Opportunities for Demand Response in California Agricultural Irrigation

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Agenda

- Energy Data for California Agricultural Irrigation
- Potential Solutions for Demand Response and Permanent Load Shifting
- Potential and Challenges for Acceptance of Demand Response and Permanent Load Shifting
- Permanent Load Shifting vs. Demand Response

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ENERGY DATA FOR CALIFORNIA AGRICULTURAL IRRIGATION

Energy Data for California Agricultural Irrigation

- Annual electrical energy consumed by California agricultural irrigation is approximately 10 billion KWhs.
- The “on-farm” component, the main focus of this presentation, accounts for nearly 75% of the total.
- Virtually all of it is consumed during the months of highest grid stress.

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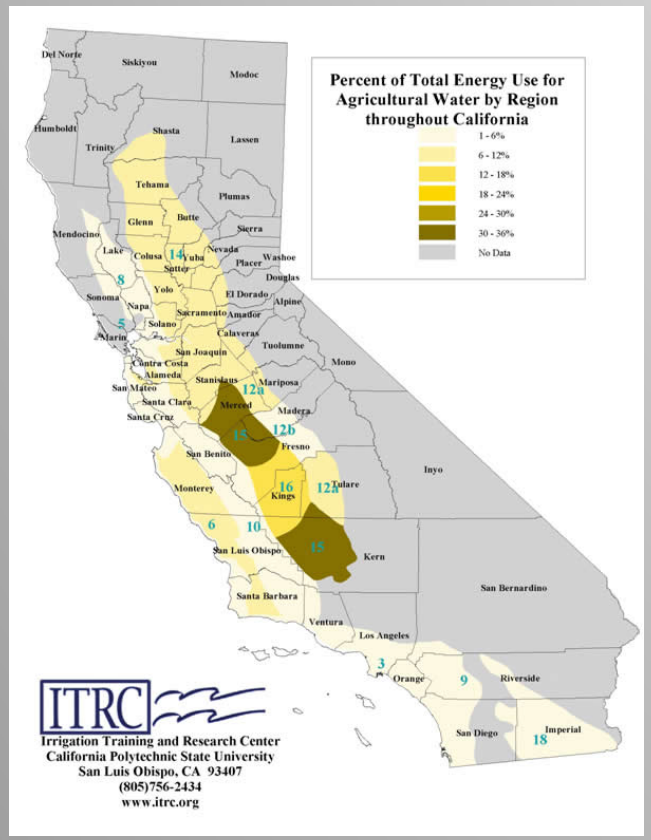
Additional Background Data

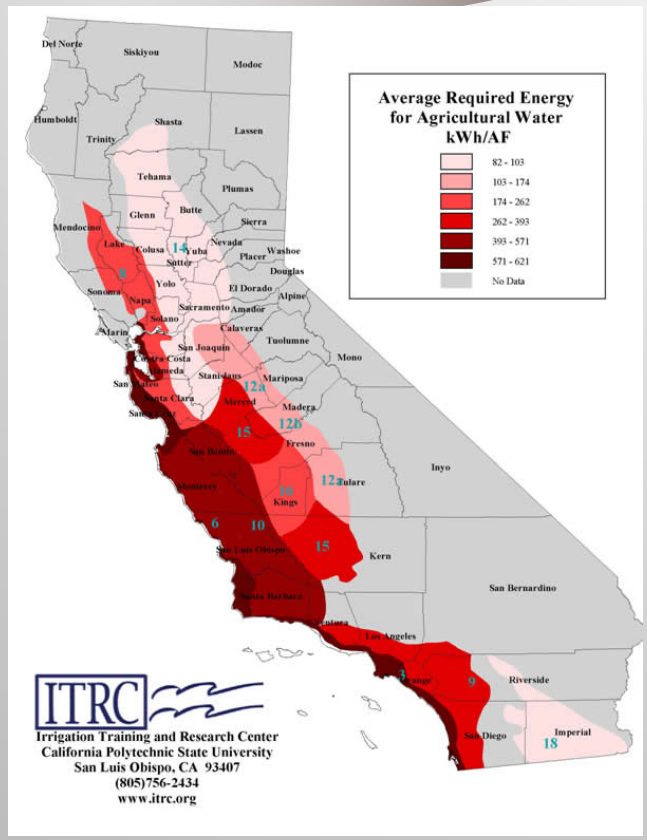
- 50,000 Irrigated Farms
- 100,000 Irrigation Pumps
- 8 Million Irrigated Acres
- 30 Million Acre-Feet Applied Annually

Pareto Principle Regional Skews

Energy Use by Region

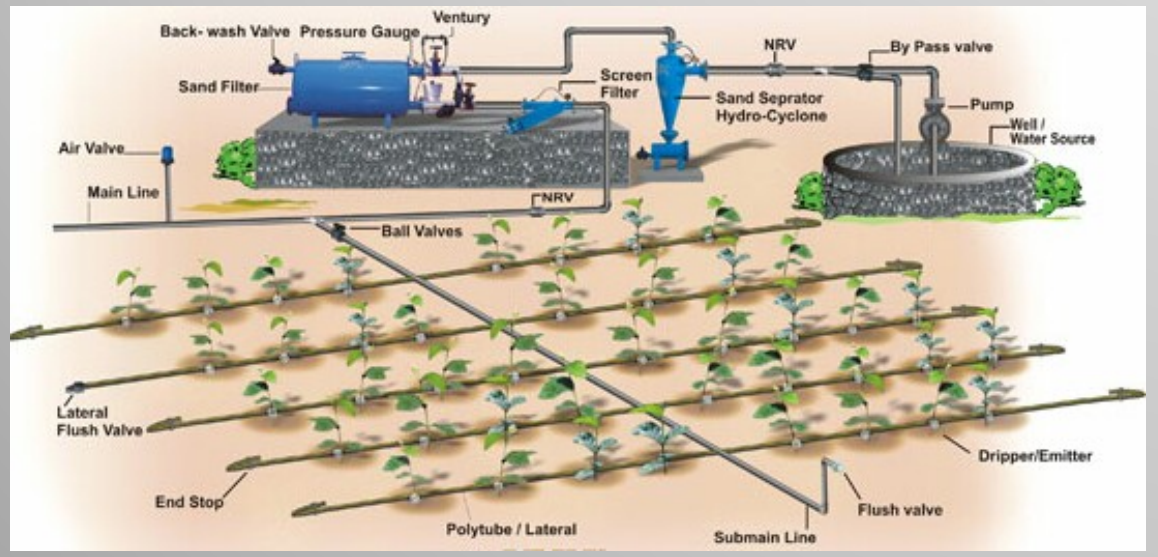


Energy per AF of Water



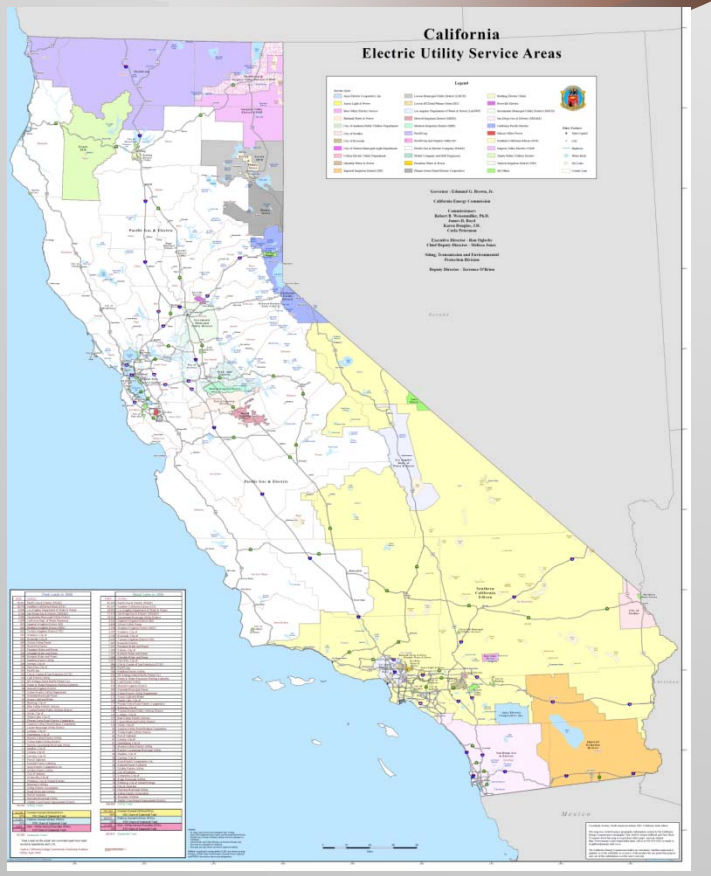
Skews and Trends by Water Source and Irrigation Method

- Greatest energy use comes from on-farm sources, especially on-farm ground water sources.
- There is a continuing trend toward drip/micro irrigation, which saves water but actually ***increases*** energy use.
- These two reinforce one another.



Pareto Principle of Grower Size and Utility Coverage

- Approximately 14% of the farms irrigate 84% of the acreage.
- Utility coverage of the growing regions in California is dominated by a few utilities but especially PG&E



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POTENTIAL SOLUTIONS FOR DEMAND RESPONSE AND PERMANENT LOAD SHIFTING

Definitions

- Demand Response: *Peak-load shifting based on "events" and/or dynamic price data*
  - Manual or Slow DR:
    - *Scheduled in advance*
    - *Human controller acceptable*
  - Fast or Auto DR:
    - *Real-time response to events and/or dynamic price data*
    - *Requires automation*
- Permanent Load Shifting :
  - *Load permanently shifted off-peak*
  - *Time-of-Use (TOU) Rate Programs*

Conditions

- Agricultural irrigation schedules are "intrinsically" flexible.
- TOU rate plans are common in California agriculture.
  - 80% of PG&E agricultural revenue
  - 70% of SCD agricultural revenue
- Nearly all pumps are manually controlled.

Solutions (Requirements)

- On-farm Source
  - More flexible than agency source
- Adequate Irrigation System Capacity
  - Does it need to run 24/7 during peak ET periods?
- Automatic Controls
  - Required for AutoDR
- Storage
  - Water pumped into storage during off-peak periods
  - Gravity fed or lower-power booster pumps during peak periods
- Variable Frequency Drives
  - Improve efficiency
  - Reduce stress on wells and pumps
- Capacity Generated by Other Efficiency Measures
  - Efficiency measures may free up capacity that can contribute to TOU or DR participation

Irrigation System Capacity

- Optimally it has sufficient capacity to irrigate crops during peak evapotranspiration (ET) periods without running constantly.
- If not, then there may still be potential for shifting load during non-peak ET periods.

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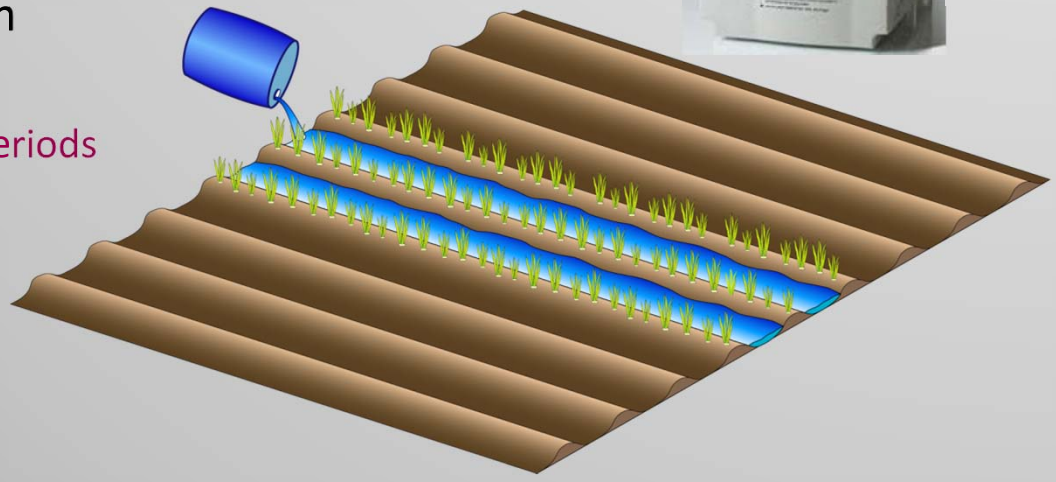
Automatic Controls

- Schedule discipline for slow DR and TOU plans.
- Required for AutoDR
- Minimal local controller with remote Demand Response Automation Server (DRAS) client
- Robust local controller with resident DRAS client (e.g. OpenADR)
- May “piggy-back” on other use such as remote monitoring and/or efficiency controls.

Variable Frequency Drives

- Efficiency: Avoid pressure shedding
  - Match pump to distribution requirement
  - Using the same pump for different distribution systems or blocks
- Variable speed for flood irrigation
  - Improve efficiency
  - Reduce speed for DR or TOU peak periods
- Soft start/stop potential
  - Reduce stress on pumps and wells
  - Increase potential for DR and TOU program participation



Other Efficiency Measures

- Still Significant Potential for Overall Pumping Plant Efficiency (OPPE) Improvements
  - 35% of well pumps and 51% of other irrigation pumps still have low efficiency (less than 50%)
  - The Advanced Pumping Efficiency Program (APEP) administered by the Center for Irrigation Technology (CIT) in Fresno resulted in less than 14% of California's agricultural irrigation pumps tested and less than 0.7% retrofitted during the 2002-2008 phase.
- Reduction in Friction losses
  - Reduce friction losses in and around pump assembly (part of OPPE)
  - Reduce mismatch between pump discharge pressure and distribution system requirements
  - Reduce flow rates for flood irrigation (where possible)
- Reduction in Water Application
  - Improve application uniformity (drip/micro conversions)
  - Improve irrigation scheduling through environmental monitoring
    - Weather, soil moisture, etc.
    - ***may go the other way*** (It may be determined that more water is needed)

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POTENTIAL AND CHALLENGES FOR ACCEPTANCE OF DEMAND RESPONSE AND PERMANENT LOAD SHIFTING

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Potential for Acceptance

- Water Source
  - On-farm source with excess capacity
  - On-farm source without excess capacity
  - Off-farm (agency) source
- Permanent Load Shifting vs. Demand Response
- Manual DR vs. AutoDR
- ROI for Grower

Grower ROI

- Financial incentives must match the cost
  - Significant if system upgrade is required
- Other potentially compelling motivations when combined with TOU or DR
  - Energy Efficiency or Demand Management (reducing peak-load fees)
  - Remote Pump Monitoring and Control

Permanent Load Shifting vs. Demand Response

- Permanent Load Shifting in the form of TOU rate plans are already widely accepted among California growers.
- Manual Demand Response through aggregators has gained some acceptance in the last few years.
- AutoDR has gained little or no acceptance.
  - Automatic controls of any kind are rare in California agricultural irrigation.