Corporate “edge networks” on the Internet (Google)
 - Pacific Research Platform (PRP) fiber network as multi-state “backbone” for seismic data (CalIT2 @ UCSD)



Interoperability with Industry

- Studying interfaces with transport, energy, other industrial systems.
- Building-to-standards to maximize competitive opportunities for private sector.
- Engagement with FEMA and FCC on future-of-warning deliberations.
- Designing an “EEW Lab” where implementers can meet and collaborate.

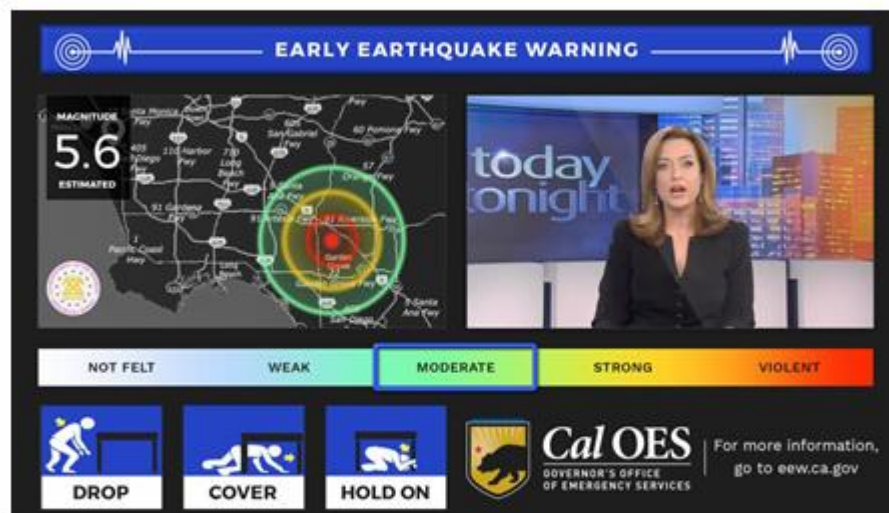




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Delivery Means and Methods

- Cellular “fast lane” alerting (ATIS, FCC)
- Design of consumer “alerting appliance” for Public TV datacast.
- Design of broadcast presentation format
- ATSC-3.0 “next-generation” digital television
 - Turn on feature
 - Location-specific delivery
- Ongoing scan of media and technology options





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Identifying Needed Standards

- Surveying existing standards for public warning, telecommunications, public information.
- Meeting with broadcasters and other technologists to identify “touch points” where standards could reduce friction.
- Building relationships with Standards Organizations (ATIS, 3GPP, ISO, OASIS, etc.)



Key Results So Far

- APTS datacast starts deploying next month
- Fiber-optic PRP now part of EEW backbone architecture along with California's state microwave network.
- UCD DIPI a partner in “user experience” design for alerting devices
- Invited to APTS 3 emergency alerting planning group (“AWARN Alliance”)
- ATIS Planning for Cellular EEW on track for availability in coming years





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Earthquake Early Warning

Automation at PG&E
November 30, 2017



Together, Building
a Better California

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EEW Key Benefits for Utilities



➡ Employees are able to take necessary self-preservation safety precautions prior to the earthquake and subsequent aftershocks

➡ Grid control automation can place critical infrastructure into safe operational modes to minimize danger to employees and customers and reduce restoration times



➡ Gas and electric field crews can safely secure systems and restore critical facilities under the threat of aftershocks.

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USGS ShakeAlert



- The ShakeAlert desktop application is currently installed on three stand-alone workstations within PG&E for testing, with hopes of network-wide desktop/laptop implementation to alert employees and contractors to immediately take protective postures.
- The application serves as a strong mitigation against earthquakes for office employees.

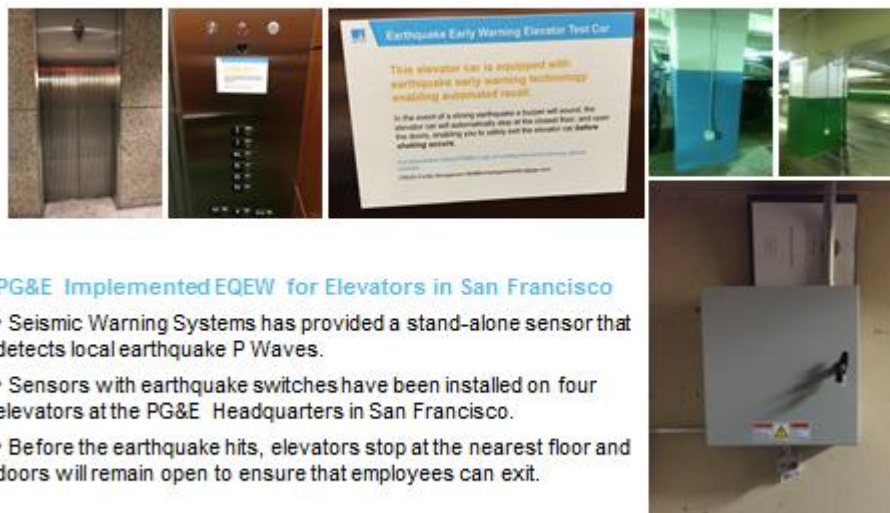
- PG&E has partnered with UC Berkeley to participate in the beta test of the MyEEW mobile application. Select users in emergency response currently have the application on their mobile devices.
- The team is seeking to expand the pilot to the grid and gas control centers as a first step toward integrating earthquake early warning into operations.



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EEW QuakeGuard Implementation



PG&E Implemented EQEW for Elevators in San Francisco

- Seismic Warning Systems has provided a stand-alone sensor that detects local earthquake P Waves.
- Sensors with earthquake switches have been installed on four elevators at the PG&E Headquarters in San Francisco.
- Before the earthquake hits, elevators stop at the nearest floor and doors will remain open to ensure that employees can exit.

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Implementation Roadmap

Employee Safety

ShakeAlert Desktop Pop-Ups w/ Geolocation
Elevator Recall
VHF/UHF Radio Multicast
Aftershock Warning During Restoration

Human-Grid Interface

ShakeAlert User Display at Gas and Electric Control Centers
PG&E Mapping Logic Provides Isolation Guidance
Machine Learning to Determine Isolation Priorities

Operational Automation

Full ShakeAlert-SCADA Interaction
Grids are Auto-Resilient
Additional EEW Technological Developments Implemented

Near Term

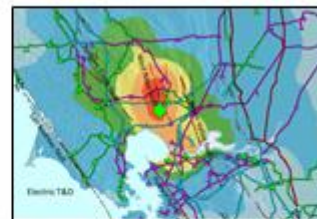
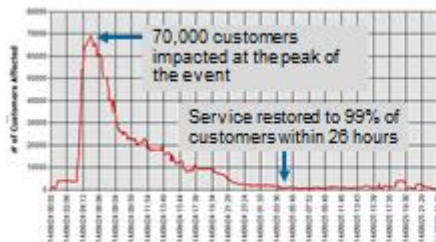
2019

2021+

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Napa Earthquake Example



2014 Napa Earthquake Reliability Impact

Customers Experiencing Sustained Outage (CESO)	97,177
System Average Interruption Duration Index (SAIDI)	5.5 min./cust. served
Customer Average Interruption Duration Index (CAIDI)	315.2 minutes



2014 Napa Scenario with EQEW Switching

Customers Experiencing Sustained Outage (CESO)	67,905
System Average Interruption Duration Index (SAIDI)	4.13 min./cust. served
Customer Average Interruption Duration Index (CAIDI)	339.1 minutes

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Training and Education Update



Emily Holland, Education and Outreach Strategist
CA Governor's Office of Emergency Services
CA Earthquake Early Warning Advisory Board
November 30, 2017

Communication, Education, Training, and Outreach

- Logo and Brand Development.
- Public Education Partnership Spots
 - Radio
 - Television
- Social Science Research into tones
- Community engagement
 - Sector Symposiums





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Social Science Research

Gaps Identified by Michele Wood, PhD. CSU, Fullerton:

1. Extent of EEW awareness among publics
2. Warning Response Time
3. Feasibility of situation-specific guidance
4. Effect of earthquake training on taking timely protective action
5. Tolerance for false positives
6. Most effective branding features



Earthquake Early Warning in California

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