Seawater Desalination in California: Promise or Peril

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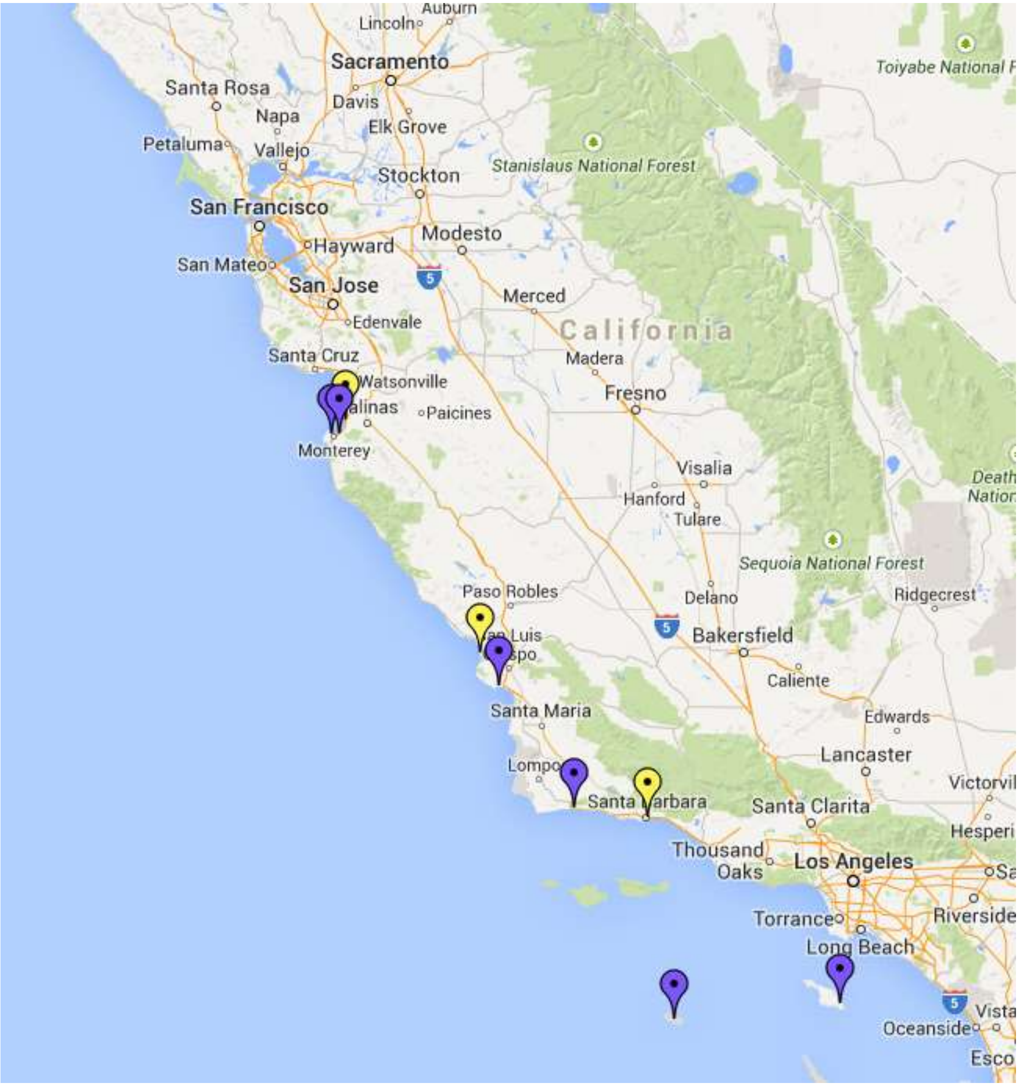
Existing Seawater Desalination Plants



A handful of small plants, mostly for industrial purposes

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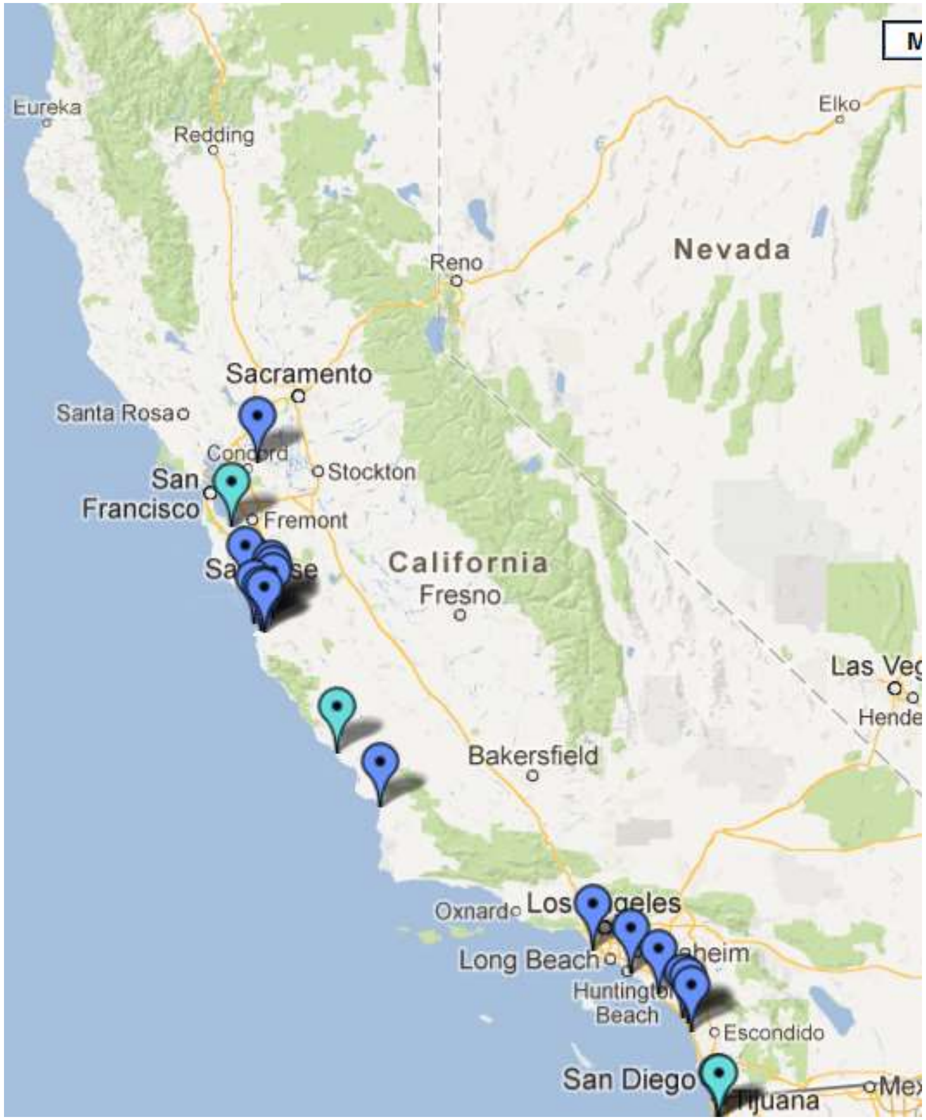
Proposed Seawater Desalination Plants



15 proposed seawater desalination plants along the CA coast

and

2 in Mexico

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Water Supply Diversity and Reliability

- Seemingly abundant new supply of water
- Largely independent of weather conditions, e.g., drought, climate change
- Source diversity
- Local control

Source: DWR website

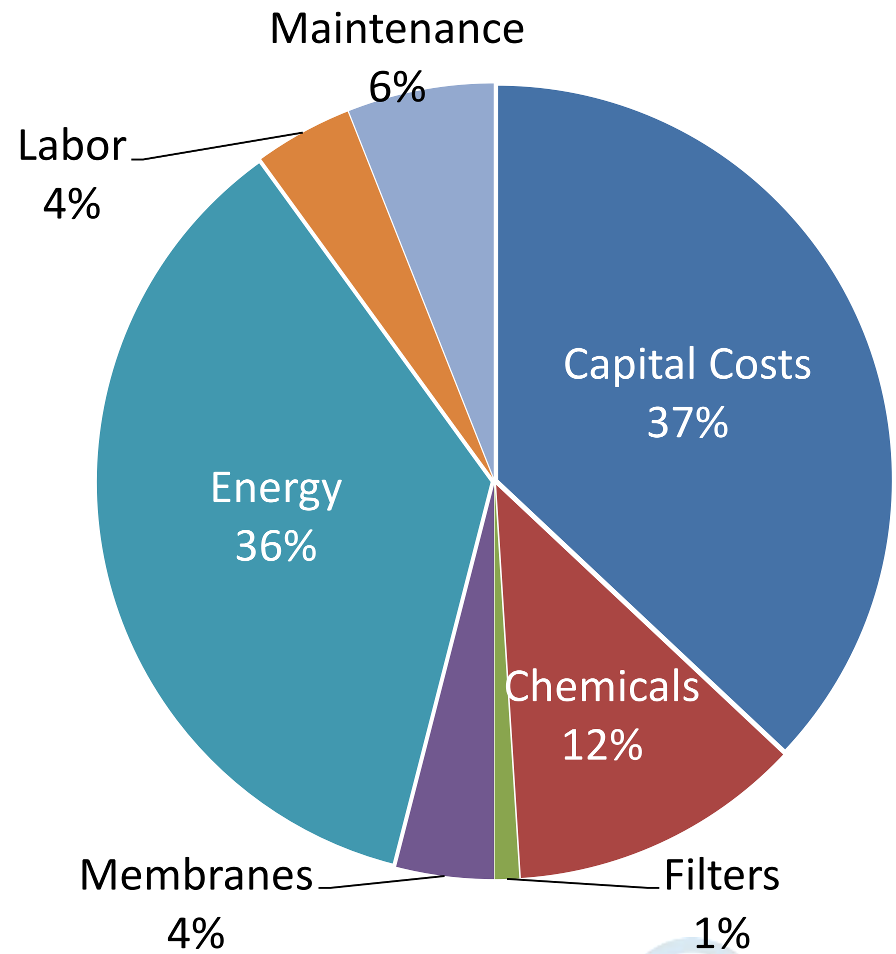
Source: USGS website

Key Outstanding Issues

- Cost and financing
- Energy use and greenhouse gas emissions
- Marine Impacts
  - Intakes
  - Brine discharge

Key Issue: Cost and Financing

- Highly variable and site specific
- California: $1,900 to $3000+ per acre-foot



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Key Issue: Cost and Financing

- Municipal bonds, e.g., revenue and private-activity bonds
- State and federal grants, e.g., Proposition 50 ($22 million for 3 construction projects, 9 pilots and demos, and 5 feasibility studies)
- Low-interest loans, e.g., Proposition 84
- Private equity

What are Some of the Risks?

- Typical project risks - permitting, construction, operation, financial risk, etc.

- Demand risk
  - Santa Barbara, California
  - 4 of the 6 plants built in Australia since 2006
  - Tampa Bay, Florida

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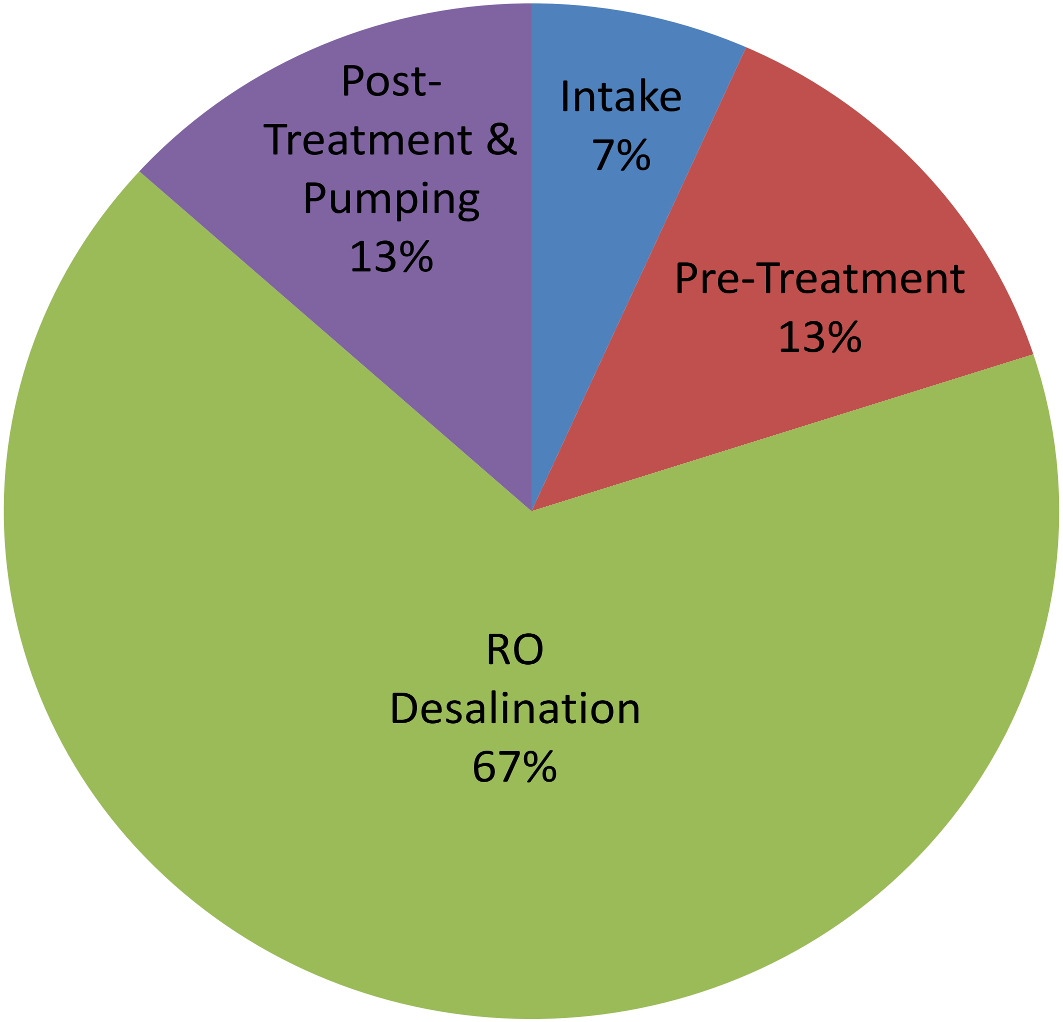
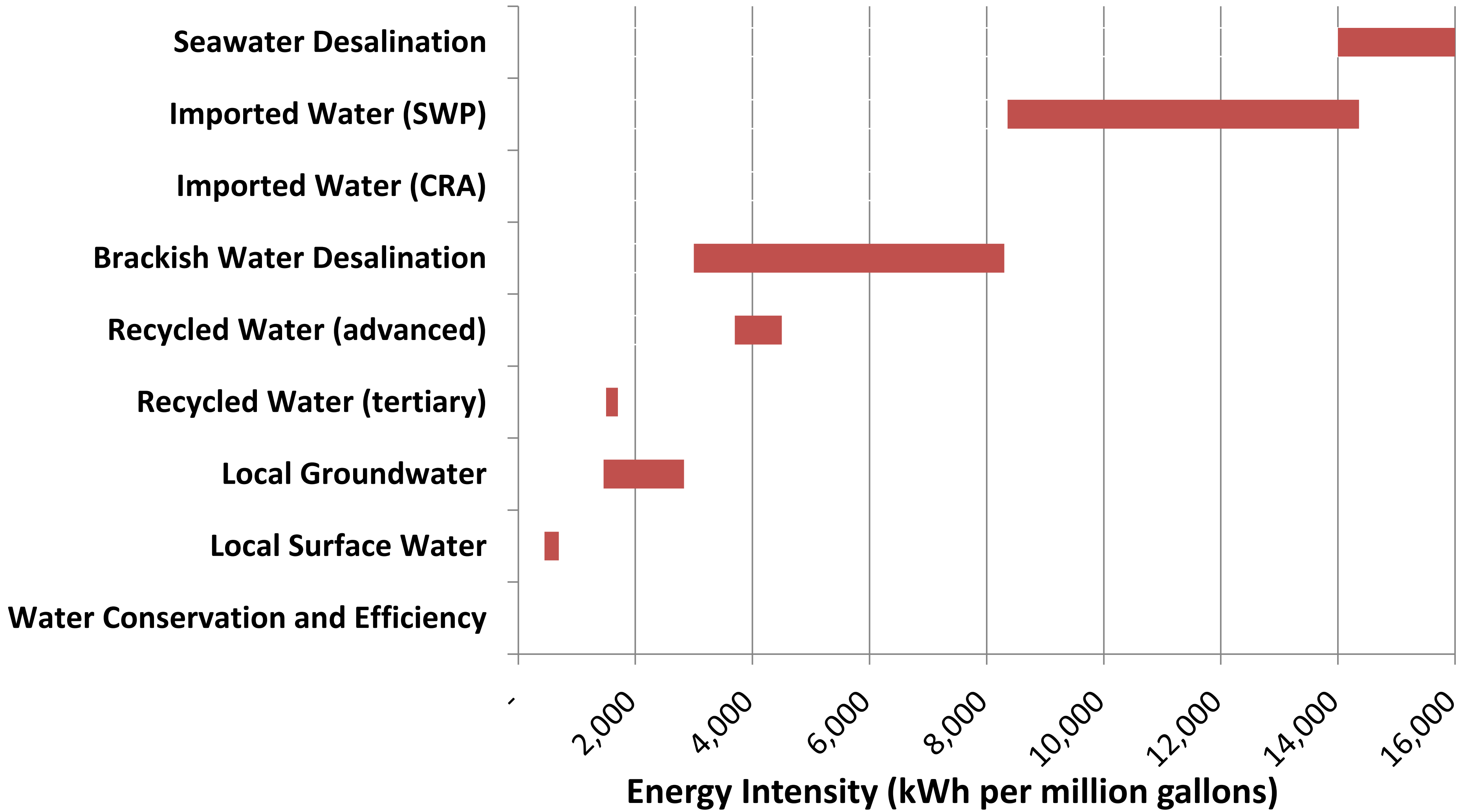
Key Issue: Energy Use and GHG Emissions



12,000 - 18,000 kWh per million gallons

Theoretical minimum for RO is around 3,400 kWh per million gallons for 40% recovery (for RO process only)

Key Issue: Energy and GHG Emissions



Includes extraction, conveyance, and treatment

Key Issue: Energy and GHG Emissions

- Total energy costs are high, leading to increased exposure to short-term and long-term energy price variability.
- Long-term: CPUC estimates that electricity prices will rise by nearly 27% from 2008 – 2020
- Short-term: precipitation affects costs

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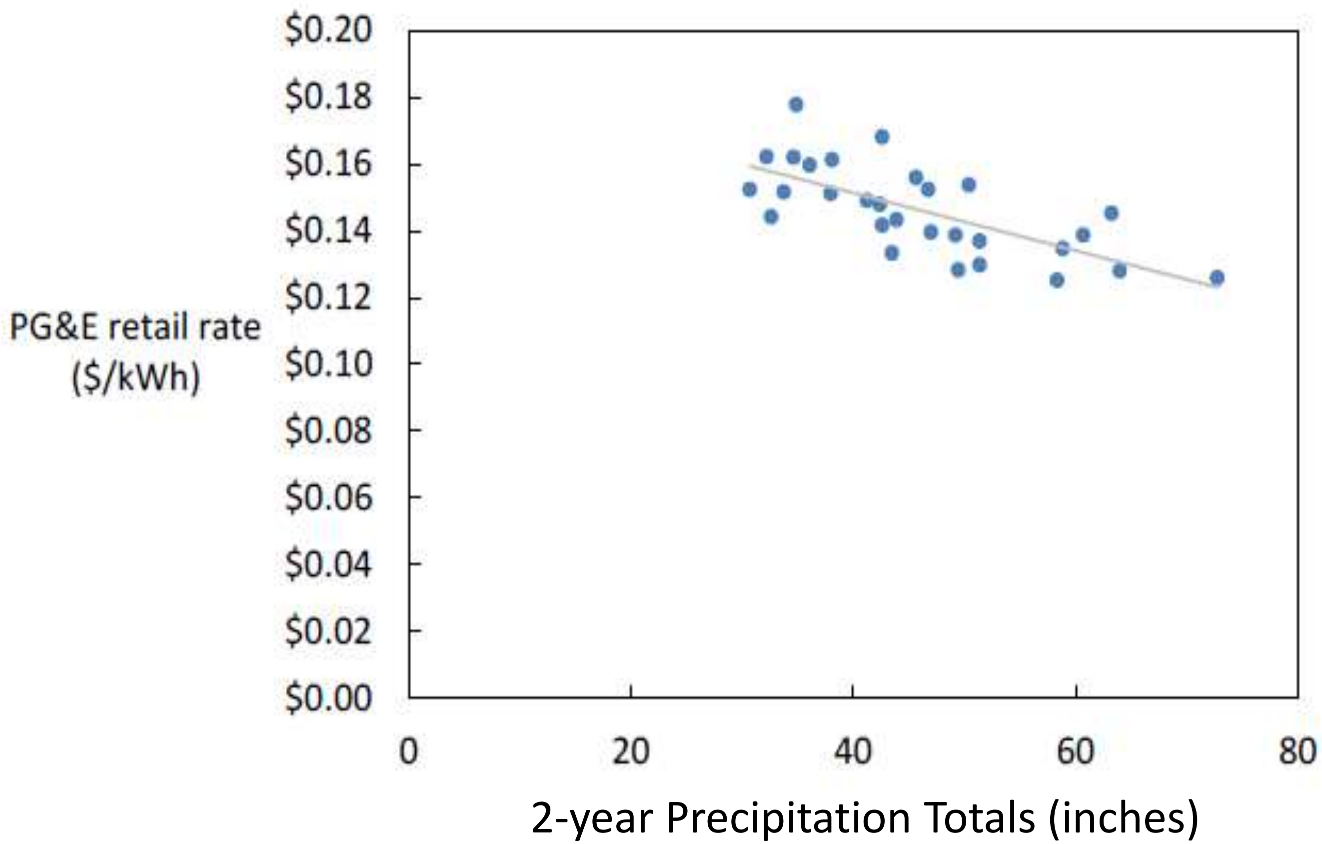
PG&E's Retail Energy Rates Versus California's Two-Year Precipitation Totals for the Two Previous Years, 1982–2010



Trend Tests

Mann-Kendall: ↓ P < 0.001

Pearson: ↓ P < 0.001

Correlation Between Precipitation and Retail Energy Price for Six CA Utilities

	Direction of Correlation	Correlation Coefficient	Pearson's R P-value	Mann-Kendall P-value
Pacific Gas and Electric (PG&E)	↓	-0.69	<0.001	<0.001
Southern California Edison (SCE)	↓	-0.49	0.005	0.003
San Diego Gas and Electric (SDG&E)	--*	+0.31	0.05	0.32
Los Angeles Department of Water and Power (LADWP)	↓	-0.38	0.02	0.03*
Sacramento Municipal Utility District (SMUD)	↓	-0.59	<0.001	<0.001
Burbank-Glendale-Pasadena (BGP)	--*	-0.25	0.15	0.10

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Energy and GHG Emissions

- Global Warming Solutions Act
  - California must reduce greenhouse gas emissions to 1990 levels by 2020
  - 4.8 $MMTCO_2e$ from the water sector

Expanding the state's seawater desalination capacity by 514 MGD would:

- Increase energy use by about 2,800 GWh per year (1% increase above current electricity use)
- Generate 1.0 $MMTCO_2e$ annually (0.2% increase above current emissions)

Measure	Reduction ($MMTCO_2e$)
Water Use Efficiency	1.4
Water Recycling	0.3
Water System Energy Efficiency	2.0
Reuse Urban Runoff	0.2
Increase Renewable Energy Production	0.9
Public Goods Charge	TBD
Total	4.8

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Reduce Energy and GHG Impacts

- Reduce total energy requirements
  - More efficient pumps and energy recovery devices
  - Higher-permeability membranes
  - Alternative desalination technologies, e.g., forward osmosis and membrane distillation
- Reduce greenhouse gas emissions
  - Renewable energy
  - Carbon offsets

Environmental Considerations

- Environmental benefits:
  - Source displacement
  - Climate change adaptation*
- And environmental risks:
  - Construction
  - Intakes *
  - Brine discharge *
  - Development
  - Greenhouse gas emissions *
  - Vulnerable to sea level rise

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Marine Intakes

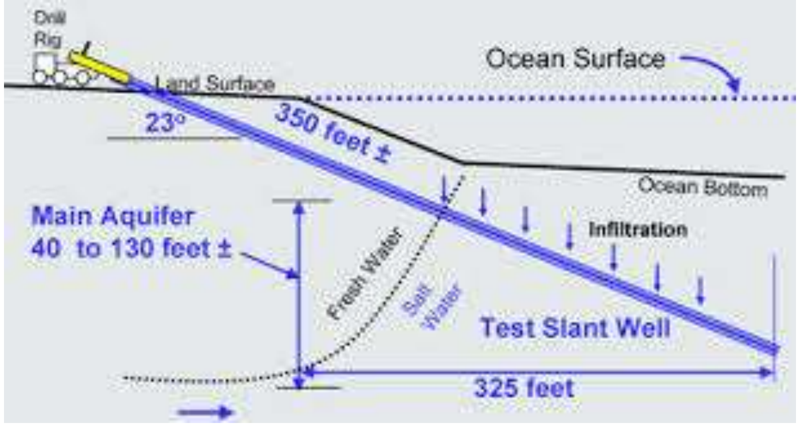
- **<u>Impingement</u>** – fish and other large organisms are trapped on the intake screen, resulting in injury or death
- **<u>Entrainment</u>** – plankton, fish eggs, and larvae, are killed during desalting process
- Impacts not well understood, site specific analysis and ongoing monitoring required

Minimizing Impacts from Intakes

- Design and operational measures
  - Locate in areas with low biological productivity
  - Reduce pumping during critical periods
  - Improve recovery rates

Minimizing Impacts from Intakes

- Technological measures
  - Behavioral deterrents (e.g., strobe lights)
  - Physical barriers (e.g., screens)
  - Subsurface intakes



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Brine Discharge

- Brine
  - Salt, natural seawater constituents, chemical additives, heavy metals
- Brine is denser than seawater, tending to sink to the bottom
- Studies on brine impacts are “extremely limited, often not peer-reviewed, not readily available, or have flaws in the study design.”

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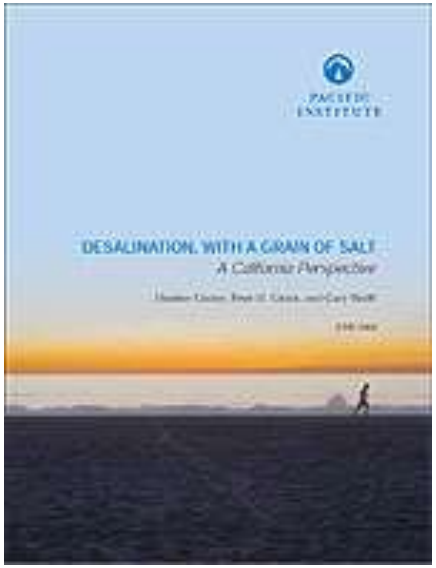
Minimizing Impacts from Brine Discharge

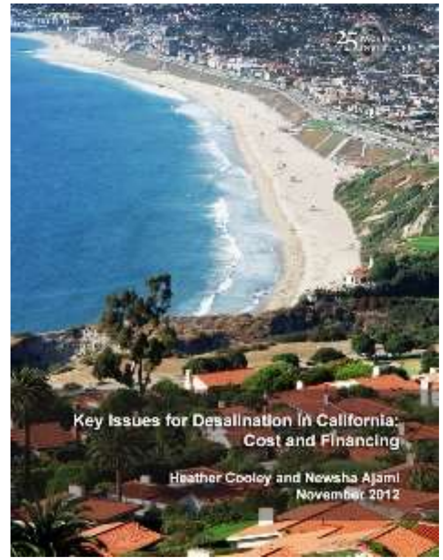
- Well-mixed, offshore environment
- Away from sensitive habitats
- Multiport diffusers
- Dilution
  - Power plant cooling water
  - In-plant dilution
  - Treated wastewater

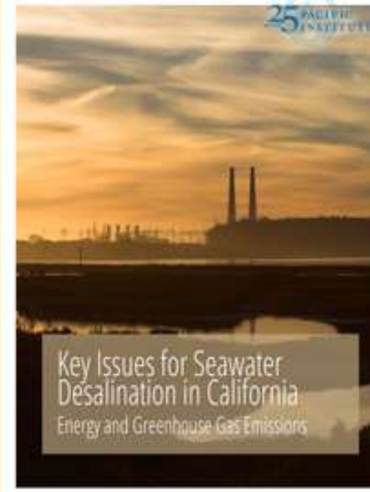
Conclusions

- Seawater desalination is a small component of California's water supply portfolio, although interest in some coastal communities.
- The technology is viable, i.e., it works.
- The key issues are its relatively high cost, energy intensity (and associated GHG emissions), and impacts on the marine environment – all of which must be balanced against the availability of other options.

Thank you!







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