A Water Resilience Portfolio for California

California Water Commission
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Points to Cover

- Resilience
- Climate Challenges
- Key Drivers and Trends
- Energy / Water Nexus and Resilience
- Portfolio and Multiple Benefits

Resilience

Resilience

The ability of a *system* to bounce back.

Three important aspects of the concept of *system resilience*:

sensitivity, adaptability, and vulnerability.

Sensitivity

is the degree to which a system will respond to a change in conditions.

Adaptability

refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes. (Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in conditions.)

Vulnerability

defines the extent to which change may damage or harm a system. (It depends not only on a system's *sensitivity* but also on its ability to *adapt* to new conditions.) .

The Climate Challenge

Potential Climate Change Impacts on Water Resources

Acceleration of the hydrologic cycle and increased precipitation *on a global average* basis.

Increased ratio of rain to snow in mountainous regions, causing earlier runoff and reduced natural storage.

Increased evaporation and transpiration due to warmer temperatures.

Increased frequency and intensity of both droughts and floods due to increased variability.

Increased demand for water due to higher temperatures.

Design for Flexibility

"Governments at all levels should reevaluate legal, technical, and economic procedures for managing water resources in the light of climate changes that are highly likely."

Roger Revelle and Paul Waggoner

Climate Change and U.S. Water Resources, 1990

Dangerous Anthropogenic Interference

"The world is already experiencing 'dangerous anthropogenic interference in the climate system'.

The question now is whether we can avoid catastrophic interference."

John Holdren NCSE Meeting,

Washington, D.C. January 2008

Three Response Options

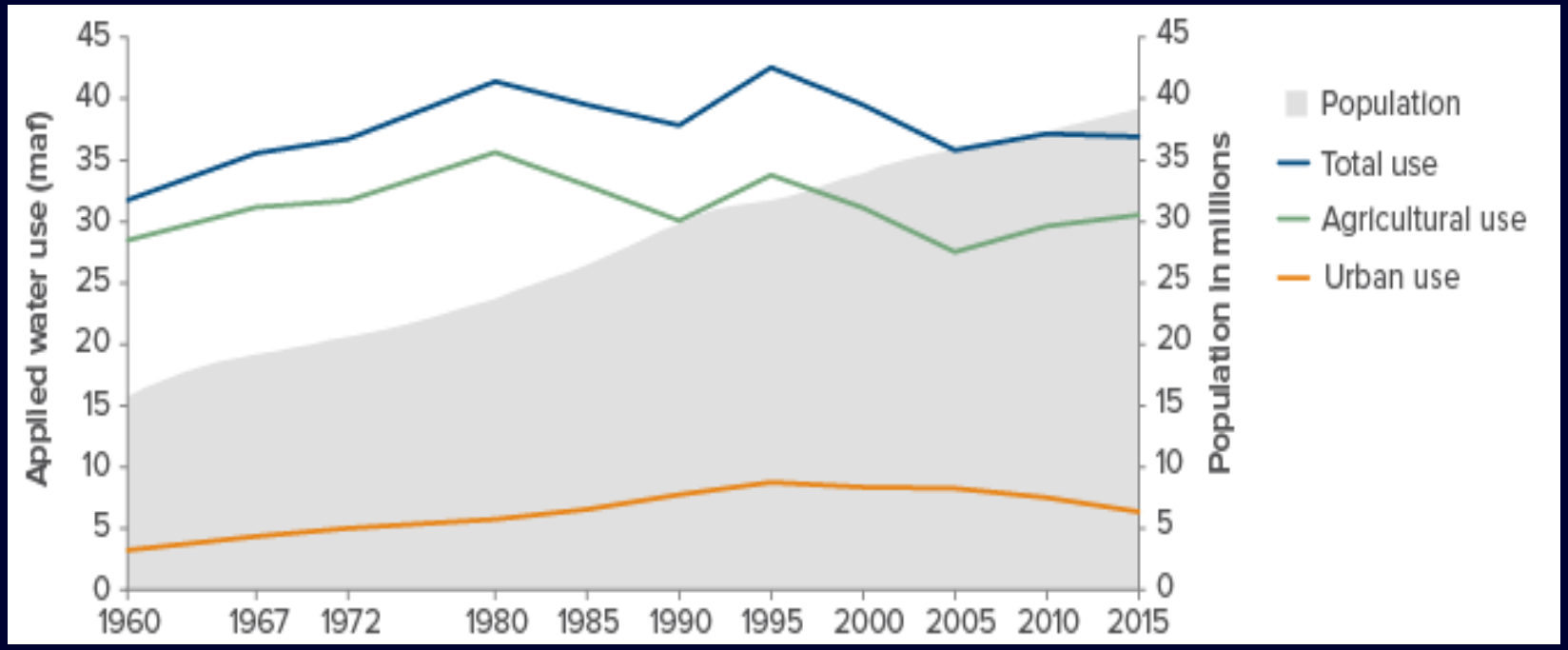
1. Mitigation, meaning measures to reduce the pace & magnitude of the changes in global climate being caused by human activities.
2. Adaptation, meaning measures to reduce the adverse impacts on human well-being resulting from the changes in climate that do occur.
3. Suffering the adverse impacts that are not avoided by either mitigation or adaptation.

Climate Response Strategies In the Scoping Plan

- Water conservation
- Water recycling
- Urban runoff and stormwater

Key Drivers and Trends

California Water Use and Population 1960-2015



Jeff Mount and Ellen Hanak, Water Use in California, PPIC, 2019. https://www.ppic.org/publication/water-use-in-california/ Water use: *California Water Plan Updates* (Department of Water Resources, various years). Population: Department of Finance.

Fresh Water and Population

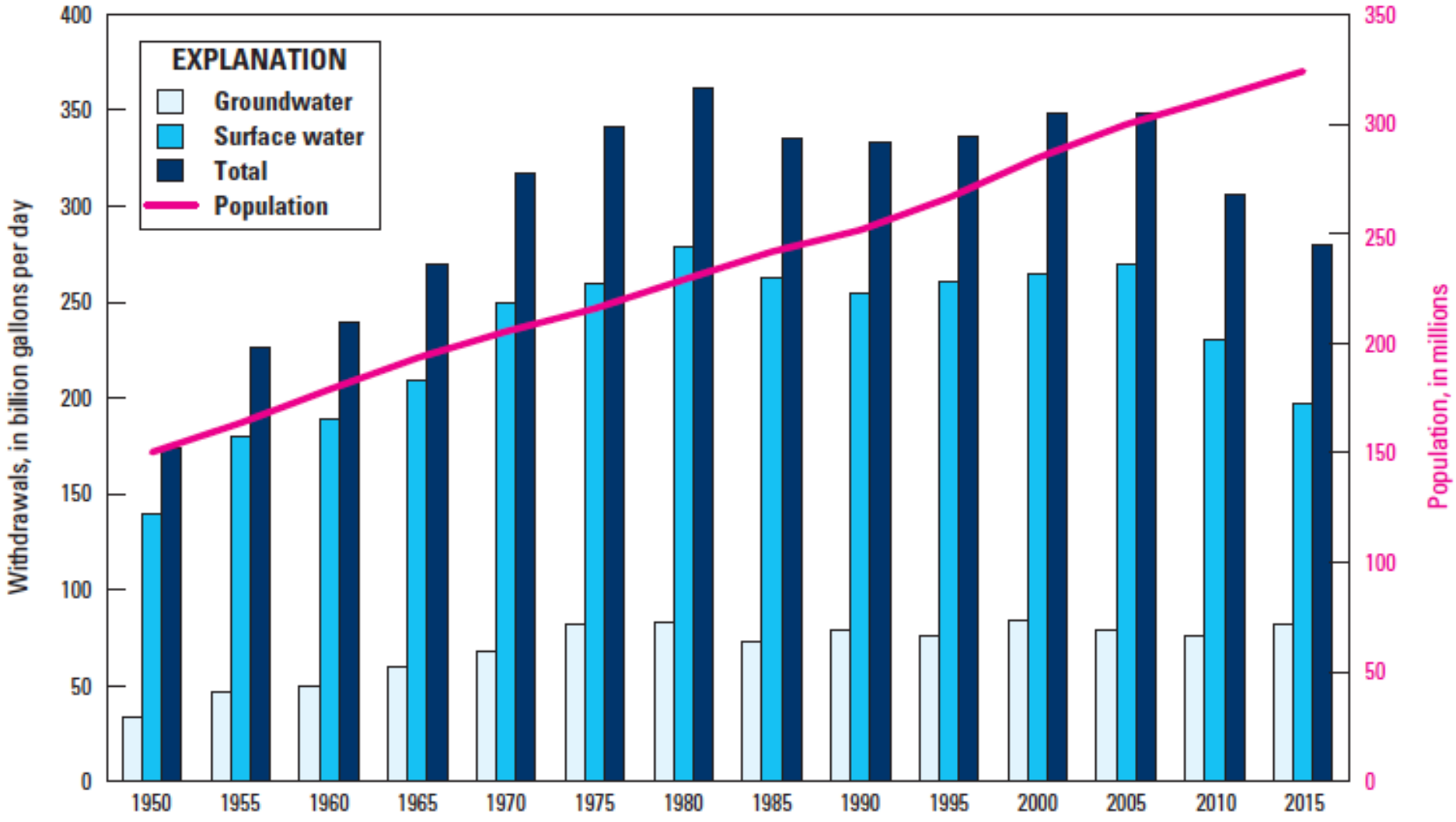


Figure 15. Trends in population and freshwater withdrawals by source, 1950–2015.

Water Withdrawals by End Use

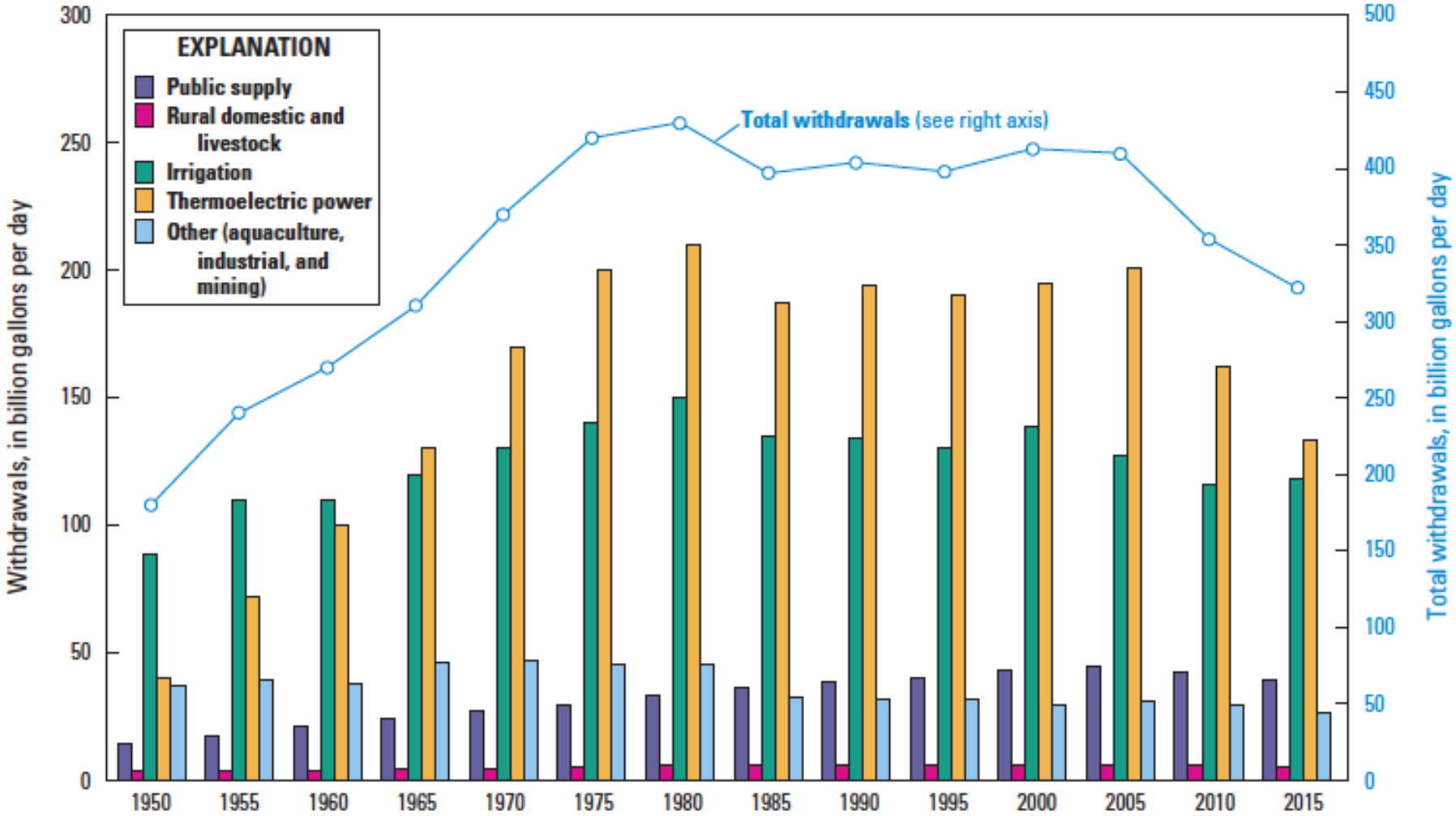
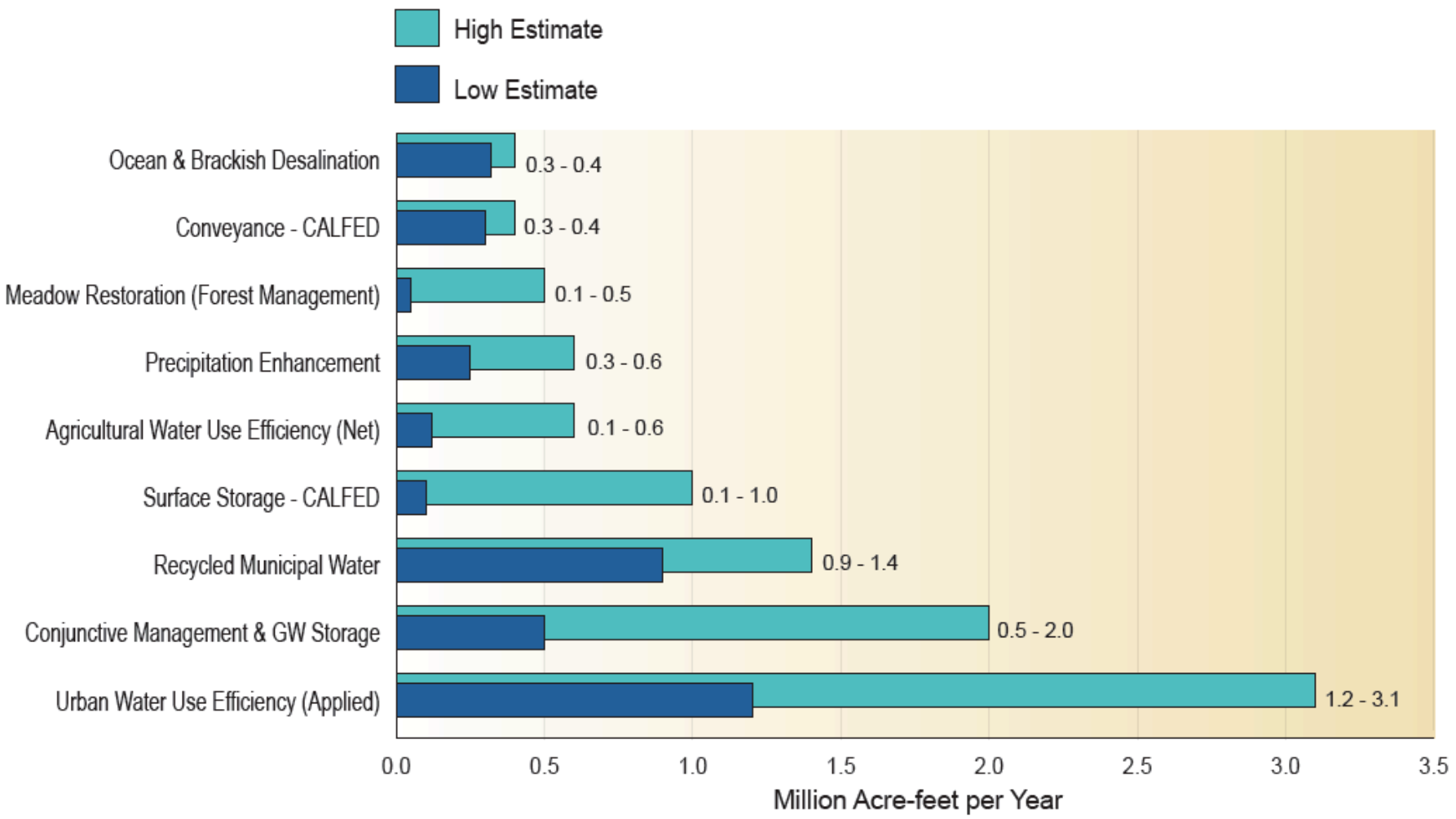


Figure 16. Trends in total water withdrawals by water-use category, 1950–2015.

Water Supply Sources to 2030: DWR B-160 09

Resource Management Strategies



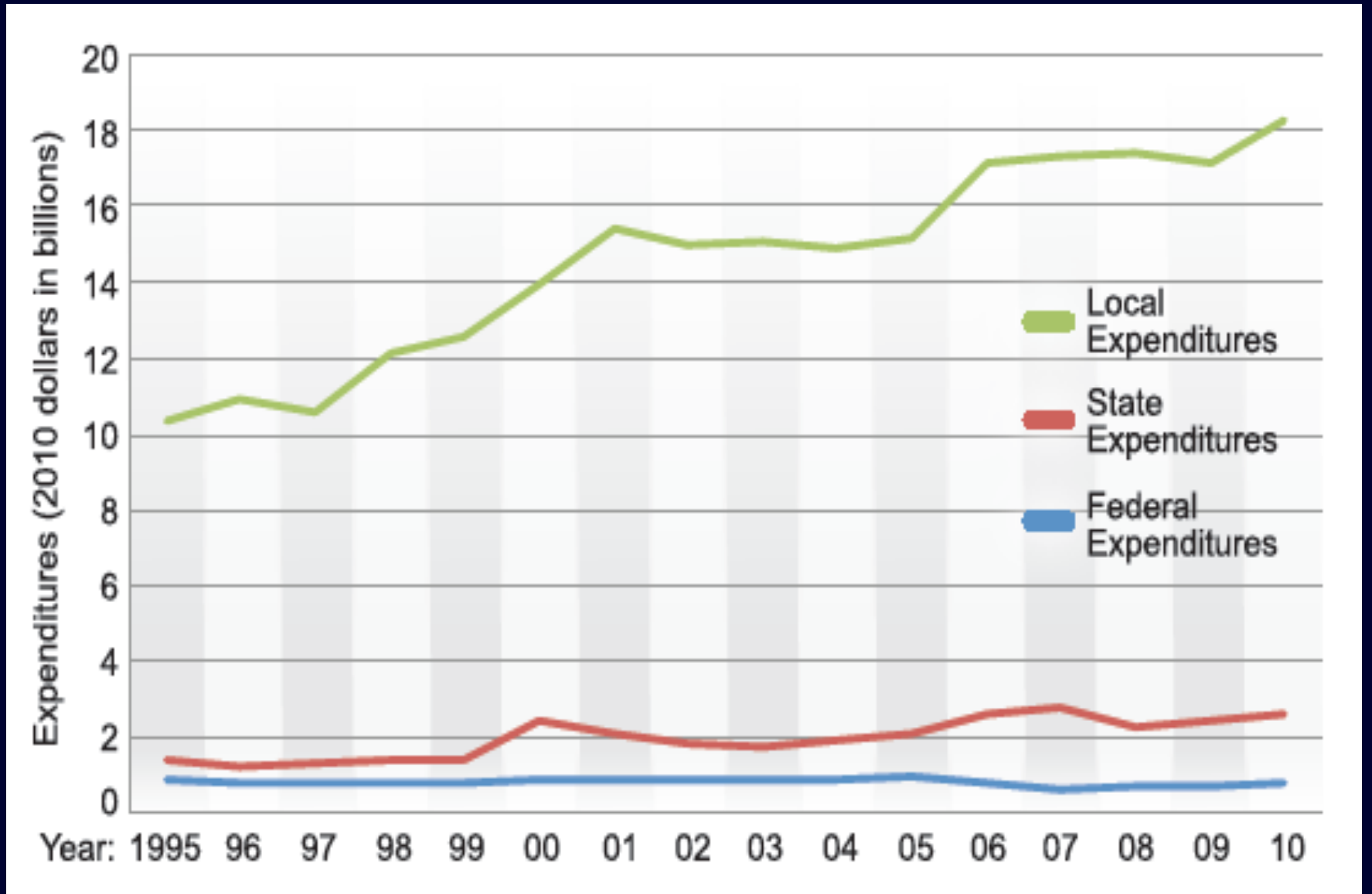
Three Key Drivers

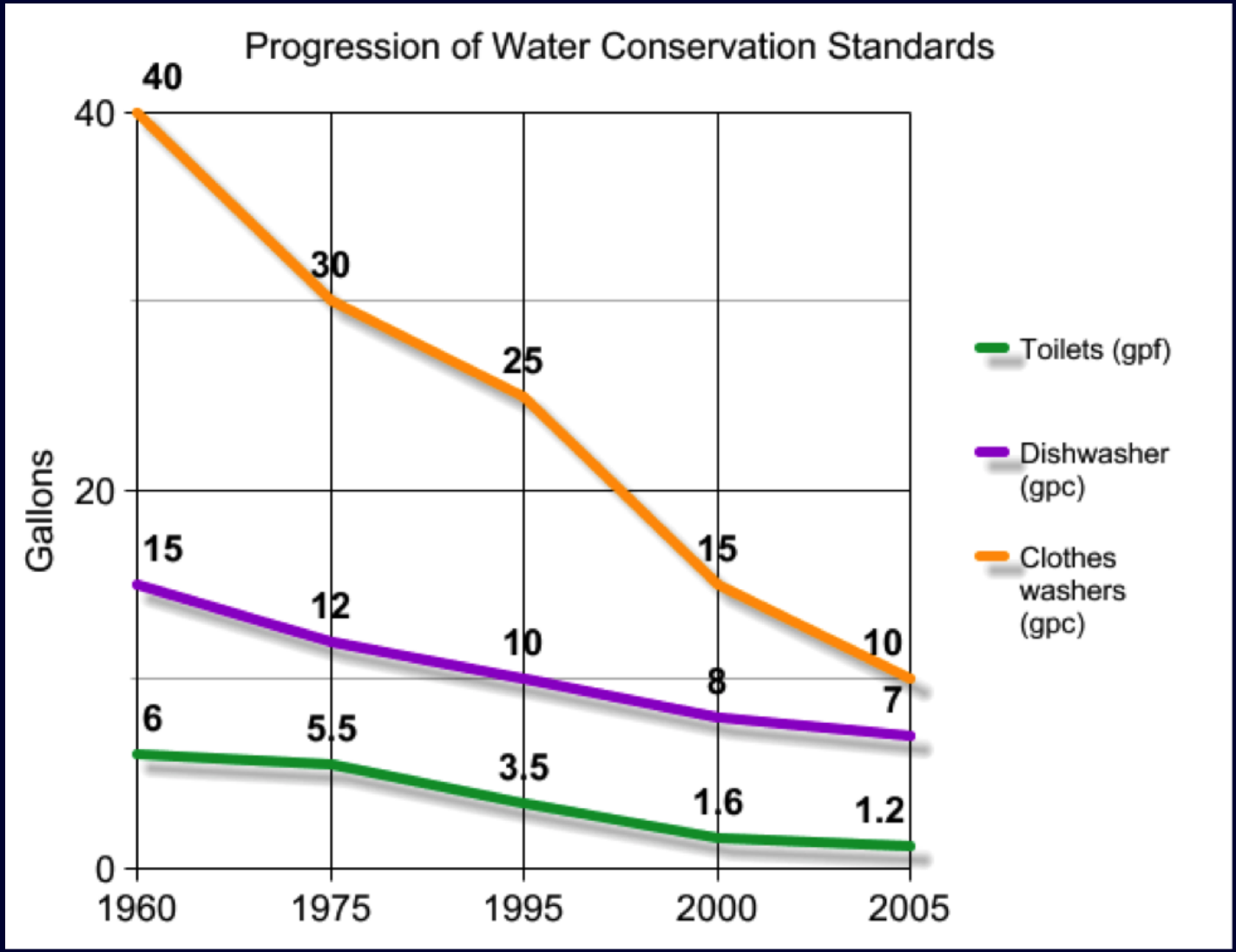
- Technology
- Economics
- Policy

Some Key Trends: Energy and Water

- increasing number of decentralized options
- *diseconomies* of large scale
- local supplies are increasingly viewed as the most cost-effective and reliable marginal sources
- local funding is paying most of the cost

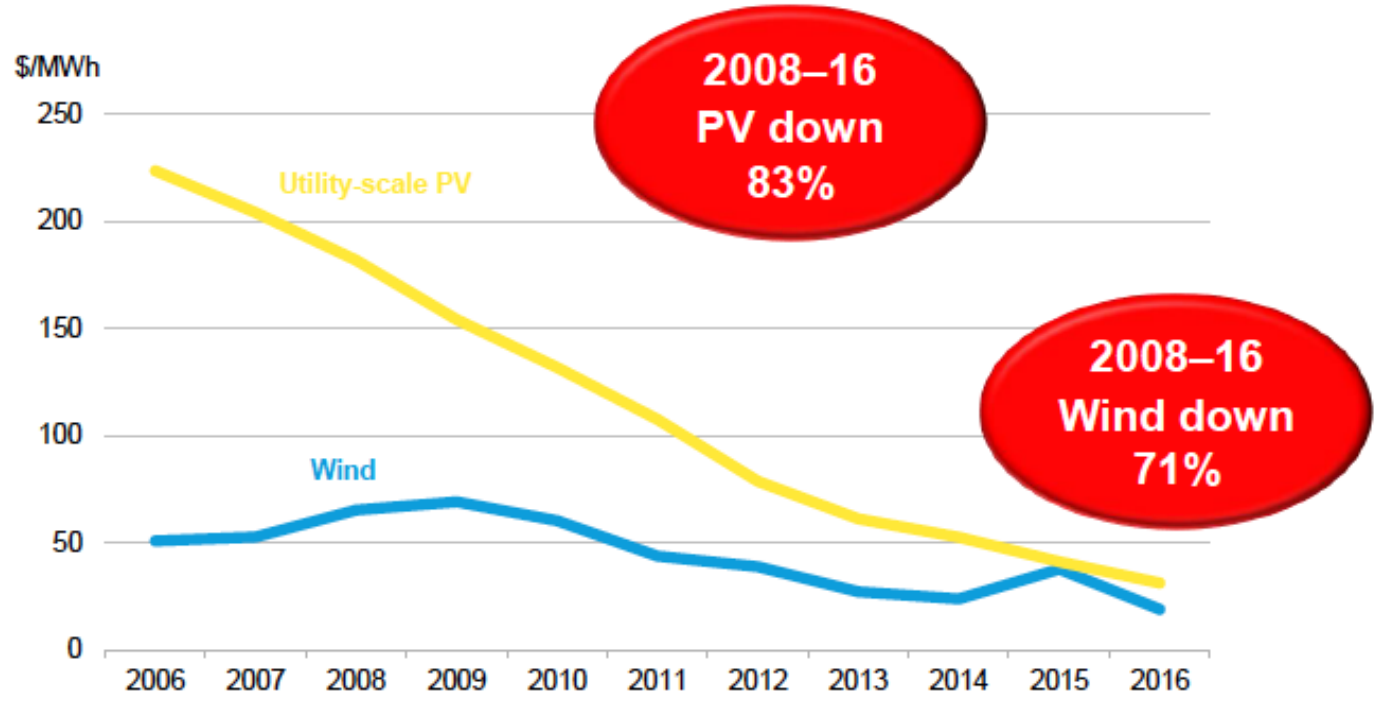
Water Infrastructure Funding





Water efficiency standards in common residential uses shows the increase in efficiency over past 50 years. Source: http://www.watercache.com/education/

Average US renewable energy PPA prices

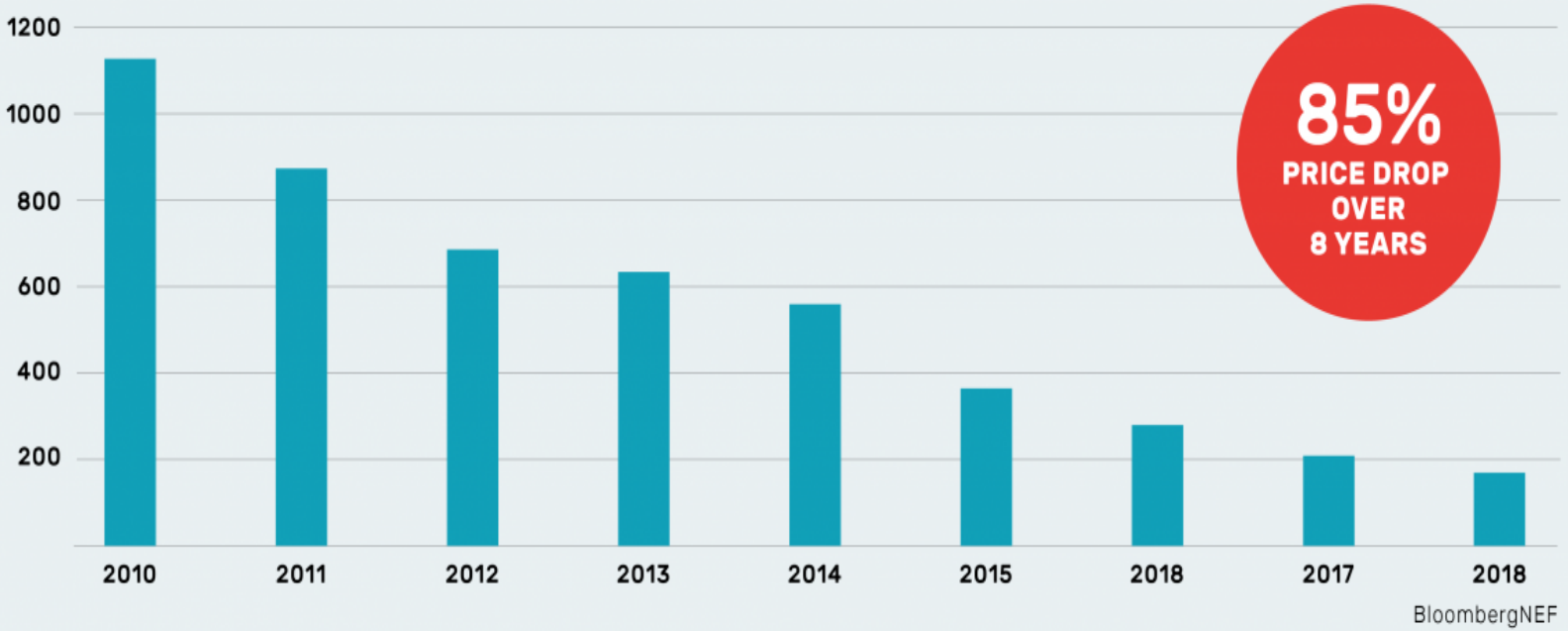


Note: Levelized, time-of-day adjusted contract price shown in real 2015 USD. 2016 PV PPA price based on preliminary data and subject to review.
Source: U.S. Department of Energy (LBNL), Bloomberg New Energy Finance

Lithium-Ion Battery Price Survey Results

Volume Weighted Average

Battery Pack Price (Real 2018 $/kWh)



BloombergNEF

The Energy / Water Nexus

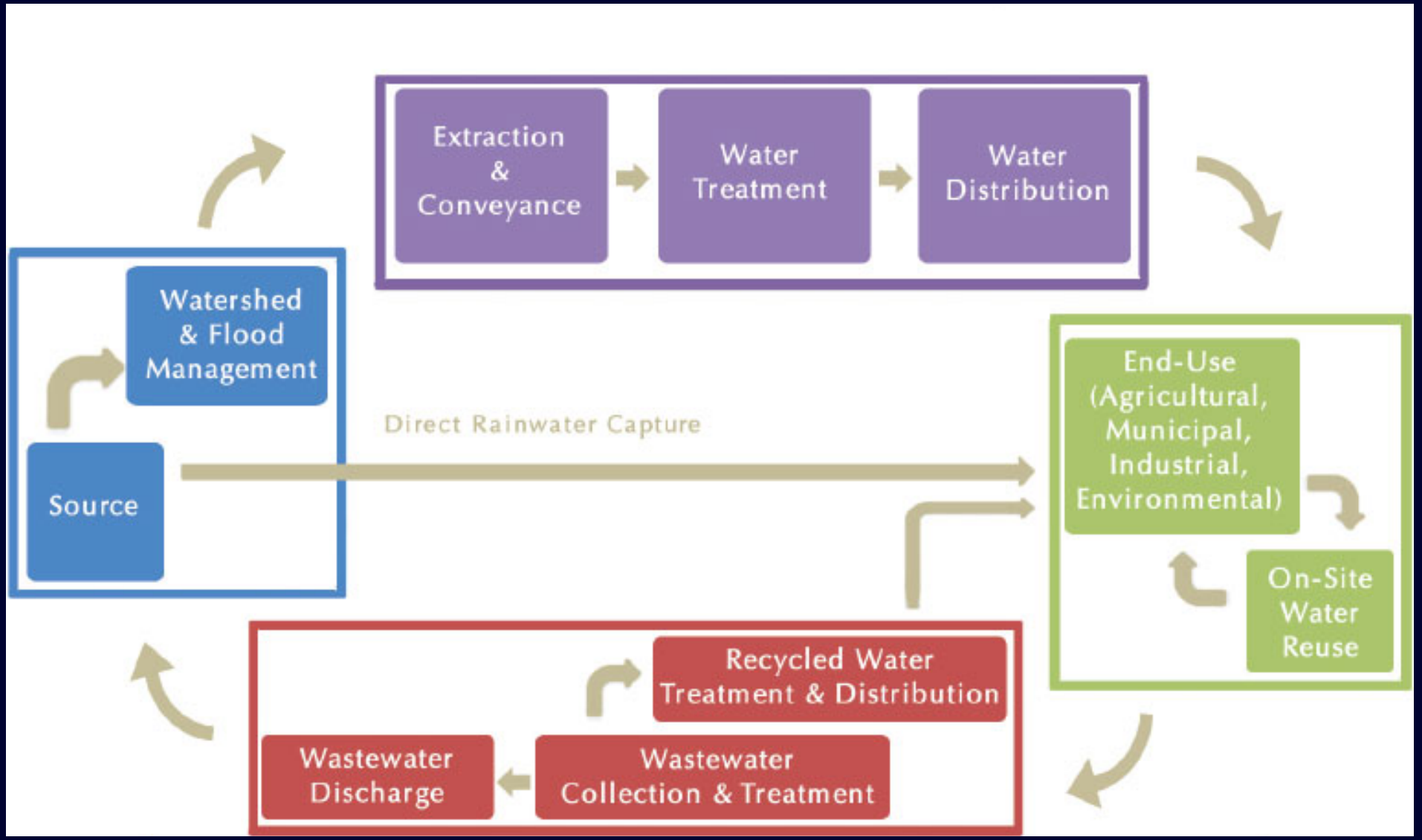
Energy Intensity of Water

California:

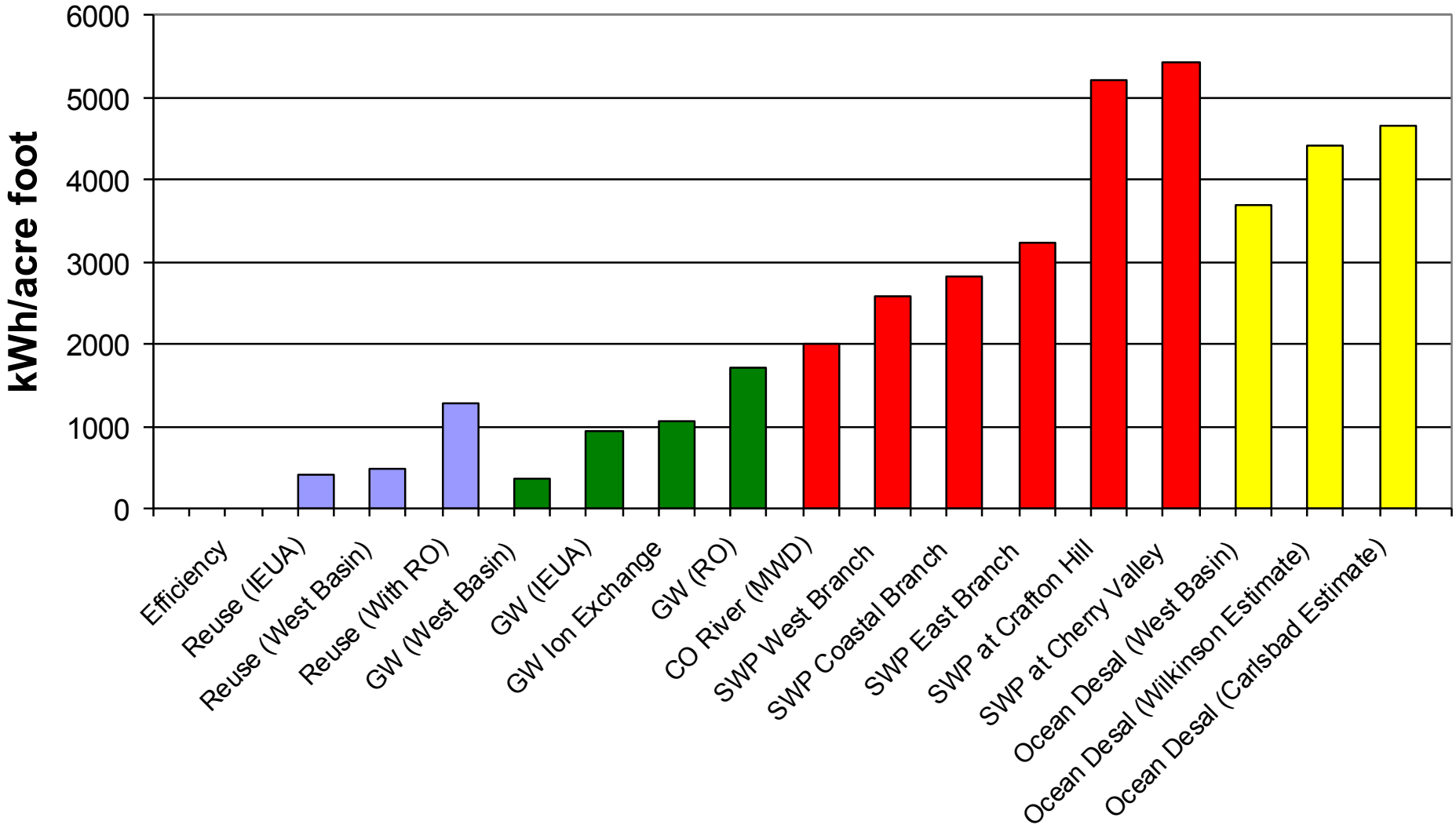
19% electricity

33% natural gas (non-power plant)

Water Use Cycle



Energy Intensity of Selected Water Supply Sources in Southern California



A Portfolio for Resilience

California Environmental Dialogue

"The protection, enhancement, and restoration of California's watersheds, riparian stream zones, and wetlands will reduce the need for costly new water treatment plants, provide high quality drinking water at reduced cost, reduce the costs of flood damage, and improve water quality for aquatic ecosystems and human recreation."

CED, *Habitat and Prosperity: Protecting California's Future*, 1998

Portfolio Logic

Portfolios include diverse elements, but “portfolio” goes beyond “diversity”.

Framing Challenges: Integrating Solutions

Is the challenge getting more water, or is it finding ways to meet demands for water services in cost-effective, equitable ways while avoiding environmental impacts and restoring natural systems?

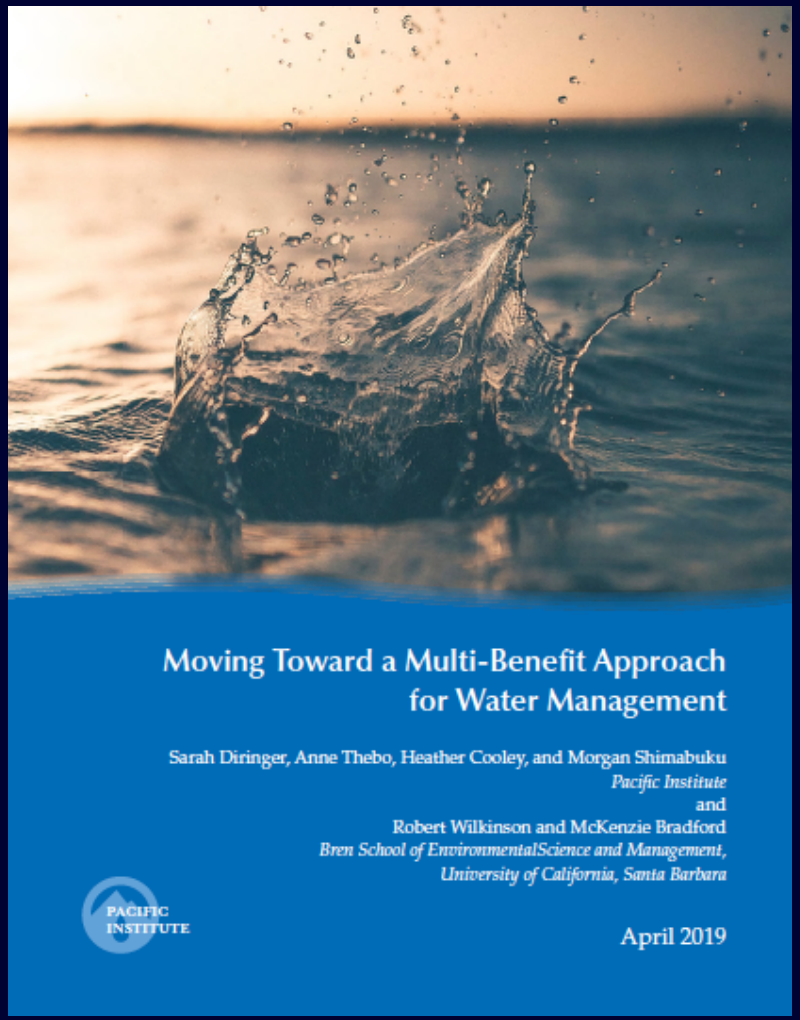
New Approaches

- Multiple benefits analysis as a basis for investments and decisions
- Integrated and collaborative approaches

Multiple Benefits

1. Identify Costs and Benefits
2. Quantify (where possible)
3. Value (where possible)

Moving Toward a Multi-Benefit Approach for Water Management



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