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Utilizing Policy Optimization for Pump Operations at Water Distribution Systems to Enable Energy Load Shifting

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California’s changing energy sector

Energy demand-side management

How water distribution utilities can shift energy load

Case study with policy optimization decision support tool

Agenda

Increased Renewable Integration

Primarily Solar

Operational Challenges

Intermittent	Non-Dispatchable

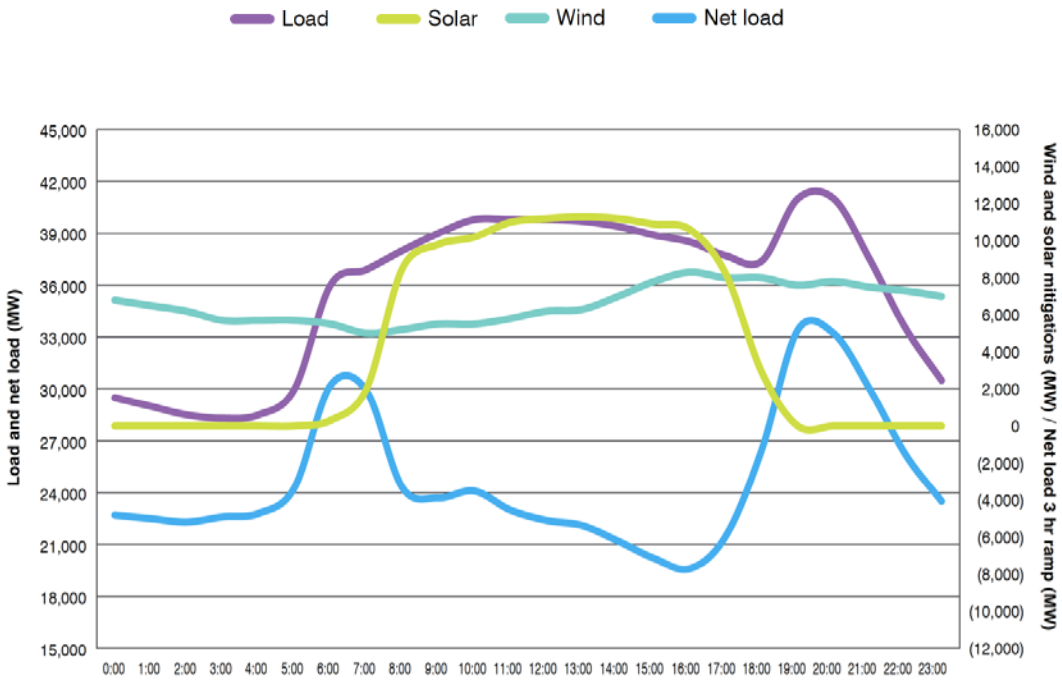


Figure from Clean Coalition 2013

Changing Energy Sector

Pursued Energy Sector Solution:

Energy Demand-Side Management

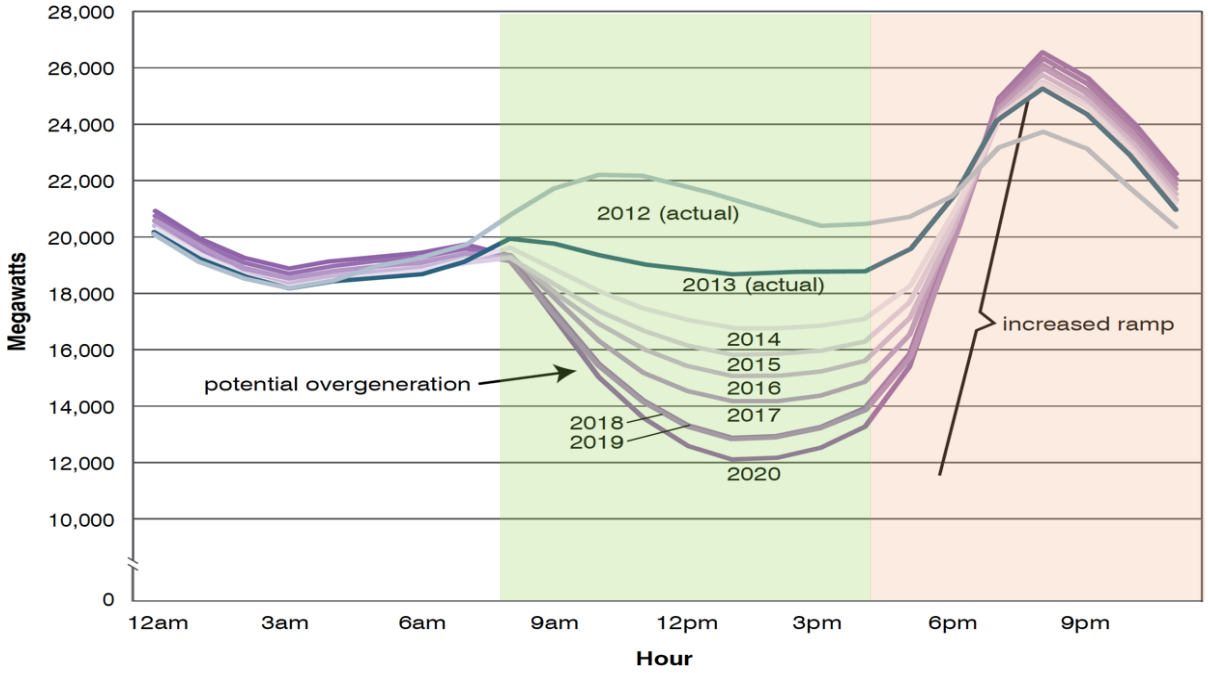


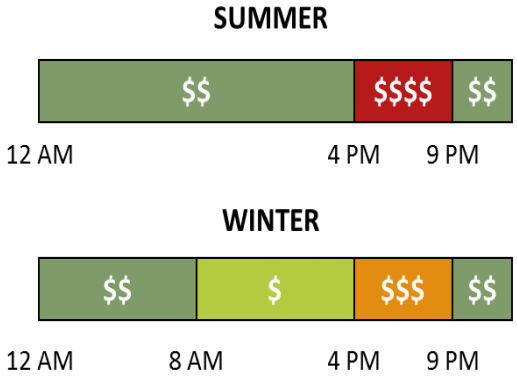
Figure from CAISO 2013

Energy Load Shaping

- ***Long-term*** behavior change
- Energy market incentive:
  - Static Time-of-Use (TOU) Energy Rates

Energy Load Shifting

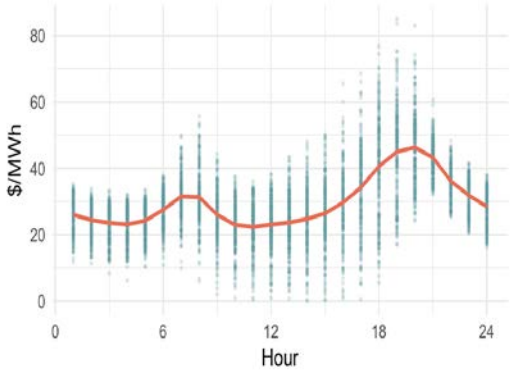
- More ***immediate*** response to market request
- Energy market incentive:
  - Energy Demand Response
  - Dynamic Energy Pricing



Static TOU Energy Rate Structures

- IOU Specific TOU Rate Schedules

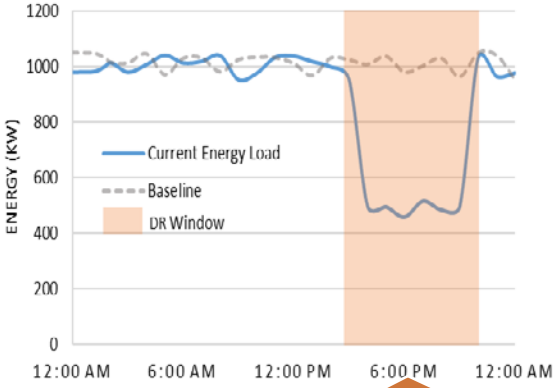
Figure Adapted from SCE



Dynamic Energy Rate Structures or Markets

- CAISO Wholesale Market

Figure from Oasis data 2017



Energy Demand Response (DR) Programs

- CAISO's Proxy Demand Resource Program
- IOU Specific DR Programs

California Energy Market Mechanisms

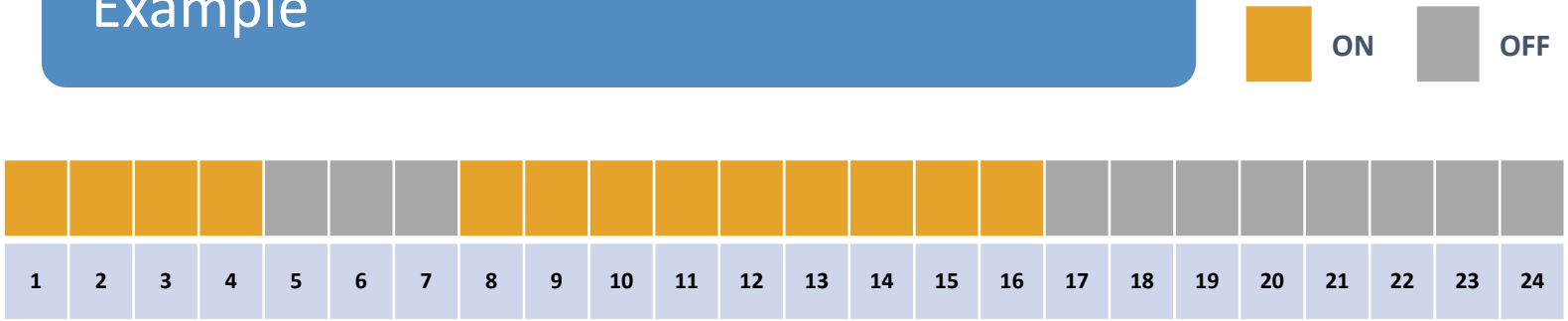
- Water utilities can **manage energy** load by changing pump operations
- Water utilities with water storage can further **shift operations** and energy load
- This is an expansion on previous research Energy/Cost/Water Quality pump operation optimization schemes

When performing **Energy Demand Management,** water distribution systems must take into account:

- Water quality
- Minimum system pressures
- Hydraulic limitations
- Operational limitations

Previous research focused on optimizing **pump schedules**

Example



Optimize **Rule-Based** Control Policies

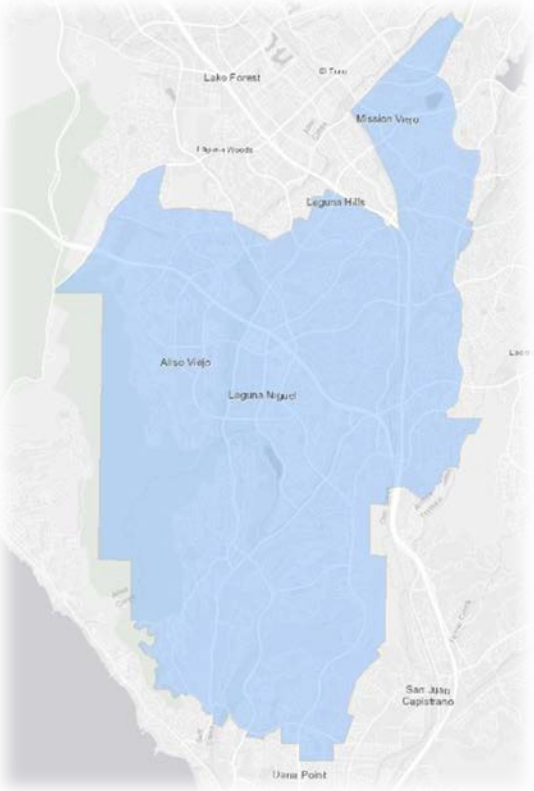
Example

- Pump **on** if tank level **is less than** **10 feet**
- Pump **off** if tank level **is greater** than **25 feet** or time is between **4 and 8 pm**

Moulton Niguel Water District

- Serves 170,000 customers
- Provides **potable water** to 55,000 sites (24 MGD)
- Provides **recycled water** to 1,300 sites (7 MGD)

System	Pressure Zones open (closed)	Pump Stations	Storage Reservoirs	Pipeline
Potable Water	12 (4)	23	28	700 mi
Recycled Water	16 (10)	11	11	144 mi

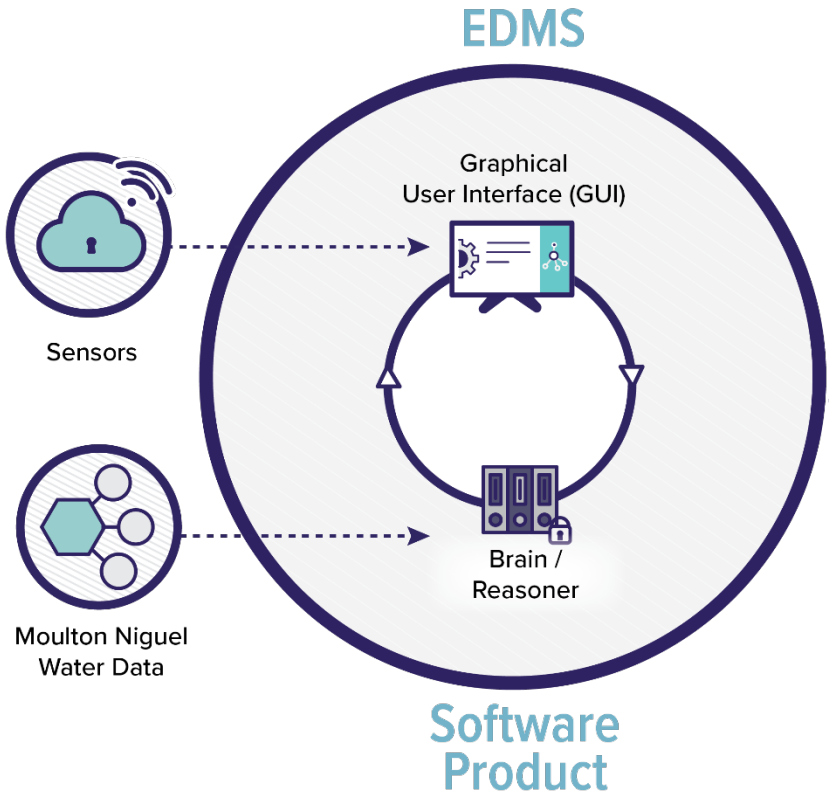


Energy Demand Management System (EDMS) software will provide:

Optimized rule-based control policies

Based on:

- Real-time SCADA system data
- A hydraulic model (EPANET)
- Energy rate program participation



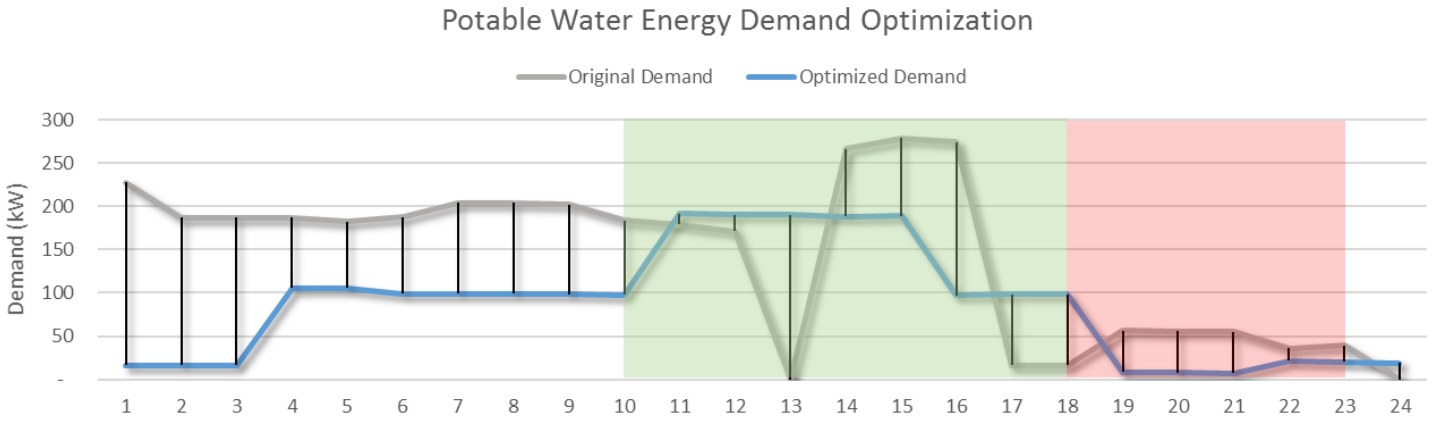
Compare operating **Policies** based on simulated results estimating:

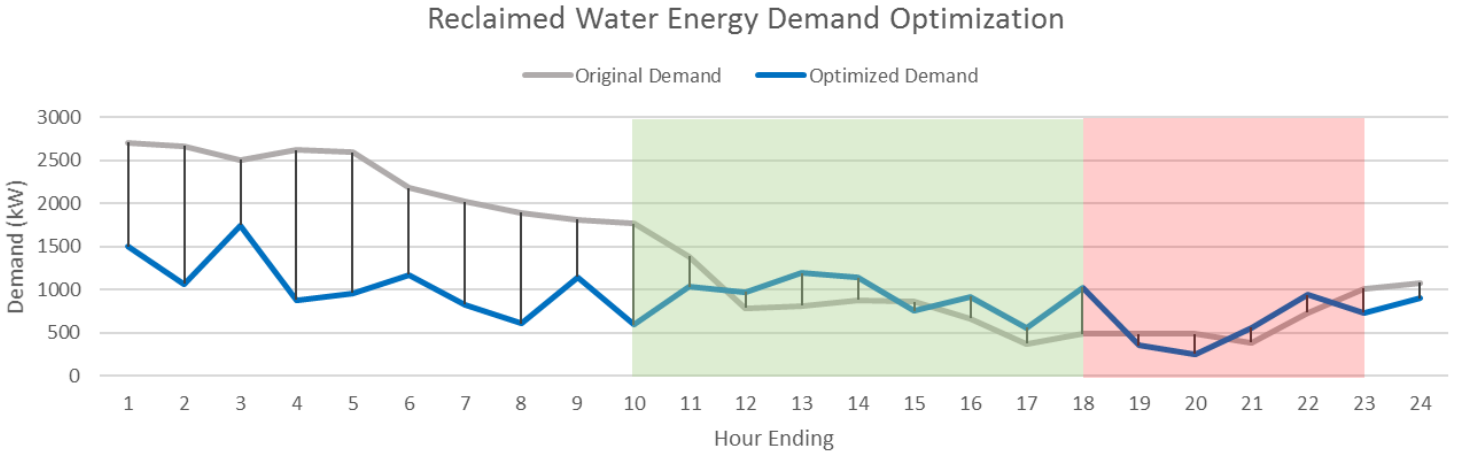
Total Energy Consumption	Average System Storage	Total Operating Cost
Peak Energy Load	Minimum System Pressure	Energy Program Revenue

Optimize pump on/off **Tank Level triggers:**

Example

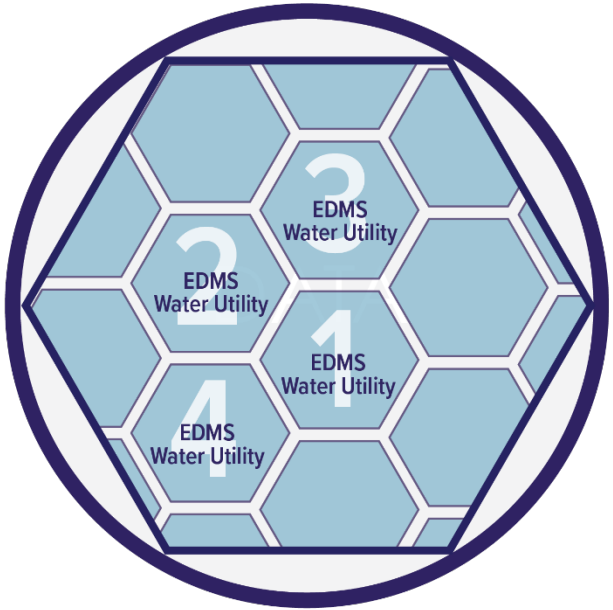
- Pump 1 on if tank level is less than … **12 feet**
- Pump 1 off if tank level is greater than … **24 feet**
- Pump 2 on if tank level is less than … **8 feet**
- Pump 2 off if tank level is greater than … **16 feet**
- Pump 3 on if tank level is less than … **7 feet**
- Pump 3 off if tank level is greater than … **20 feet**


Potable Water Energy Demand Optimization
Original Demand
Optimized Demand
Demand (kW)
300
250
200
150
100
50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


Reclaimed Water Energy Demand Optimization
Original Demand
Optimized Demand
Demand (kW)
3000
2500
2000
1500
1000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour Ending

EDMS User Support Group

Managed by CalWEP



Outreach and
Widespread Adoption

The California Water Efficiency Partnership (**CalWEP**) and CWEE will build, maintain and support an EDMS user group and software.

CALIFORNIA
WATER EFFICIENCY
PARTNERSHIP
A Chapter of the Alliance *for* Water Efficiency

Next Steps: Expand User Group

Alstone, P., Potter, J., Piette, M. A., Schwartz, P., Berger, M. A., Dunn, L. N., Smith, S. J., Sohn, M. D., Aghajanzadeh, A., Stensson, S., Szinai, J., Walter, T., McKenzie, L., Lavin, L., Schneiderman, B., Mileva, A., Cutter, E., Olson, A., Bode, J., Ciccone, A. and Jain, A. (2017) 2025 California Demand Response Potential Study, Final Report and Appendices on Phase 2 Results: Charting California's Demand Response Future. Lawrence Berkeley National Laboratory. Prepared for California Public Utilities Commission. April, 2017. http://www.cpuc.ca.gov/General.aspx?id=10622

California Independent System Operator (CAISO), “What the duck curve tells us about managing a green grid,” October 2013.

Cherchi, C., Badruzzaman, M., Oppenheimer, J., Bros, C. M., & Jacangelo, J. G. (2015). Energy and water quality management systems for water utility’s operations: A review. Journal of Environmental Management, 153, 108–120. https://doi.org/10.1016/j.jenvman.2015.01.051

References

Questions?


moulton niguel water district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Thank You