Goaded into Action:

California's Regulatory Response to the Power Line Fire Threat

Joseph W. Mitchell, Ph. D
M-bar Technologies and Consulting, LLC
Ramona, CA USA
www.mbartek.com

Prepared by M-bar Technologies and Consulting


October 2007
Southern California
• 9 out of 20 fires associated with power lines
• $1.6 Billion in property damage
THE FIRST POWER LINE FIRESTORM

Australia

- Black Saturday, February 2009 – 5 of 11 fires investigated by the Victoria Bushfires Royal Commission due to power lines.
- Ash Wednesday, February 1983 – 4 of 8 fires started by power lines
- February 1977 – 9 of 16 fires due to power lines.

Power Line Firestorms

"Black Swans" or "Common Cause Failures"?

Black Swans:

- Unlikely scenarios (out of many possible)
- Unforeseeable consequences
- Unpredictable
- Reduced liability

Common Cause Failures

- ONE cause
- Inevitable chain of events
- Correlated failures
- Preventable

Examples

Black Swan

- **December 17, 2010 – Street vendor Mohamed Bouazizi lights himself on fire.**
- **Jan-March 2011 – Protests and regime change throughout the Middle East**

Common Cause Failure

Photo courtesy of DigitalGlobe

- **March 11, 2011 – Northeast Honshu hit by 9.0 earthquake and tsunami**
- **Tsunami overflows sea-walls and destroys backup generators at Fukushima-Daiichi nuclear plant**
- **Power loss causes core melting and hydrogen explosions in several reactors.**

Power line wildland fire – a common-cause failure

While rare, power line fires are more destructive:

Santa Ana Winds

Power Line Faults + **Rapid Fire Growth**

Catastrophic Wildland Fire

So if power line fires are preventable how do we prevent them?

Required: Adequate Regulation

California Public Utilities Commission (CPUC)

NEW – Gov. Brown Appointees

- Charged with protecting public safety
- Regulating rates

Power Line Fire & the CPUC

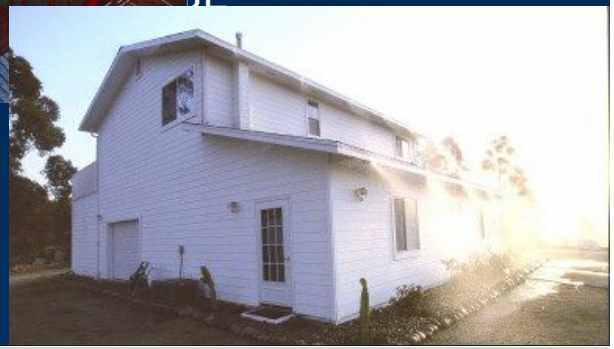
- Prior to 2006 – No explicit recognition of power line fire threat
- 2006 – San Diego Gas & Electric (SDG&E) – "Sunrise Powerlink" Application
  Hundreds of pages of EIR & testimony on wildfire
- October 2007 – Power line firestorm
- 2008 – Investigations (OII), Rulemaking (OIR), SDG&E Shutoff application
- 2009 – Utility application to collect liability costs from ratepayers (WEBA – Wildfire Expense Balancing Account)

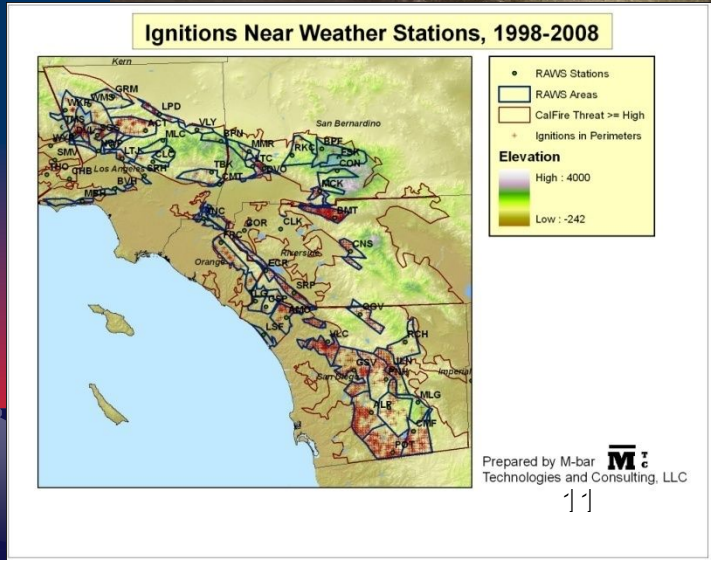
CPUC Actors & Intervenors

- DRA - Division of Ratepayers (CPUC)
- CPSD - Consumer Protection and Safety Division (CPUC - investigations)
- TURN (The Utility Reform Network)
- UCAN (Utility Consumer Action Network)
- Many others (Disability Rights, Farm Bureau, neighborhood organizations)

A little about me, powerline fires, and the CPUC…

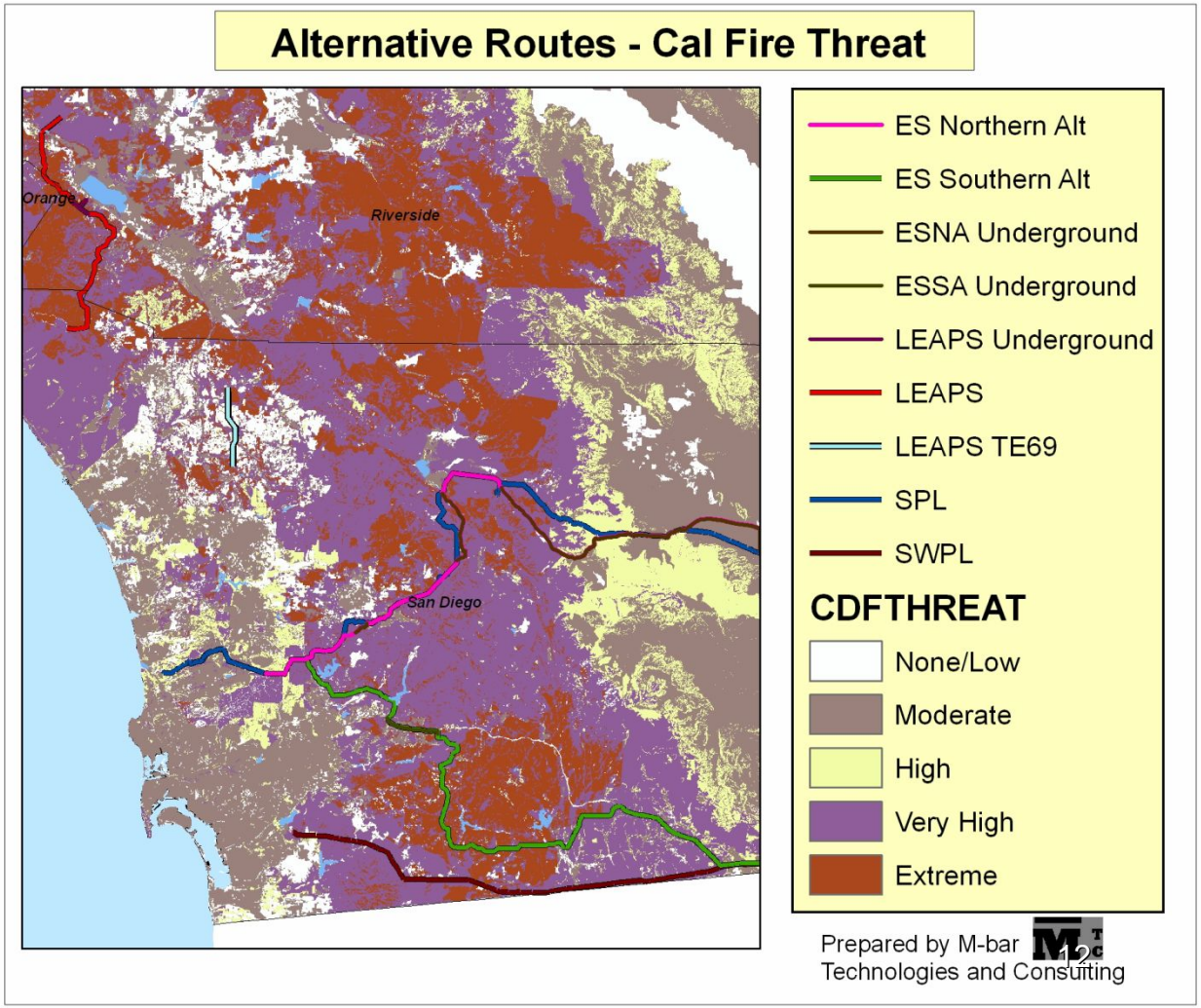
- Particle physics research (1981-1996)
- Wildland fire research (home ignition prevention 2002-?)
- CPUC expert witness for neighborhood organization (MGRA – 2006-?)





SDG&E – Sunrise Powerlink (2006 – 2009 - ?)

- First transmission project to consider wildland fire
- First analysis of outage and power line fire data (public and SDG&E)



Power line fire history

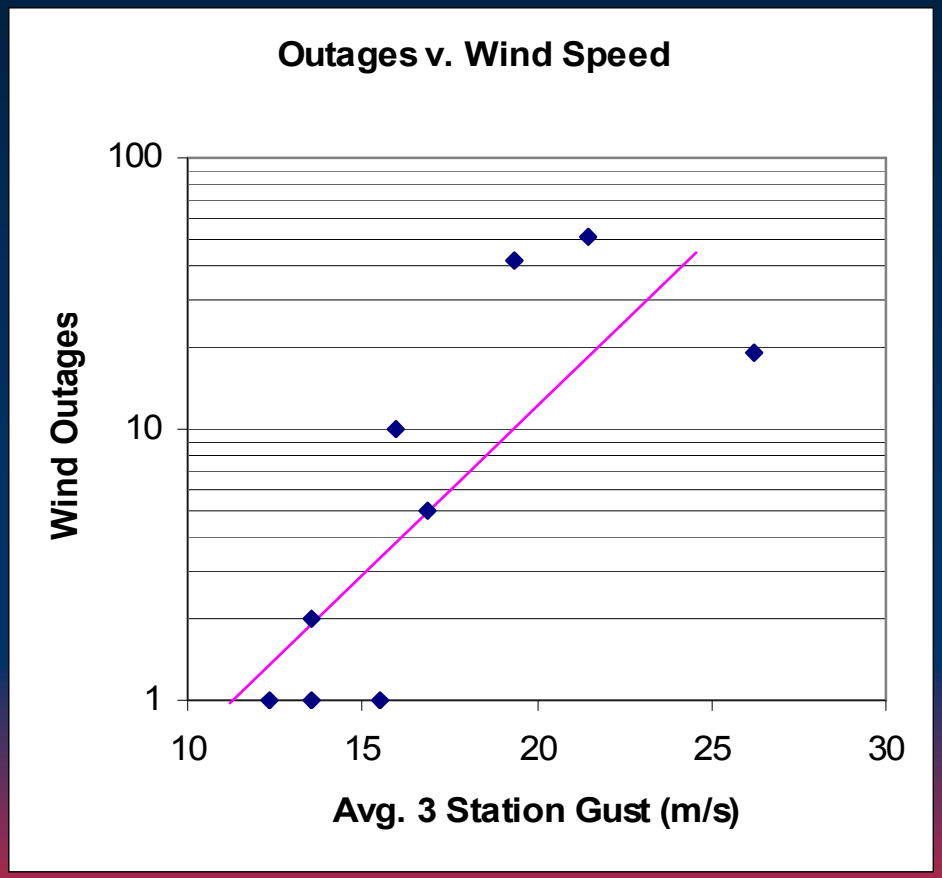
- 4 out of the 20 largest fires in California.
  - start only 3% of fires
  - 0.3% probability this is coincidence
- From 1960-2006 burned 17% of the total area burned in San Diego County.

Line faults and wind speed

SDG&E transmission line outage data, 2000-2007 (not including Oct 07)

Multiple outages in 12 h versus average of wind gust speed at three weather stations in SD County

Threshold at ~ 30 mph

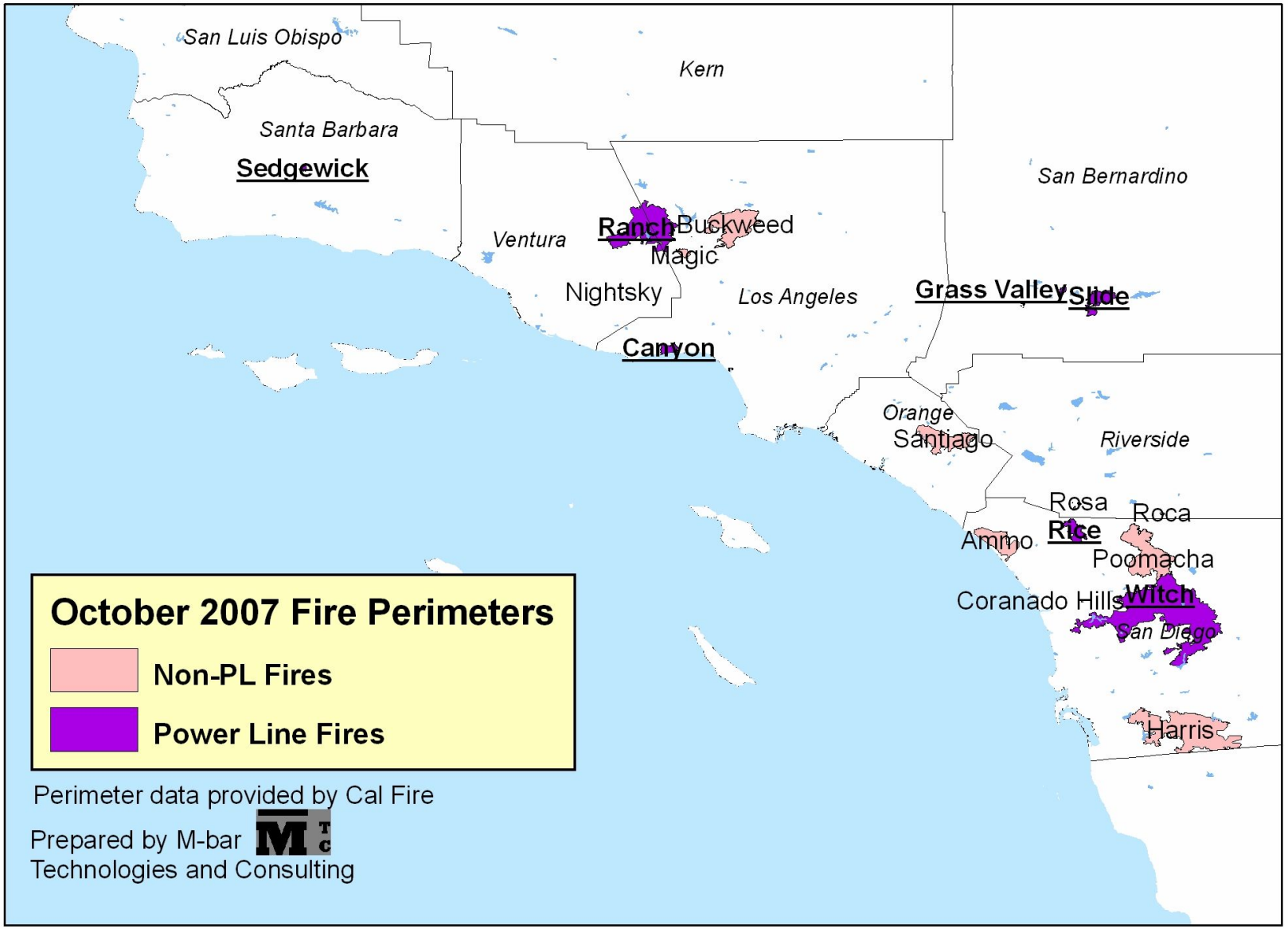


Summary: Power Line Fires are Larger (10X)

Totals for all Southern California

Fires (since 1960, >100ac)	2,090
Acres burned	5,872,010
Average size (ac)	2,810
Power line fires	22
PL acres burned	591,576
PL average size (ac)	26,890
Fraction PL fires	1.05%
Fraction PL area / total	10.05%

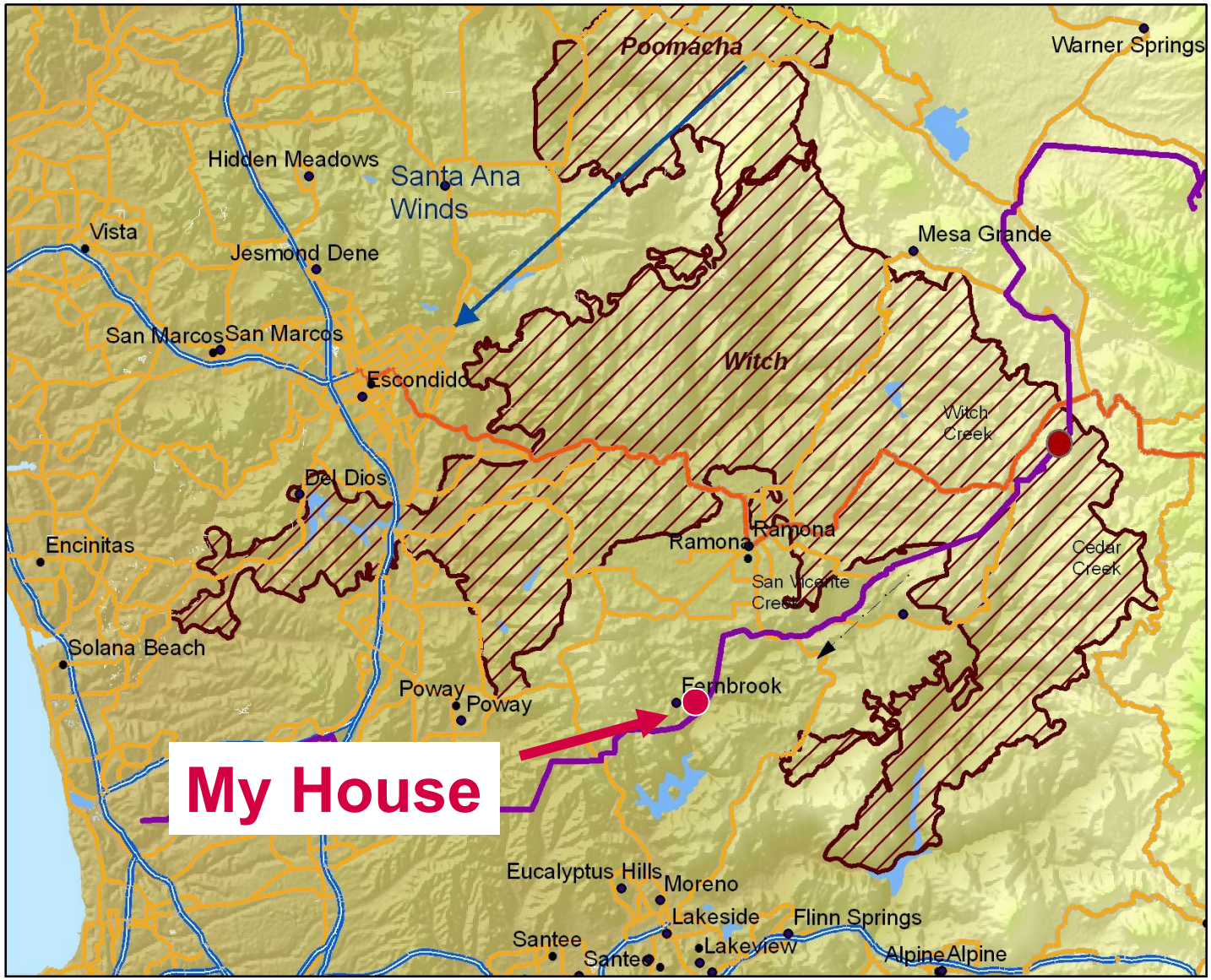
October 2007 Fires



Perimeter data provided by Cal Fire

Prepared by M-bar Technologies and Consulting

Witch Fire, October 2007

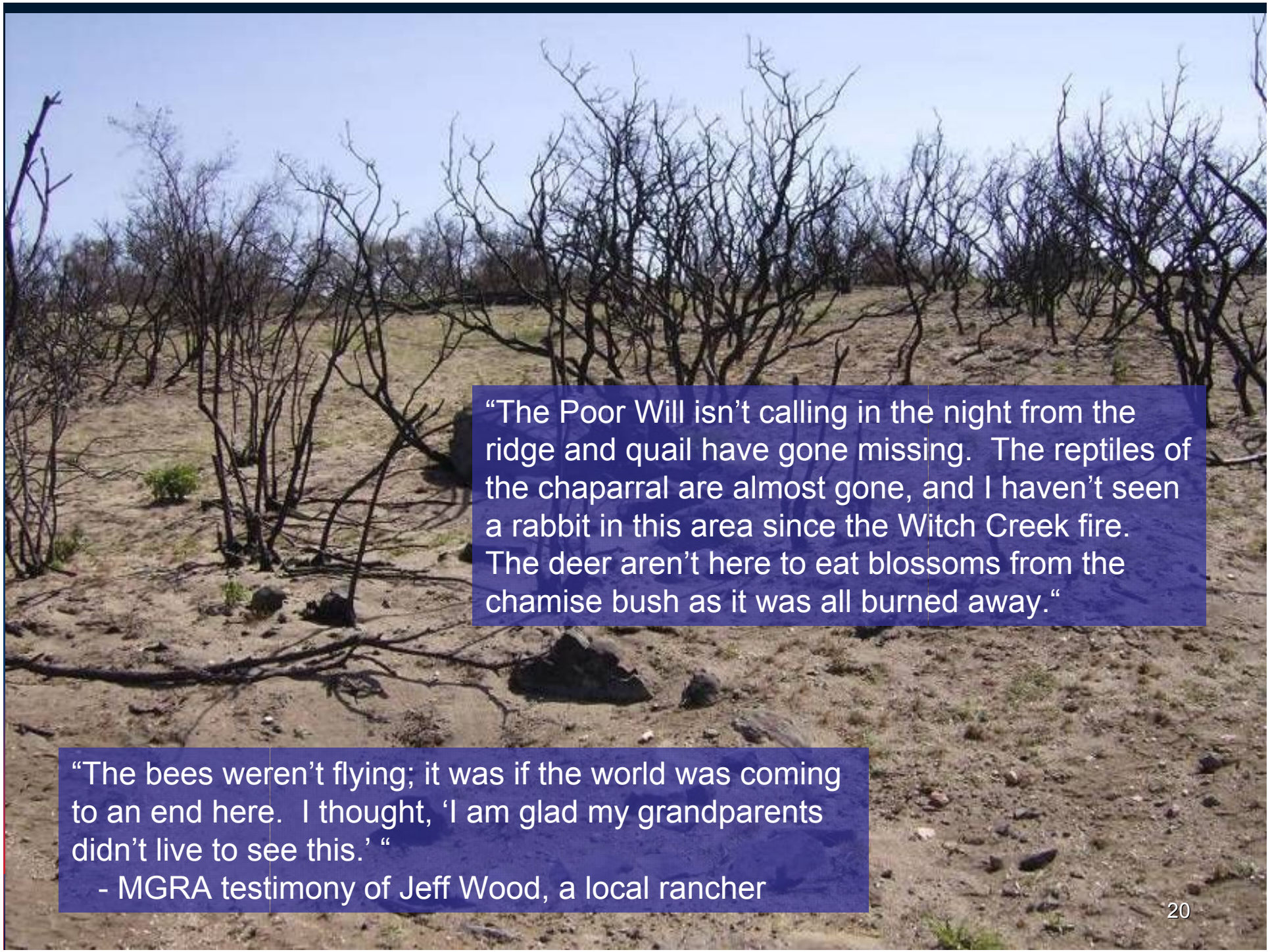


Prepared by M-bar Technologies and Consulting

Cost of power line fires – Oct. 2007

- 9 out of 20 fires alleged to have been started by power lines.
- Cal Fire confirms that the 3 in San Diego, including the largest (Witch) are power line fires.
- Witch Fire burned 197,990 acres, destroyed 1,650 structures, valued at over $236 million, costing taxpayers $18 million in suppression costs. There were two civilian fatalities, 40 firefighters injured.
- Insurance Commissioner estimated that overall claims will exceed $1.6 B for all Oct. 2007 fires (most losses are from power line fires).
- Almost 100,000 acres that burned in 2003 in San Diego burned again in 2007 and are threatened with permanent habitat loss.

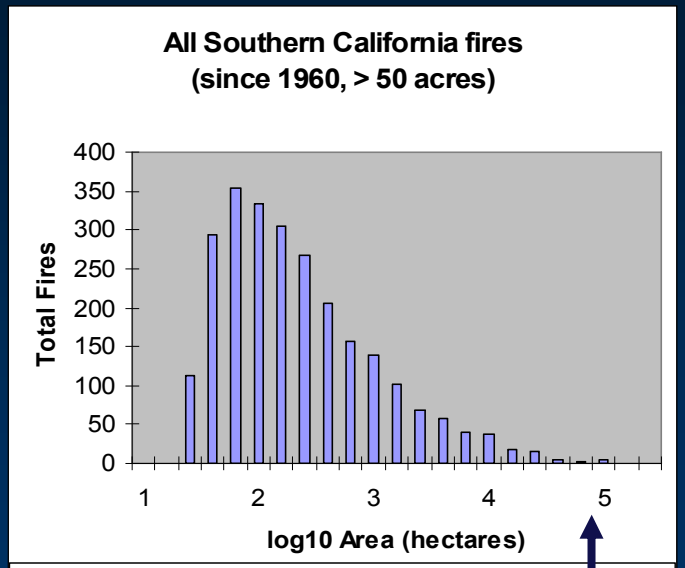
From chaparral to sand dunes and grass…
"type conversion" occurs when fires burn too frequently.
Wood ranch, near Witch Fire origin

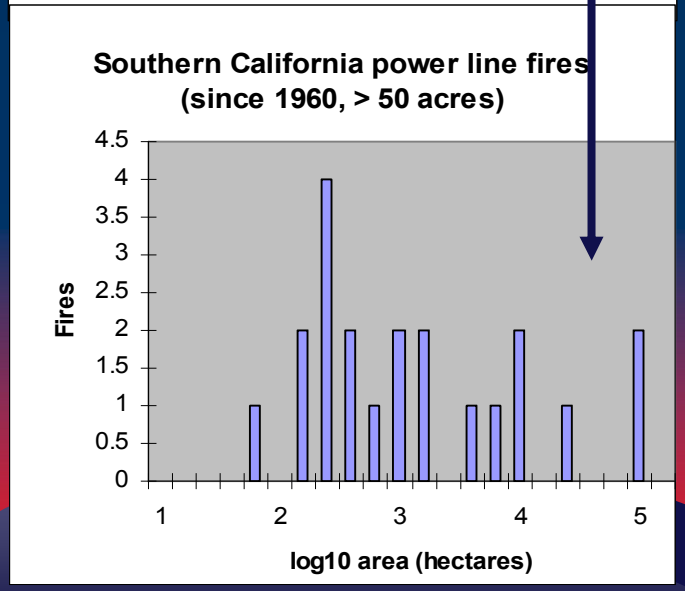

“The Poor Will isn’t calling in the night from the ridge and quail have gone missing. The reptiles of the chaparral are almost gone, and I haven’t seen a rabbit in this area since the Witch Creek fire. The deer aren’t here to eat blossoms from the chamise bush as it was all burned away.“
“The bees weren’t flying; it was if the world was coming to an end here. I thought, ‘I am glad my grandparents didn’t live to see this.’ “
- MGRA testimony of Jeff Wood, a local rancher

Power Line Wildland Fires in Southern California

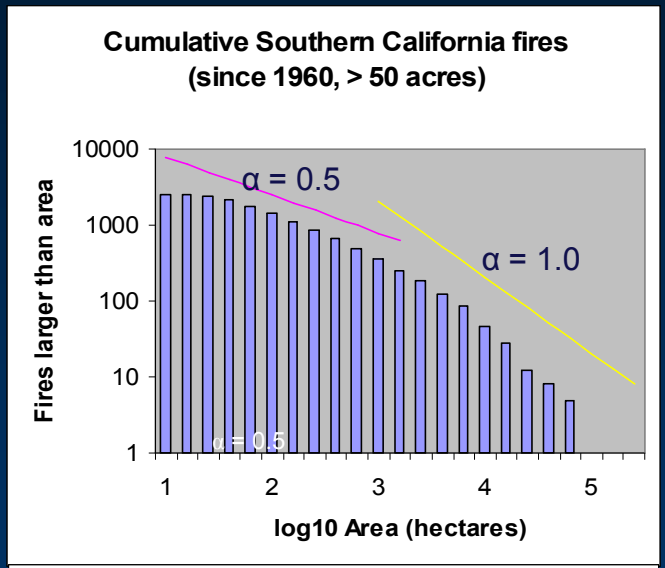
Results form historical and utility data analysis
Presented at Fire & Materials 2009

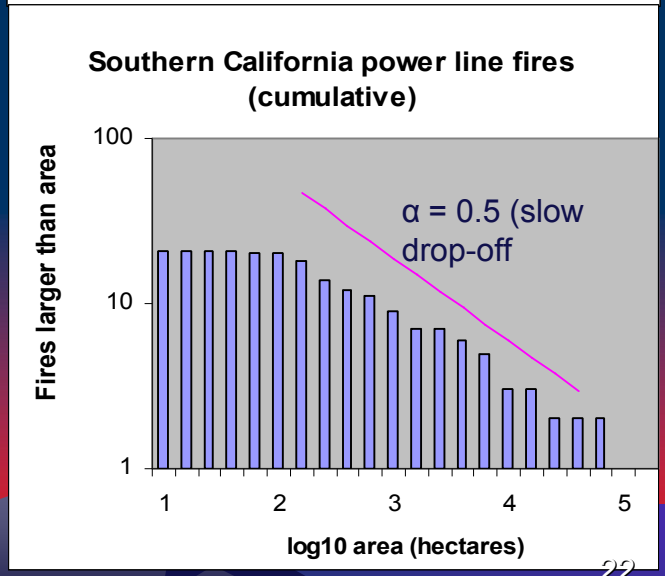
Power line fire sizes



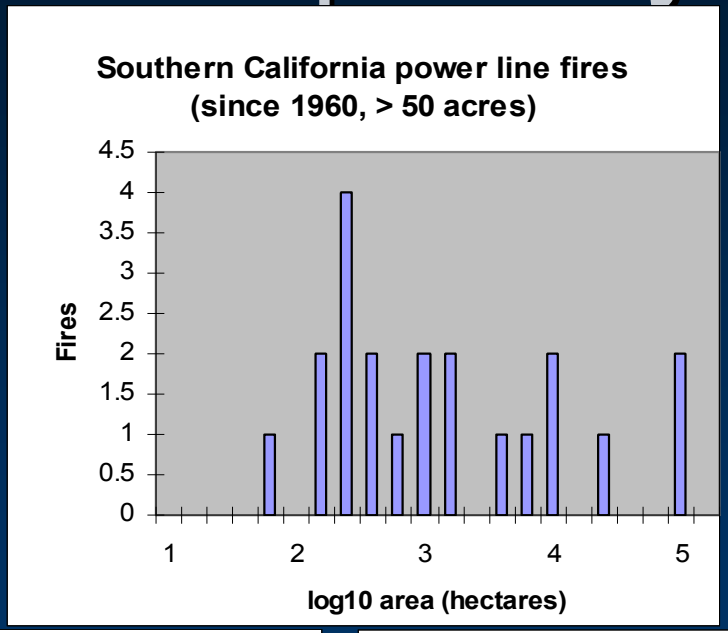


Power line fires fires more likely to be large; fewer medium-sized.



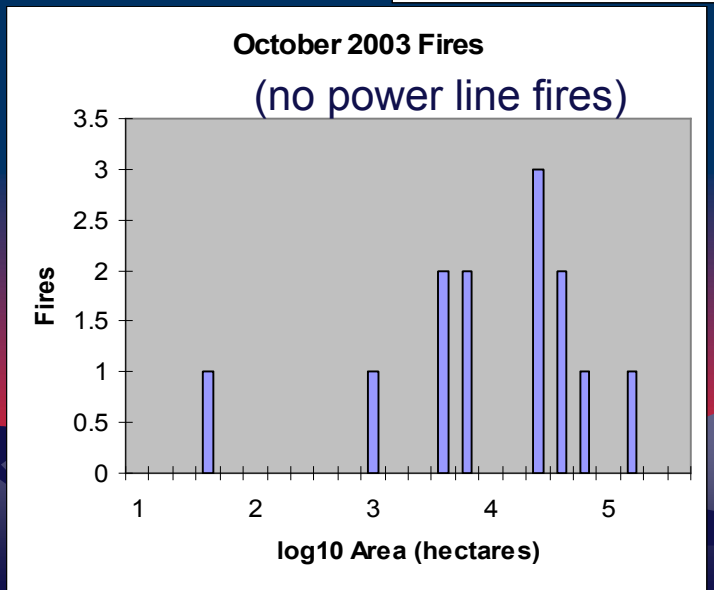


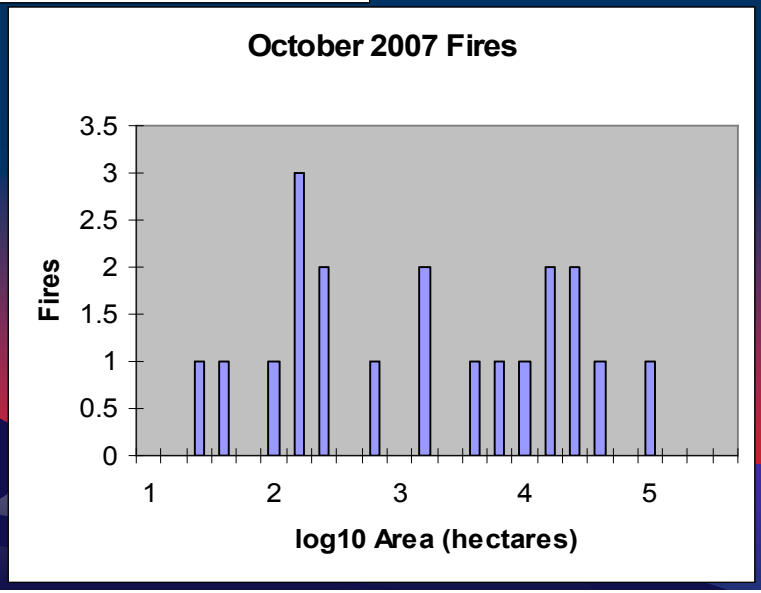
Wind: The primary cause



Comparison of power line fires with 2003 and 2007 fire storms shows a similar size distribution.

Implicates wind as the primary cause.





Two conflagrations: 2003 & 2007

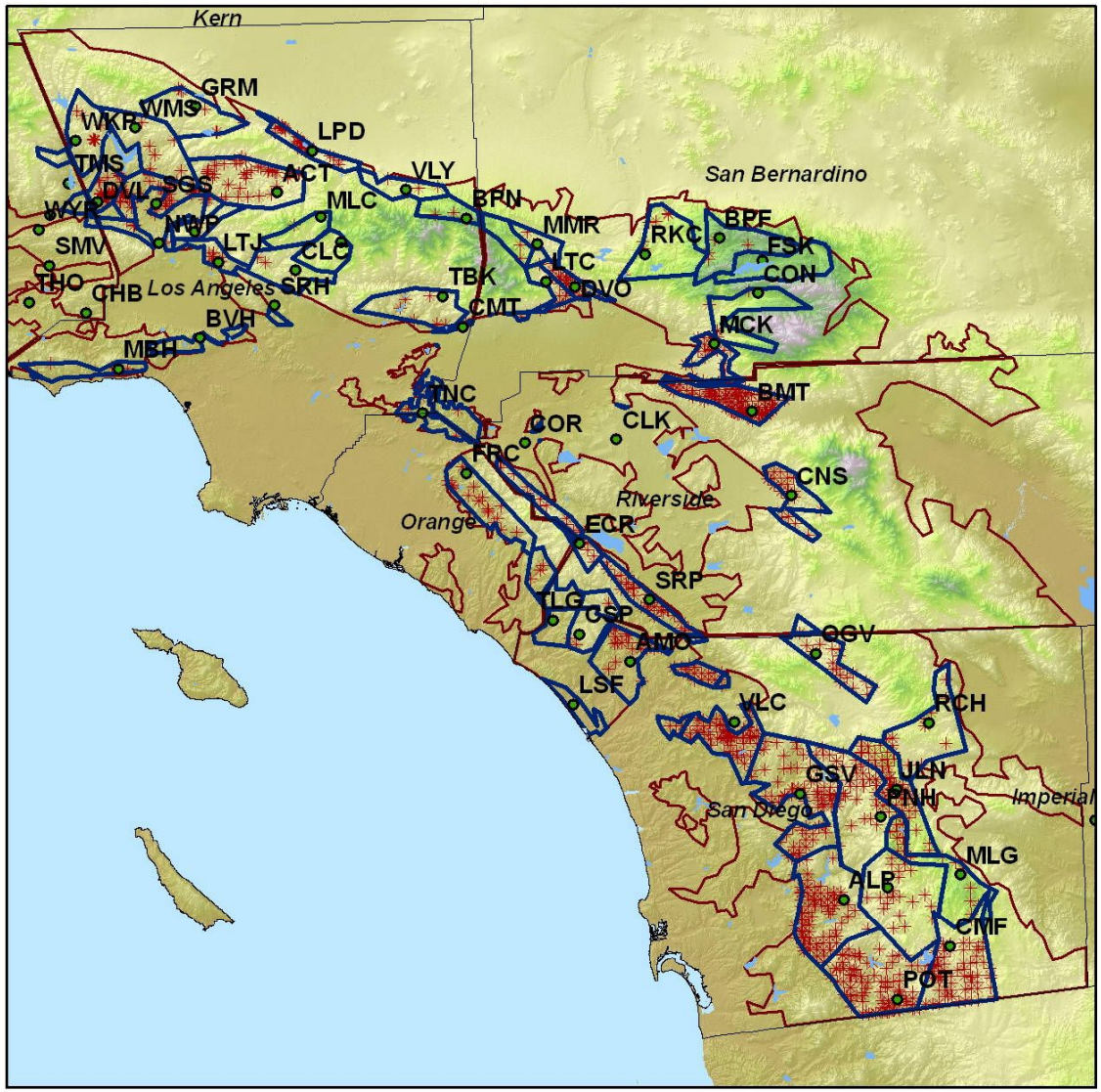
Event	**Wind speed** (Max gust speed averaged over 3 weather stations in SD County)	**Number of power line fires in S CA**
October 2003	33 mph	0
October 2007	59 mph	9

Questions: 1) Was the number of ignitions seen in Oct 2007 indicative of a rapidly rising threshold

2) What number of ignitions would we expect if winds were 10 mph or 20 mph greater?

3) How often do we expect events of this severity?

Ignitions Near Weather Stations, 1998-2008



RAWS Stations

RAWS Areas

CalFire Threat >= High

Ignitions in Perimeters

Elevation

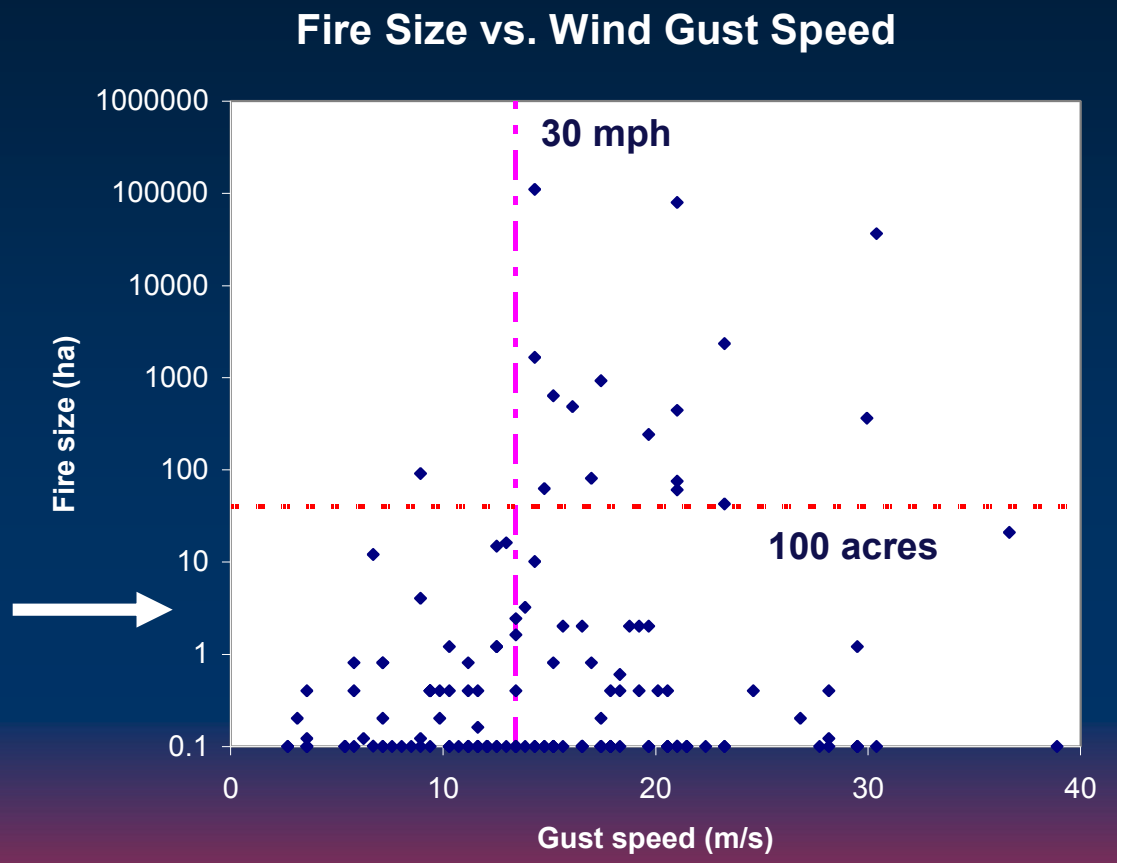
High : 4000

Low : -242

Prepared by M-bar Technologies and Consulting, LLC

Suppression & Wind Results

	Fires	> 100ac	%
Total Fires	19,715	231	98.8
Near Station + high fire threat	2333	66	97.2
Sept. – March	802	34	95.8
Santa Ana (low humidity)	158	17	89.2
Wind gust > 30 mph	83	16	**80.3**



It depends on the wind…

Firefighters put out 97% of all fires before they become large…

… but 80% when Santa Ana winds >30 mph are blowing nearby

8 times more fires escape initial attack

Ignition Causes in High Winds

- Stress Failures
  - Electrical Infrastructure
  - Other infrastructure (telecommunications)
  - Vegetation
- Distention & Line Contact
  - Clashing
  - Vegetation

Stress failures:
defects, aging, high stress

Can arise from
- **defects in materials**
- **defects in construction**
- **aging and corrosion**
- **stress beyond design limits**

PG&E
Redwood City wetlands
December 26, 2006
High winds & defect

Photo courtesy of www.ericcastro.biz

How does # of ignitions increase with wind? (Answer: Rapidly)

- Three effects:
  - Force & flexing will increase as v^2 (tree limb)
  - Rapid increase of faults near threshold (line slap); possibly a Weibull distribution:

$$N(s,v) = N_0 \exp\left(-\left(s / Bv^2\right)^{\gamma}\right)$$

  - Fatigue failures increase as power law (Basquin & Miner's Rules), with threshold effects.

$$P(v) \sim v^{-2/b}$$

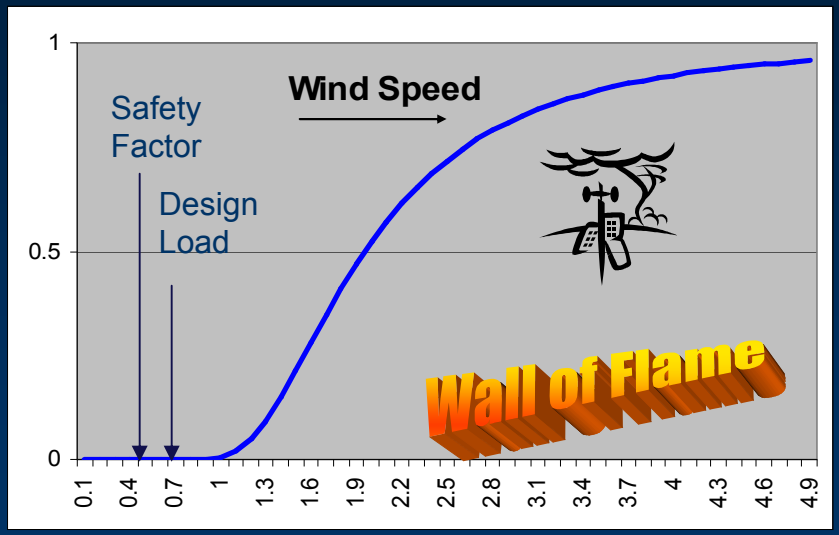
$$N(v) \approx N_0 \exp\left(-\left(v^{-2/b}\right)^{\gamma}\right)$$

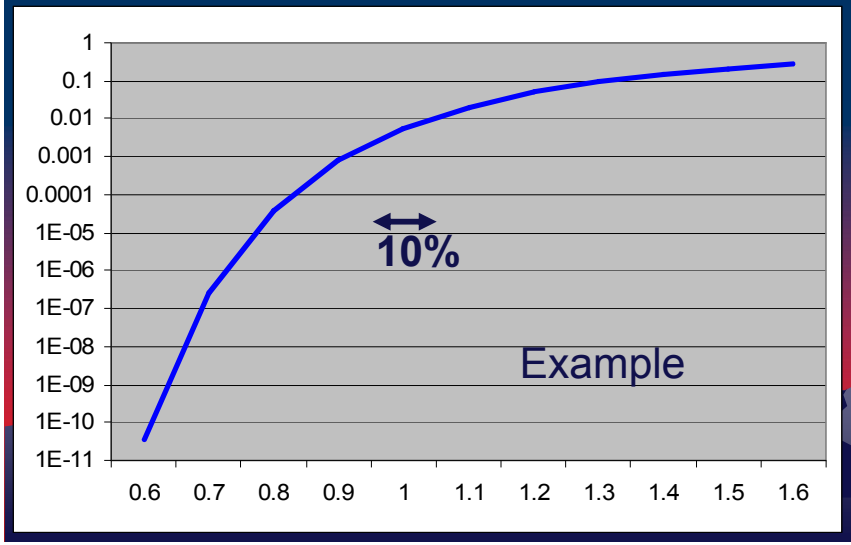
Failures versus wind speed

Example: Weibull distribution ("weakest link")

Fraction of failures

Safety factor of 2X in stress/pressure is only 1.4X in wind speed.





Rapid increase in failure probability in the "tail" region.

➔ ***Once failures start to appear, we expect the number to increase rapidly with wind speed.***

Hurricane data from Florida

Courtesy Quanta Technology

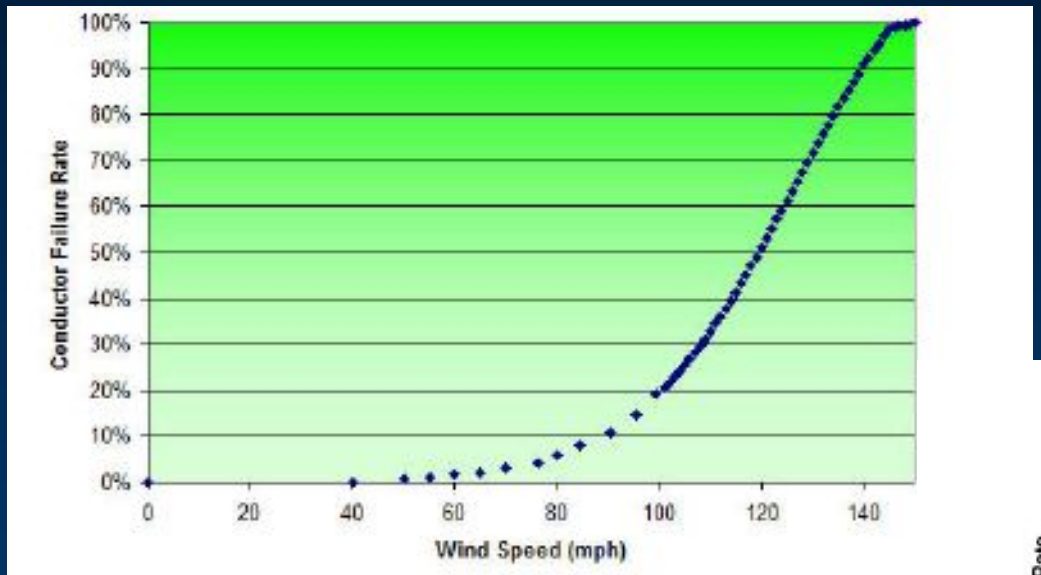


Figure 5-2. Florida Power & Light Span Failure Rate Data

~Factor of 2 every 10 mph

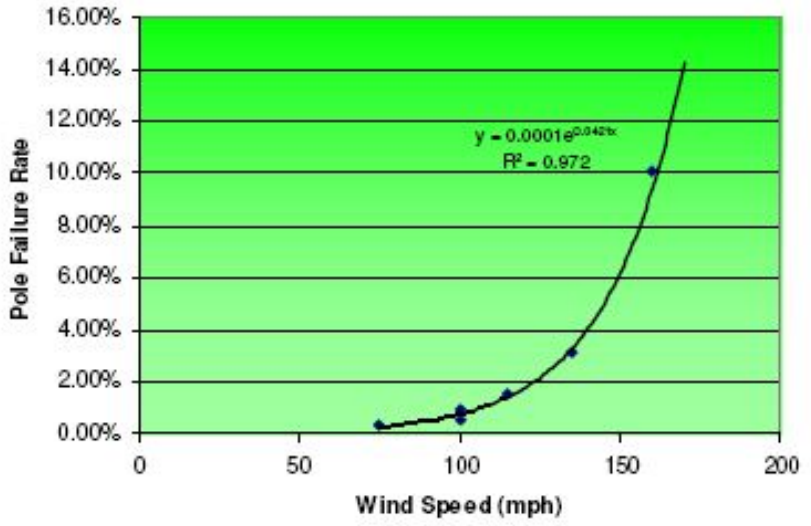


Figure 5-1. Pole Failure Rate vs. Average Wind Speed in Affected Area

Question:
What was failure rate due to wind in Oct. 2007?
Answer:
Probably very small

Summary of the Problem

- Power line wildland fires are “common cause failures”.
- Power line fires are BIGGER than fires from other sources.
- Number of ignitions will increase rapidly with wind speed.

Response by the CPUC and Utilities

- INVESTIGATIONS
  - Into the Witch, Guejito, Rice, Malibu fires
- REGULATIONS
  - Rulemaking R.08-11-005
- APPLICATIONS
  - Power shut-off, insurance cost recovery, litigation cost recovery.

CPUC Investigations
of the 2007 Fires

- Witch fire
- Guejito fire
- Rice fire
- Malibu fire

CPUC Investigations
of the 2007 Fires

- Witch fire
- Rice fire
- Guejito fire

SDG&E: $14.8 M uncontested settlement + CPSD funding + changes to procedures

Cox agrees to $2M settlement

- Malibu fire

Litigation

Order Instituting Rulemaking (OIR)

- General Orders (GO) – Utility regulations
  (GO-95, GO 163 – safety & inspection)
- Changed by Rulemaking proceeding
  (EVERYBODY shows up – electric utilities / communication providers (CIPs))
- Changes proposed & vetted by CPUC (CPSD), utilities, CIPs and other parties
- Most suggestions post-hoc (reactive versus strategic)

Reactive Rules

(direct causes of 2007 fires – horses/barn doors)

- Pole loading
  - Record-keeping, communications
- Inspections
- Reporting
- Vegetation Management
  - Increased trim distance, more frequent inspections
- Conductor spacing

Lots of haggling
Expect some changes

Strategic Rules

- Intended to address “big picture”
- Sponsored by CPSD & MGRA
- Strong utility opposition – cost and liability implications
  - *Data collection*
  - *Fire hazard maps incorporating wind*
  - *Contingency planning*

Example: Data Collection Results (Australia)

Ground fires that start at rural electricity assets

VRBC evidence indicates the causes of five Black Saturday fires are suspected to have been:

1. Kilmore East (Kinglake fire): a live wire broke, fell onto a pole stay, then the ground
2. Horsham: coach screws holding pole top structure worked loose
3. Coleraine: a tie (holding a conductor to an insulator) broke allowing the conductor to detach from the pole and contact a tree
4. Beechworth-Mudgegonga: a tree outside the vegetation clearance zone fell on the line
5. Pomborneit-Weerite: evidence on the cause of this fire remains conflicting and disputed.

Type of day	CFA fires reported	Fire starts at electrical assets	%
All days	40	0.4	1%
Non total fire ban days	30	0.3	1%
Total fire ban days	280	2.2	0.8%
Black Saturday	592	10-20	1.7% to 3.4%

Table 8: Fire starts per day (last five years)

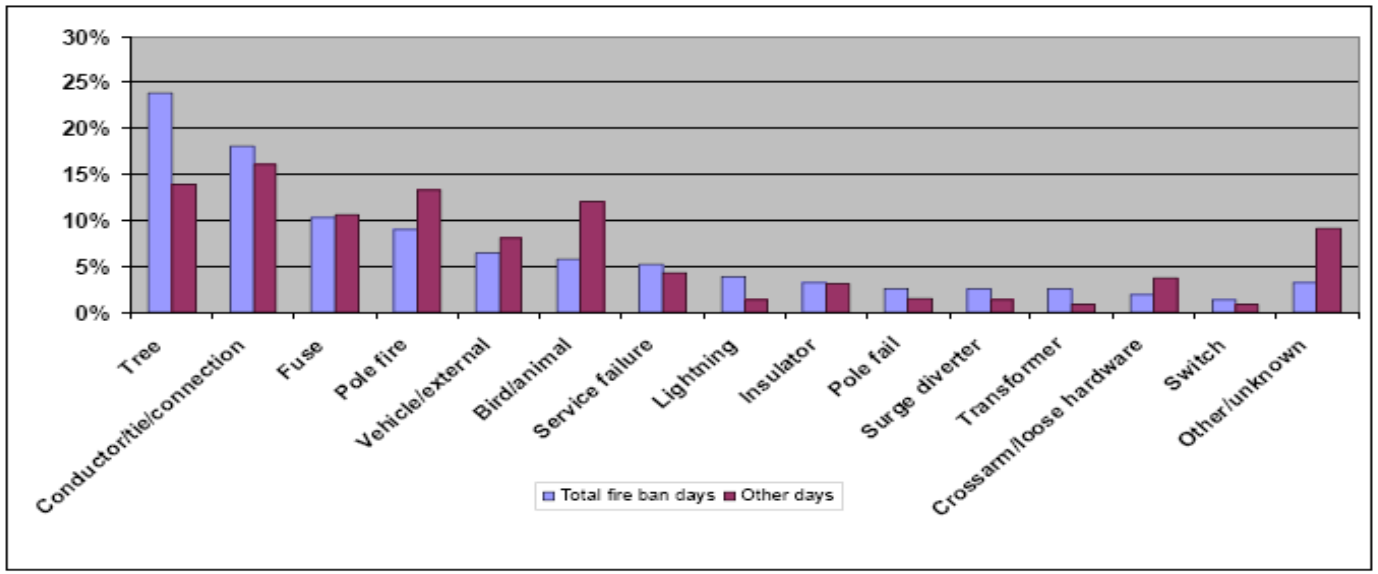


Figure 14: Causes of ground fires started by rural electricity assets in Victoria (last five years)

Why can't California do this?

Data Collection

How it would help:

- Knowing how *small* fires start allows prevention of *big* fires
- Identification of common failure modes

Objections:

- Utilities (ratepayers) need to pay for process & infrastructure changes
- You
(data mining for lawsuits)

Fire Hazard and Wind Maps Rule

- Maps are necessary to determine where ignitions due to high winds are likely to occur.
- Information can be used for vegetation management, wind loading, routing, and hardening measures.
- Maps from Cal Fire inadequate (per Cal Fire)

What we needed:

Maps for electrical utilities in Southern California

What we got:

Maps for communications facilities in Northern California

Need expansion, planning & further review

Contingency Planning

- What are utilities supposed to do when faced with an extreme wind event (winds higher than design limits)?
  - How do they even know they have one, or are going to?*
  - How often do they expect this?
- Power line fire storms occur when high winds cause multiple simultaneous failures:
  - California – October 2007
  - Australia – February 2009, 1983, 1977
- Utilities need to plan for either an *operational* or *engineering* response to *foreseeable but rare* conditions.

*Example – SDG&E has deployed wind gauge array

What does everyone else do?

- ASCE 7-10
- 300-1700 year return intervals
- California listed as 115 mph gusts
- ASCE CA wind measurements NOT in Santa Ana prone areas

What is the strongest possible Santa Ana wind event?

OIR status

Decision pending

Applications

Utility proposals

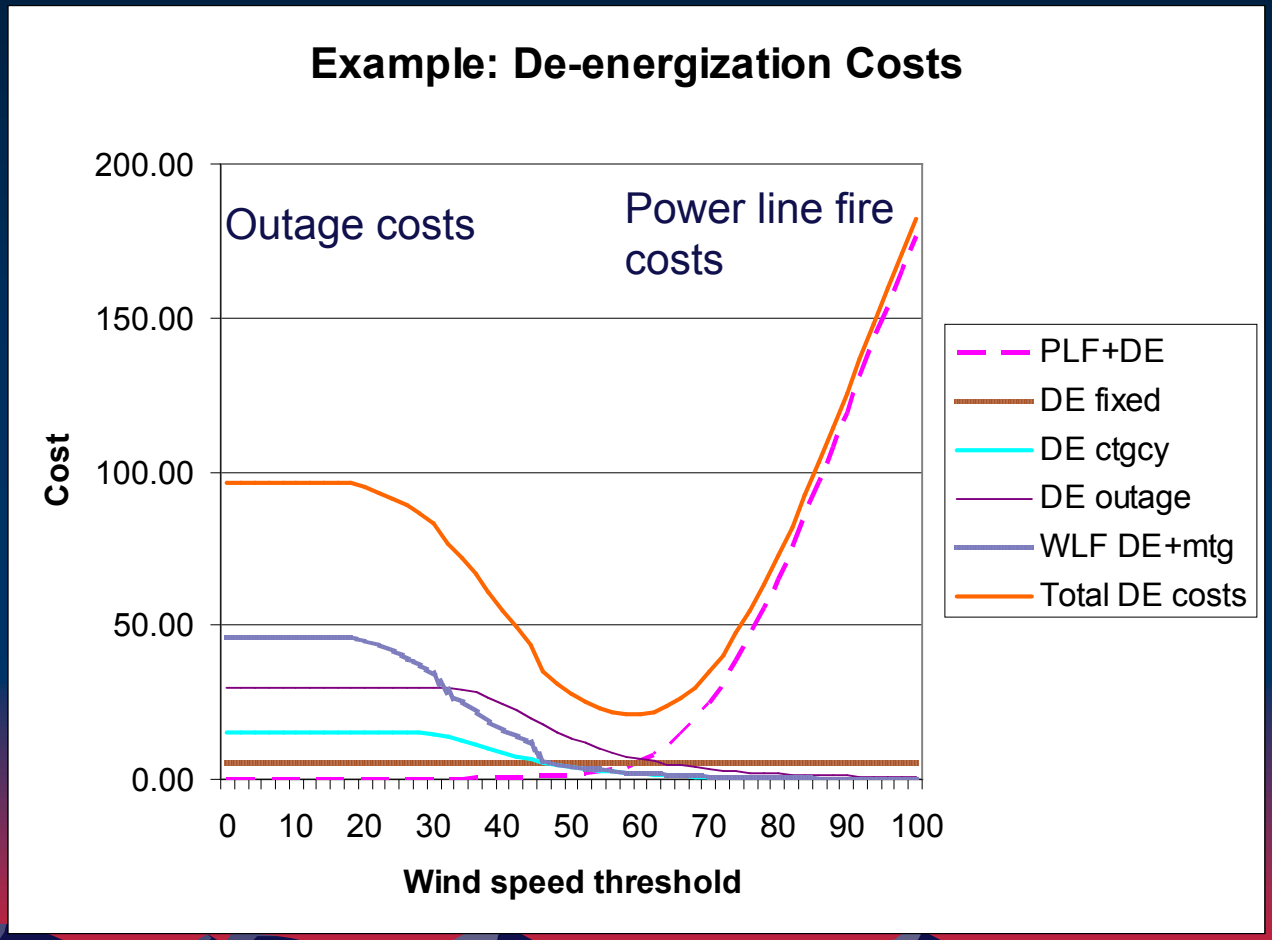
SDG&E – Turn off the power

PRO:
- Removes ignition source
- Prevents power line firestorm

CON:
- SDG&E risk only
- Economic & safety issues
- Sensitive populations
- Other fire sources – generators / candles
- Disrupted communications (fire reporting)
- Shifts liability to government & service providers

Cost/Benefit
Logical way forward

EXAMPLE ONLY: NOT REAL CALCULATION!!!

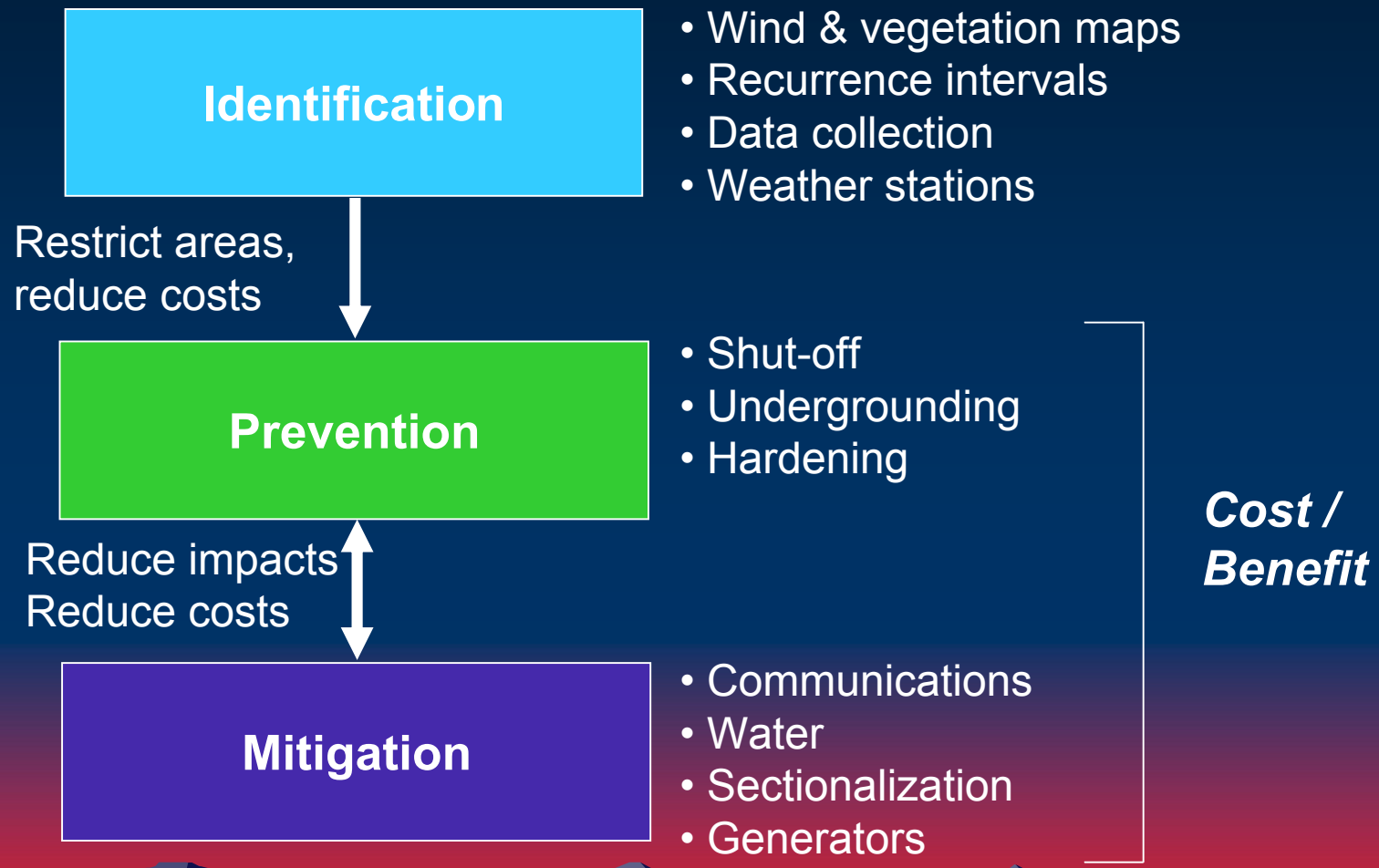


Shut-Off shut down

What actually happened

- Application denied
- SDG&E directed to meet & confer with stakeholders & parties
- 18 months of meetings
- Cost/benefit shunned – liability avoidance
- No best solution – “Nash equilibrium”
- SDG&E declares fiat shut-off threshold; CPSD & other parties dare them to try it

Holistic View – Rules and Options



Who pays for power line fires?
WEBA – a modest proposal

- San Diego Gas & Electric (SDG&E), Southern California Edison (SCE), Pacific Gas & Electric (PG&E) application
- Insurance difficult / expensive
- Wildfire Expense Balancing Account (WEBA)
- Ratepayers cover uninsured costs (*including litigation*)

WEBA

Justification

- Utilities must operate in hazardous areas
- Potential losses are massive
- Commission has ruled that utility bankruptcy is bad.

Opposition

- Moral hazard – reduced incentive for safety
- Reduced incentive to defend against lawsuits
- Profits privatized, costs socialized

WEBA Round 1

- Initial application denied
- Meet & confer – 9 months
- New application, December 2010
- Still awaiting scoping

- Sneak preview: Proposed Phase 2 would discuss reducing utility liability

So where are we?

- OIR – will new rules help? How long before we know?
- WEBA – Awaiting direction
- New Commissioners
- Utility-initiated efforts

Waiting for the winds to blow