Climate Change Impacts and Readiness Planning

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Powering forward. Together.

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Presentation Overview

- SMUD Background
- Approach & Objectives
- Current findings and potential SMUD impacts
- Recommended next steps
- Other local climate planning efforts

SMUD Overview

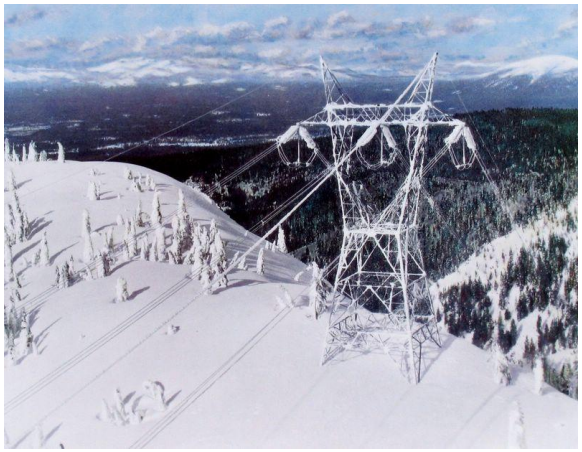
- Publicly-owned utility formed in 1946
- Governed by independent locally elected governing Board of 7 members
- Serves electricity to 1.3 million people in Sacramento region
- 2,100 Employees
- Peak Demand of 3,300 MW July 2006
- Annual Sales ~11,000,000 MWh

SMUD Energy Resources

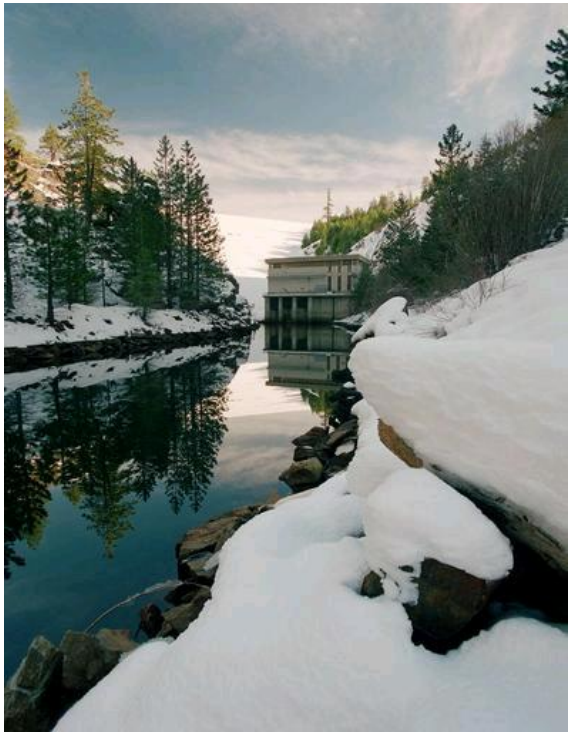
Distributed Solar – 50MW rooftop, 100 MW groundmount

Biomass - 203 MW

Solano Wind – 230 MW



COTP Transmission from NW – 1600 MW



Upper American River Hydro Project – 688 MW

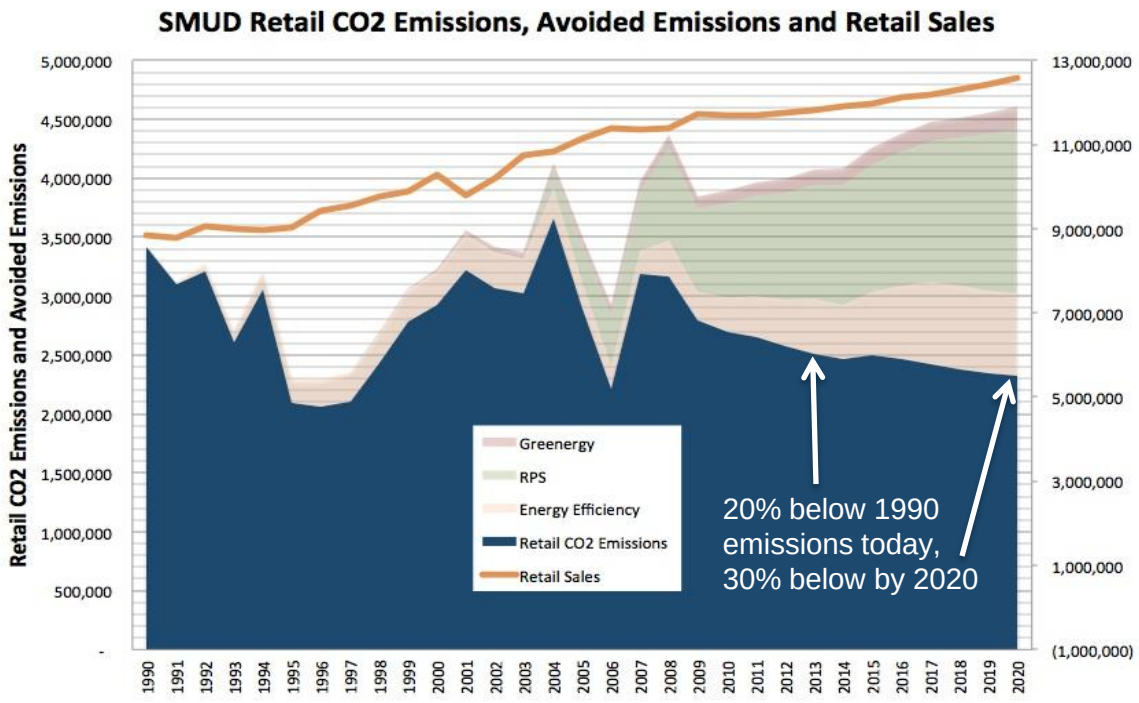
Natural Gas Combined Cycle – 850 MW at 4 locations, NG Peakers 150 MW at 3 loc's

SMUD's Board Strategic Direction on Resource Planning and Carbon Reduction

A sustainable power supply is defined as one that **reduces SMUD's net long-term greenhouse gas (GHG) emissions** to serve retail customer load to 350,000 tonnes (**10% of its 1990 carbon dioxide emission levels**) by 2050, while assuring reliability of the system, minimizing environmental impacts on land, habitat, water quality, and air quality, and maintaining a competitive position relative to other California electricity providers.

To guide SMUD in its resource evaluation and investment, the Board sets the following interim goals:

Year	Net GHG Emissions
2012	2,608,000 metric tonnes
2020	2,318,000
2050	350,000



SMUD's Current Climate Change Mitigation & Preparation Efforts

- Sustainable Power Supply Objective
- Renewable Energy Goals
- Energy Efficiency Programs
- Electric Transportation Programs
- Leadership in Smart Grid
- GHG Policy Initiatives
- Disaster Recovery & Emergency Response Coordination

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Concerns about Climate Impacts

- Initially examined in 2008/9 with SAIC
- Work focused on summarizing effects of temperature on peak demand, hydro impacts, flood risk, thermal limiting on power plants
- Informed industry-leading 2008 Board goals to address climate change

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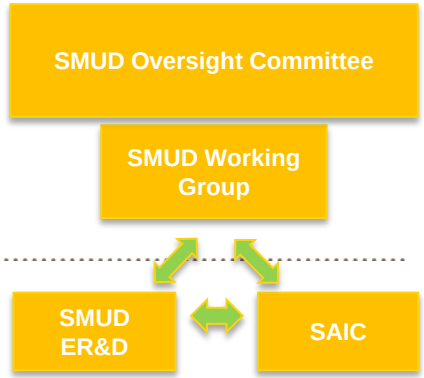
Current Approach



- Phase 1
  - Review 2009 summary of physical impacts
  - Investigate and summarize new findings (no original research)
  - Review best science available for areas not addressed in 2009 (wind, wildfire)
  - Develop recommended next steps for consideration
- Subsequent Phases
  - Identify SMUD operations or processes that warrant closer discovery and data analysis
  - Pursue opportunities for collaborative research in targeted areas

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Why Prepare? Objectives of SMUD's Climate Readiness Strategy

- To assist SMUD's workforce and our community of customer owners to prepare for changes in climate and weather in our region, some of which are already happening.
- To enable SMUD to manage many of these changes and prepare for those beyond our control, helping to prevent unnecessary risks.

Why “Readiness”?

- Adaptation not well understood among general public
- “Readiness” better conveys the desired end state

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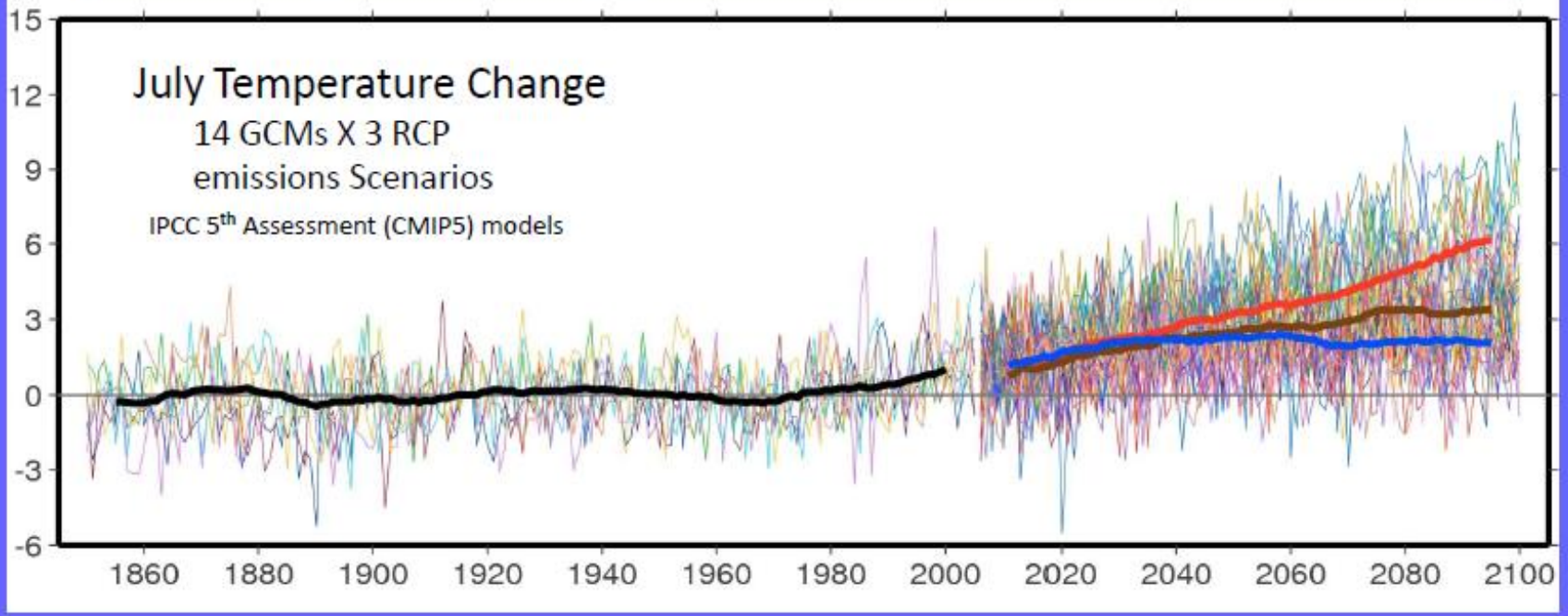
Projected Climate Warming is substantial

especially during summer in interior locations



Climate Warming:

summer warming higher than winter

interior warming greater than coastal/marine

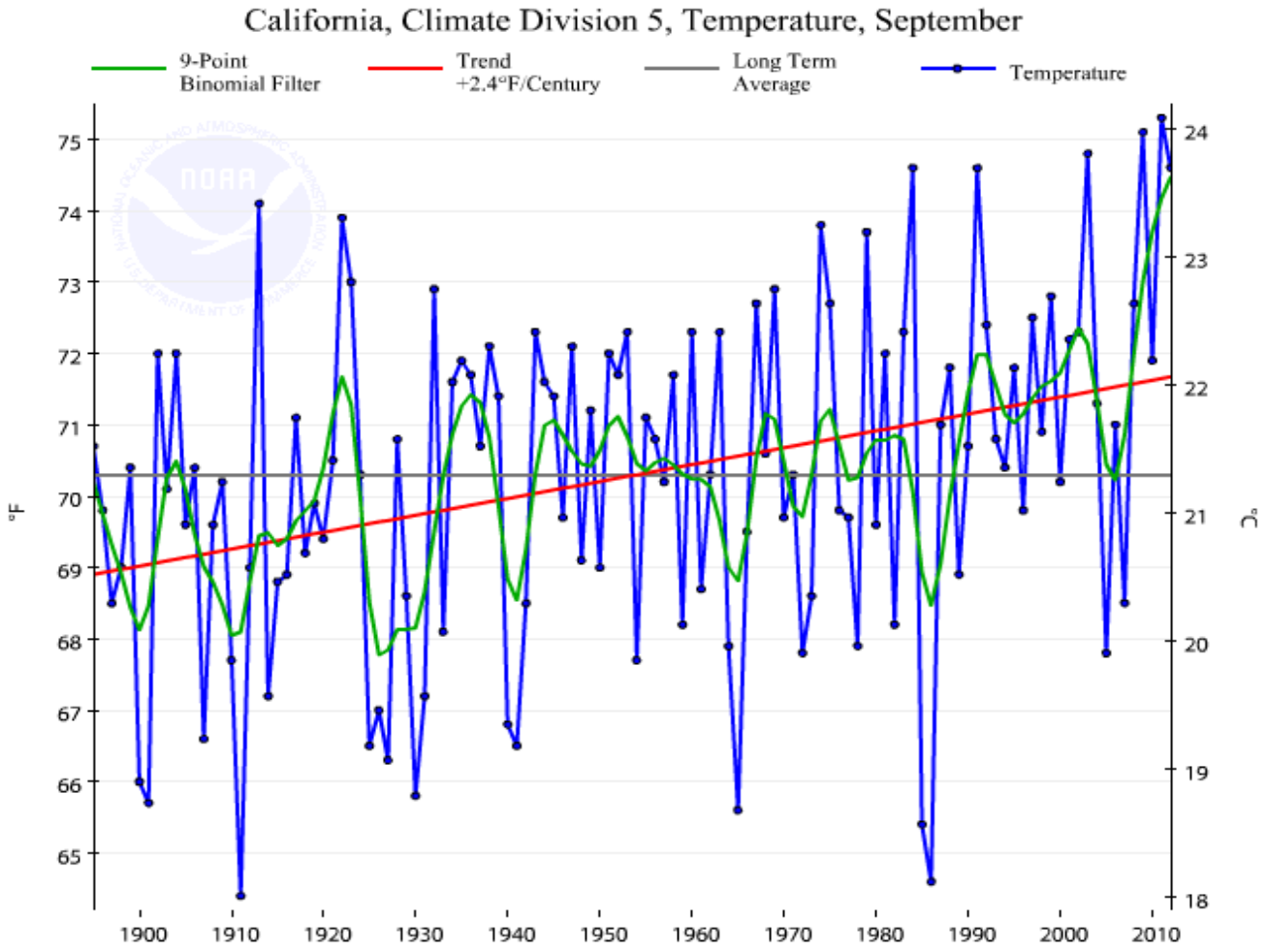
nighttime warming has exceeded daytime warming in last few decades

heat wave incidence projected to become more frequent, intense, durable

"The hottest July…over the historical period becomes a modestly cool July in the future"

Source: Dan Cayan, Scripps Institute of Oceanography, June 2013

California, Climate Division 5
Sept Avg. Temps from 1895-2012



Note: September data shows the largest increase in monthly average temps
Source: National Oceanic & Atmospheric Agency (NOAA)

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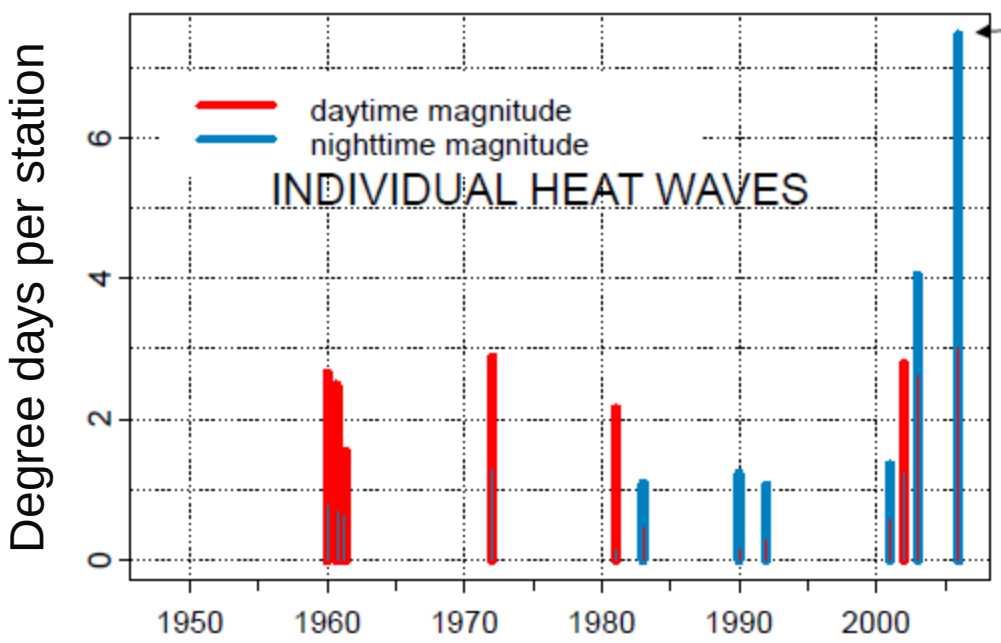
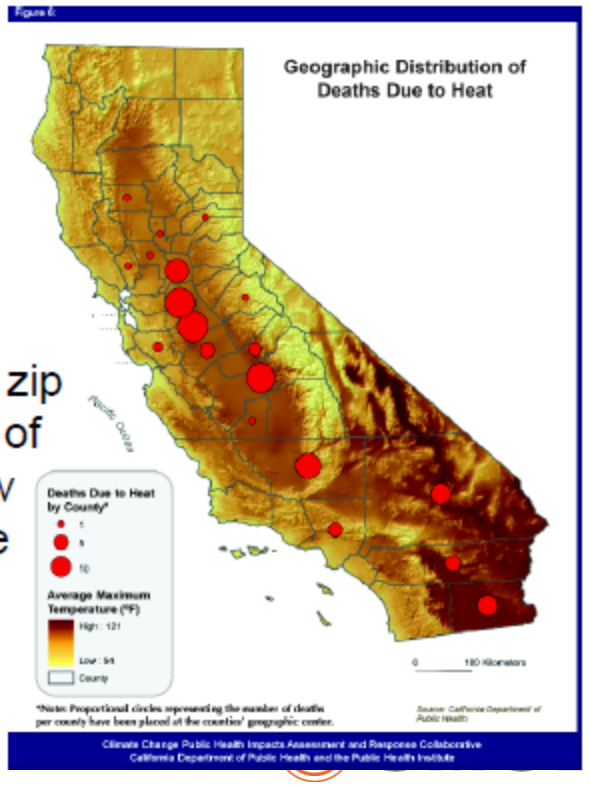
California Heat Waves might be Changing!



The heat wave of July 2006 was an unprecedented deadly event.



California heat wave activity increased during last decade

Specifically, nighttime-accentuated heat waves are on the rise…

99% of cases lived in zip codes where > 50% of residents live below Poverty Guide Line

~600 total excess deaths

Alexander Gershunov Scripps Institution of Oceanography

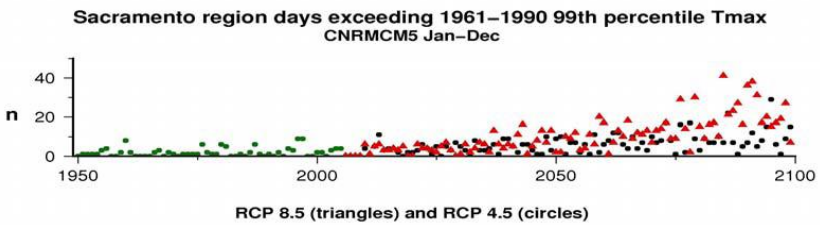
Projected Growth of Heat Wave Occurrence

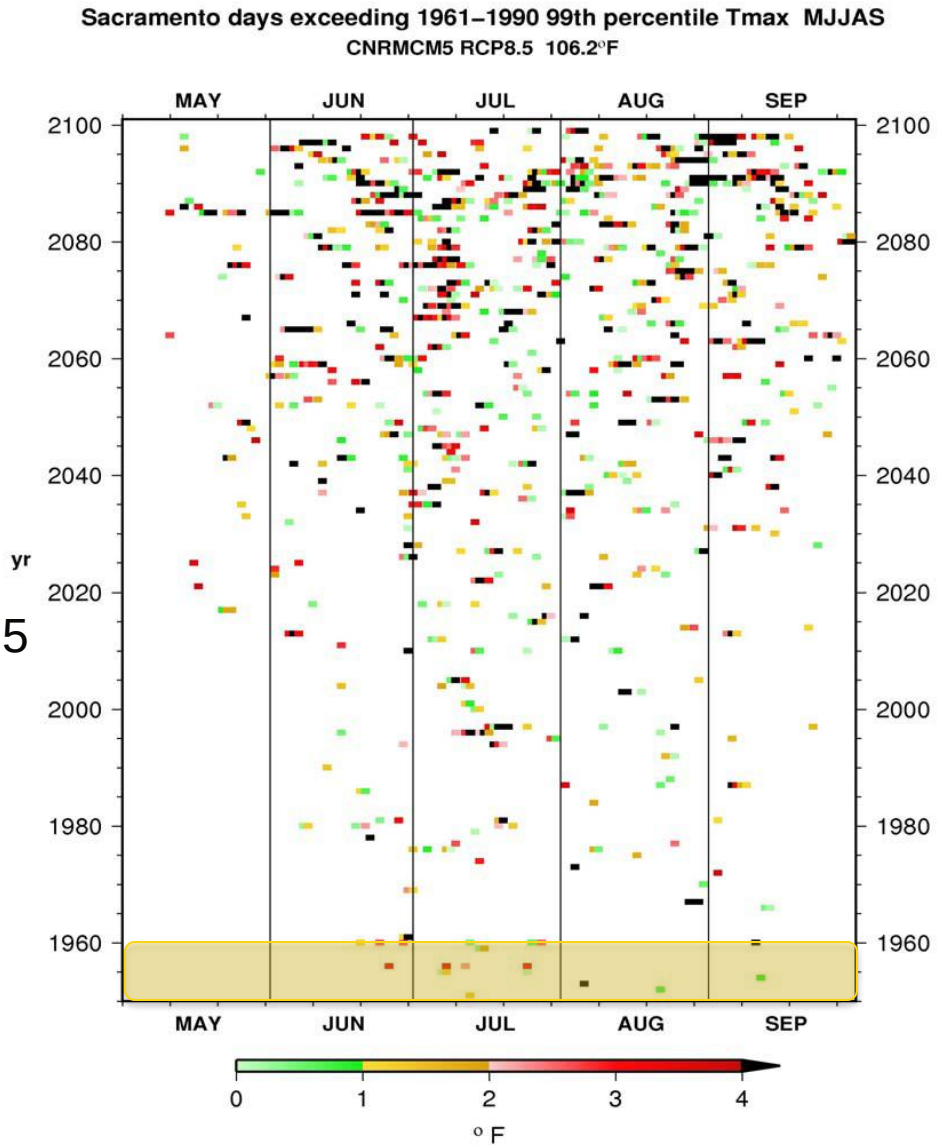
Over 21stCentury, trends toward:

Increased frequency,
higher intensity,
longer duration heat waves

And, trend toward
earlier start and later end
to heat wave season.

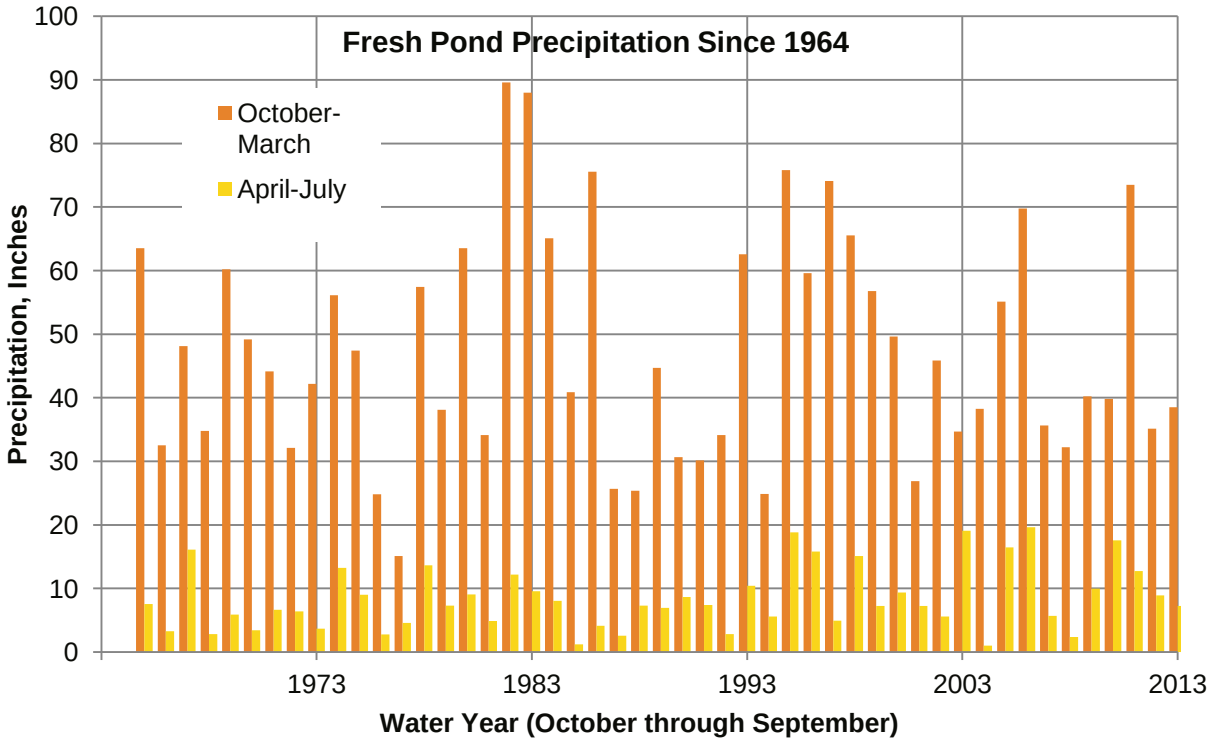
from BCCA downscaled CNRM RCP8.5 simulation





Dan Cayan, Scripps/USGS
Presented to CEC IEPR workshop 6/4/13

Precipitation & SMUD's UARP



No discernable change in fall-winter or spring precipitation over the past 50 years

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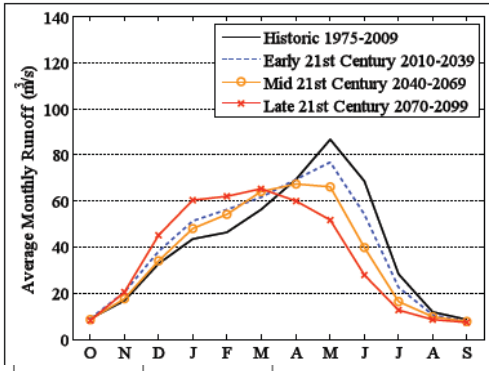
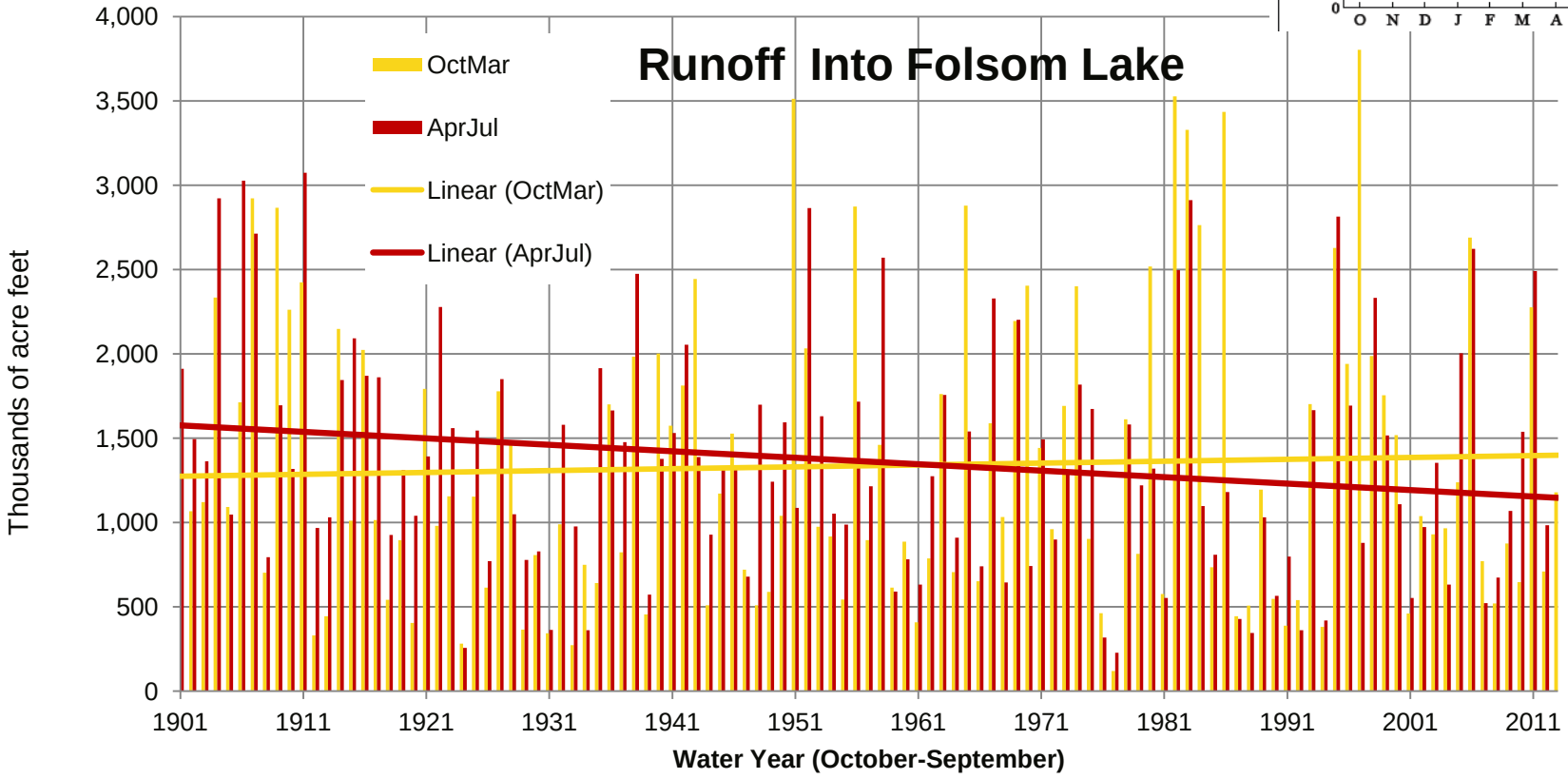
Spring Runoff Downward Trend





Modeled data source: http://www.energy.ca.gov/2009publications/CEC-500-2009-019/CEC-500-2009-019-F.PDF

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Observations & Projected Impacts

	Observed Changes	Mid-Century Projections	End of Century Projections
California Average Temperatures	0.4°C (0.8°F) increase over last century	1.7-2.8°C (3-5°F) increase by 2030	1.6 to 6°C (2.8-10.8°F) increase
Sacramento Area Average Temperatures	0.3°C (0.6°F) increase over last century	0.7 to 2.2°C (1.3 to 4°F) increase by 2050	1.5 to 4.5°C (2.7 to 8.1°F) increase
Sacramento Extreme Heat Days (>101°F)	Average of 13 days annually from 1971 to 2012	Average of 44 days annually by 2050	Average of 85 days annually by 2099

Sources:

1. California Climate Action Team, 2012 (multiple studies)
2. Department of Water Resources, Using Future Climate Projections to Support Water Resources Decision Making in California (May 2009)
3. Sacramento Extreme Heat Days as measured by the National Weather Service Sacramento City weather station. Projections from California Climate Action Team, State of California Extreme Heat Adaptation Interim Guidance Document, Draft for Public Comment, Developed by the Heat Adaptation Workgroup of the Public Health Workgroup, August 31, 2012

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Projected Impacts, Cont.

	Mid-Century Projections	End of Century Projections
Sacramento Annual Precipitation	2 to 19% decrease in overall precipitation	6 to 23% decrease in overall precipitation
Northern Sierra Nevada Snowpack	12 to 42% decrease in April 1 SWE	32 to 79% decrease in April 1st SWE
California Large Wildfire (>500 acres) Occurrence	11 to 55% increase by 2035-2064 period	25 to 128% increase by 2070-2099 period
Wind Patterns	-	-

Sources:

1. Department of Water Resources, Using Future Climate Projections to Support Water Resources Decision Making in California (May 2009)
2. Vicuña, S., J.A. Dracup, L. Dale. 2009. Climate Change Impacts on the Operation of Two High-Elevation Hydropower Systems in California, Draft Paper, California Climate Change Center, March 2009
3. Westerling, A.L. and B.P. Bryant. 2008. Climate Change and Wildfire in California. Climatic Change. 87:S231-S249
4. Studies to date are inconclusive as to the effects of climate change on wind patterns

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Potential Impacts to SMUD Infrastructure and Operations

Ambient Temperatures	• More extreme summertime high temperature events, including daytime and nighttime heat waves • Increased warm season electrical load and peak demand • Reduced thermal and hydroelectric generation • Extreme temperature and variability impacts on system reliability • Increasingly severe "one-in-ten" heat storms effects on overall system reliability • Less efficient operation of transmission and distribution systems, including decreases in facility ratings and loss of operating life
Wildfires	• Projected increase in wildfire frequency and intensity • Potential wildfire impacts to transmission and out-of-district generation sources
Wind Patterns	• Increases or decreases in wind energy production and timing • Increases or decreases in delta breeze cooling capacity
Regional Hydrology	• Effects of changes in temperature and precipitation on snowpack in the Sierra Nevada mountains • Changes in timing and volumes of streamflow and impacts on hydroelectric capacity
Flooding	• Sacramento flood threats • Localized impacts on electricity infrastructure • Indirect impacts on gas transmission infrastructure in the San Francisco Bay Delta region

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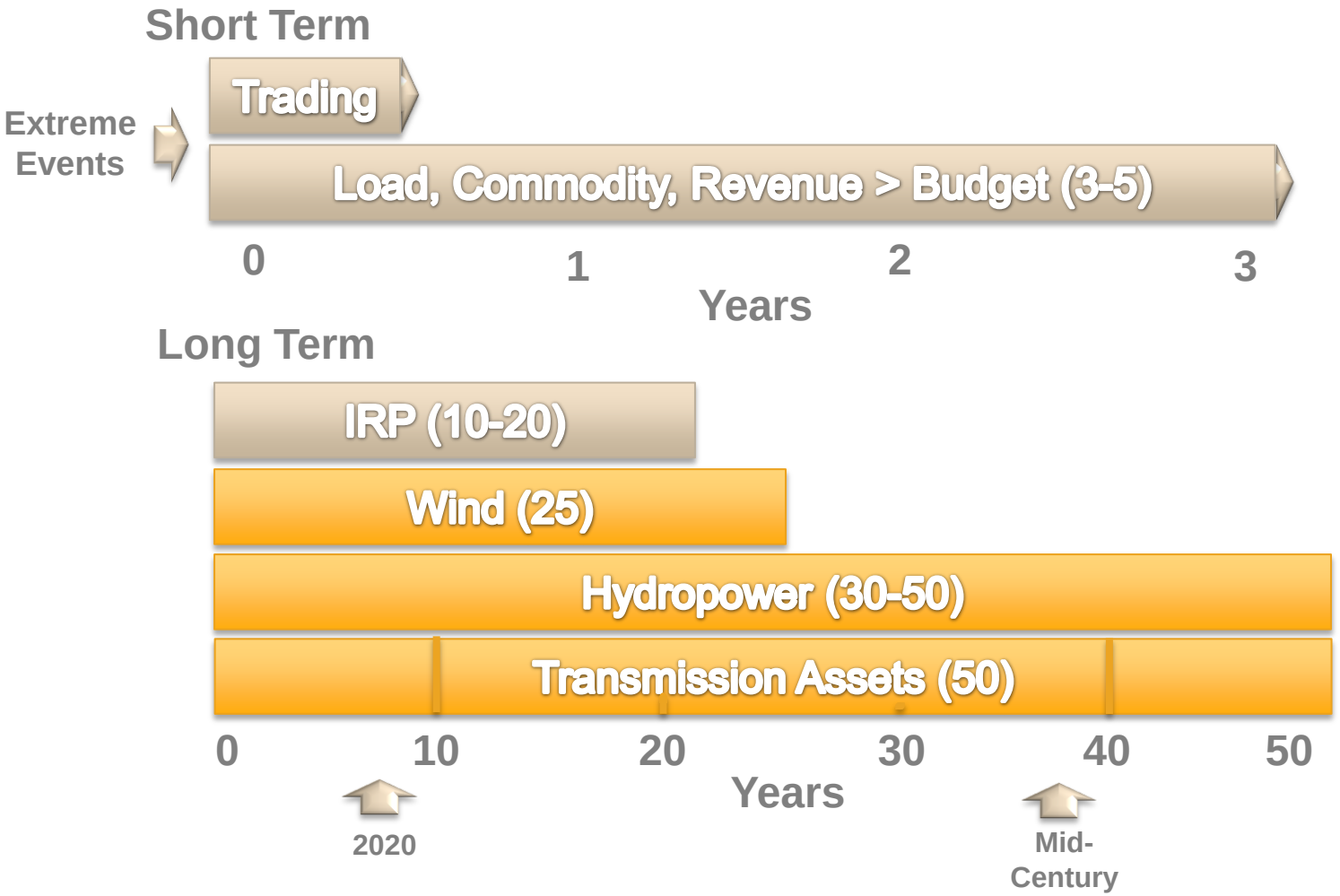
SMUD Planning Horizons & Asset Life Cycles



SD-17 ERM Dashboard – Residual Business Critical Risk Exposure : May 1, 2013

Financial Risks

1.Budget Planning & Rate Setting
2. Financing
2a.Accounting/Financial Report
2b.Capital Availability/Cashflow
2c.Grants Administration
3. Liquidity
4. Price Volatility
4a.Commodity
4b.Interest Rate
5. Project Execution
5a. Solano Phase 3
5b. East Campus Operations
5c.Enterprise Project Portfolio Process
6. Legislative/Regulatory
6a. (Intentionally Left Blank)
6b. NERC/FERC Standards
7.Revenue Collection/Write-offs: Electric Sales, Loans & Theft
8. Volumetric-Weather
8a.Hydro Generation
8b.Retail Load
9. Wholesale Credit Default

Legend: by Risk Heat Zone

- Extremely High Residual Risk
- High Residual Risk
- Medium Residual Risk
- Low Residual Risk
- Extremely Low Residual Risk

Operational Risks

OP: People

10. Employee Safety
10a. Physical Work Environment
10b. Work Processes & Standards
10c. Employee Safety: Work Culture
11. Ethics/Integrity
12. Illegal Acts/Fraud
13. Institutional Knowledge
14. Performance Gap/Skilled Workforce

OP: Systems and IT

15.Applications / System Support
16. Cyber Security
16a. Smart Grid
16b. Electronic Tagging System
16c.Energy Management System
16d.Outage Management System
16e.SAP
17. Information Management
17a. Enterprise Content Management
17b. Enterprise-Wide Compliance Documentation
17c. Smart Grid
18. Systems Development/Integration
19. Systems Infrastructure: SAP Landscape
20. System Relevance and Obsolescence
21. Grid Operational Systems & Support

OP: Process

22.Balancing Authority Operations: Business Disruption
23. Bulk Power Op & Maintenance:
23a. Gas Pipeline Related Assets
23b. Power & Gas Contractual Assets
23c. Power Generation Assets
23d. Transmission Contractual Assets
24. Communications
24a.External Communications
24b.Internal Communications/Alignment
25.Customer Serv Ops: Business Disruption
26. Grid Infrastructures:Business Disruption
26a. T&D Line Assets
26a.i. Underground Cables
26a.ii. Poles
26a.iii. Secondary Network
26b. T&D Substation Assets
26b.i. North City Substation
26b.ii. Station A
26b.iii. Hurley Substation
26c. Telecommunications Assets
26d. New Services
27. (Intentionally Left Blank)
28.General Facilities Op & Maintenance
28a.Customer Service Center
28b.Energy Management Center
28c.Existing Corporation Yard
28d.Headquarter Building
28e.Physical Asset Security
29.Labor: Business Disruption
30. Litigation Liability
31. Nuclear Waste Disposal
32. Operational Efficiency/Effectiveness
33. Payroll Disruption
34. Pricing/Rate Design
35. Public Safety
36. Regulatory Compliance Practices
36a. Environmental Protection
36b. OSHA/Safety
36c. NERC/FERC CIPS Standards 706
36d. NERC/FERC Reliability Standards 693
36e. Compliance - CPUC General Orders
37. Revenue Collection Ops & Maintenance
37a. Meter to Cash
38. Supply chain: Business Disruption

Strategic Risks

39. Business Model
39a. Technology/Competition Driven
39a.i.Distributed Generation/Storage
39a.ii.Electrification of Transportation Sector
39a.iii. Energy Efficiency/Demand Management System
39b. Regulatory Driven
39b.i. Independent Balancing Authority
39c. Large Customer Retention
40. Competitive Workforce
40a.Health & Wellness Benefits
40b.Pension Reform
40c.Salary
40d. Stratgeic Workforce Agility
41. Corporate Governance
41a.Board Driven
41b.GM Driven
42. (Intentionally Left Blank)
43. Enterprise Grant Integration, Execution and Alignment
43a.Customer BU Related Grants
43b.R&D Related Grants
43c.SmartSacramento (AMI+Grants)

Strategic Risks

44.Sustainable Energy
44a.Carbon Emission
44b.Load Serving Capability
44c.Renewable Portfolio Standard
45. Product/Service Development
45a. Smart Grid Customer Interface and on-going integration

External Risks

46. Economy - Business Agility
47. Employee/Labor Relations
48. Legislative/Political Issues
48a. Federal
48a.i Limits on Muni Bond Tax Exemption
48a.ii Cyber Security
48b. Local Gov't
48c. State
49. Media & Community Relations
50. Natural / Other Hazards
50a.Earthquake
50b.Flood
50c.Global Pandemic
50d.Non-Cyber Terrorism
50e.Wildfire
51. Regulatory Changes
51a.Federal
51a.i DOE-PMA Initiative Related Issues
51a.ii Dodd-Frank Implementation
51b.Regulatory Litigation
51b.i FERC Order 1000
51c. State
51c.i Bay Delta Flow Issues
51c.ii RPS Eligibility Related Issues

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Additional Research Needs

- Wind
  - Impact on patterns and speed at our Solano Wind facility
  - Delta breeze patterns and speed
- Temperature granularity
  - Certainty of daytime peak vs. average annual temp projections
  - Increase in nighttime temp?
  - Relationship between extreme and normal peak demands
- Wildfire
  - Modeling of post-fire debris and sediment flows
- Improved downscaling for our climate zone “edge” location

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Potential Phase 2 Projects

- Detailed probabilistic assessment of projected temperature, addressing peak timing, duration, hourly temps
- Map Sac County flood maps to SMUD infrastructure and customer meters
- Assessment of forecast methodologies and hedging strategies to determine if/when to begin including forward looking climate projections or new set points
- Equipment maintenance & lifecycle assessment

Proposed Readiness Next Steps

- Incorporate climate scenarios and readiness findings into long-term planning process (>5 yrs)
- Participate in new Sacramento regional adaptation collaborative and other regional efforts
- Support and help fund new research to help fill significant gaps in current knowledge
- Summarize new scientific conclusions and incorporate into Readiness Strategy every 4 years or as new methodologies warrant

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Questions?

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