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**

- 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
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Pareto Principle
Regional Skews

Energy Use by Region

Energy per AF of Water

Percent of Total Energy Use for Agricultural Water by Region throughout California:
- 0 - 12%
- 12 - 20%
- 20 - 28%
- 28 - 36%
- 36 - 44%
- 44 - 52%
- 52 - 60%
- 60 - 68%
- 68 - 76%
- 76 - 84%
- 84 - 92%
- 92 - 100%
- No Data

Average Required Energy for Agricultural Water (KWH/AF):
- 82 - 100
- 100 - 125
- 126 - 150
- 151 - 175
- 176 - 200
- 201 - 225
- 226 - 250
- 251 - 275
- 276 - 300
- 301 - 325
- 326 - 350
- 351 - 375
- 376 - 400
- 401 - 425
- No Data
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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.
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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.
POTENTIAL SOLUTIONS FOR DEMAND RESPONSE AND PERMANENT LOAD SHIFTING
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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*
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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.
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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.
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.
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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
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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 (AEP) 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)
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
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**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.