

# **Time of Use (TOU) Pump Scheduling Case Study**

## **Executive Summary**

Agriculture consumes nearly 8% of California's electricity, and approximately 70% of this energy is for water pumping (CA Department of Food & Agriculture). The majority of energy consumption for irrigation occurs during summer months when the power grid experiences maximum stress.

In 2017, the California Public Utilities Commission voted to establish time-of-use (TOU) electrical rates. Under TOU, rates are higher at periods of Peak demand and lower Off-Peak. Given the linkage between irrigation needs and maximum summer electricity usage, TOU plans are now mandatory for agricultural customers.



This case study examines the impact of changing irrigation schedules to minimize Peak rate energy consumption. We analyzed small agricultural rate plans from the major utilities and encountered savings of 30-40% by maximizing Off Peak crop watering.

These savings require discipline and visibility into pump status. The majority of savings applies to growers whose irrigation systems have excess distribution capacity during peak EvapoTranspiration

(ET) periods and do not need require 24/7 pump operation. Growers with minimum capacity can also benefit from TOU scheduling discipline outside of peak ET periods in May or June with commensurate energy savings.

## **Drip Irrigation Energy Use**

Since the mid 2000's, growers have increasingly migrated to drip or micro sprinkler irrigation methods to control uniformity of water and fertilizer application (fertigation). Conversion to drip systems often results in substitution of surface water with groundwater due to scheduling or quality issues. Drip systems may require more frequent irrigation cycles than the local water district allows and groundwater provides water on demand. Also, groundwater is typically of higher quality than surface water with less contaminants that can plug emitters. District supplied water often contains debris that must be filtered before application.

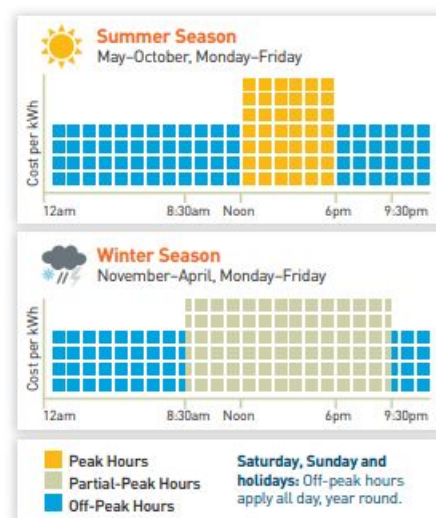
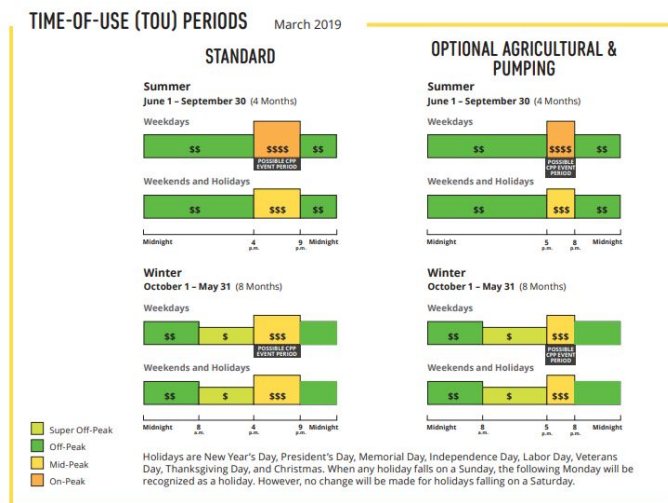
Groundwater is one of the most energy-intensive sources of water available, using between 170 and 600 kilowatt hours (kWh) per Acre-Foot (AF) of water to bring to the surface. The migration to drip irrigation actually increases energy usage because in addition to the well pumps needed to bring water to the surface, lower horsepower booster pumps are required to maintain pressure in the distribution lines.

## Time of Use Rate Plans

Pacific Gas & Electric and SoCal Edison provide the bulk of California agricultural electrical service. Both have introduced Time of Use (TOU) rate plans to create financial incentives to permanently load shift demand.

TOU rates vary according to the time of day, season, and weekday/weekend. Higher rates are charged during the Peak demand hours and lower rates during Off-Peak hours. The agriculture and pumping service summer rates for [PG&E](#) apply from May 1 to October 30 (6 months). [SCE](#) summer rates apply from June 1 to September 30th (4 months). Rates also differ slightly for daily consumption; with Peak usage applicable from 12p-6p for PG&E, and 4p-9p for SCE.

Scheduling information for two popular small agricultural TOU plans for PG&E / SCE appear below:



Both utility rate plans have several cost components:

- Demand charge is calculated by using the 15-minute interval during each billing month when your farm uses the maximum amount of electricity.
- Daily consumption during Peak periods.
- Daily consumption during Off Peak periods.

Rate per kilowatt hour [PG&E](#) [SCE](#)

- Peak \$0.48 \$0.36
- Off Peak \$0.21 \$0.08

Both companies also offer a discounted plan for Demand Response activities where growers turn off power equipment for Critical Peak Power (CPP) events on extremely hot days. SCE offers an option E schedule that has a higher Time Related Demand Charge, that generates a higher fixed monthly fee but minimizes the difference between Peak and Off Peak usage. Our analysis indicates this option becomes more cost effective as the farm approaches 24/7 irrigation operation.

## Labor Costs & Pump Automation

The majority of irrigation pumps in California are manually operated. Manually operated pumps have high electricity costs and high labor costs. With manual operation, it is very difficult to maintain discipline to adhere to TOU schedules, so electricity costs are higher. For example, without remote actuation it is difficult to find irrigation operators to turn on equipment at 9:01 PM to take advantage of Off Peak electricity rates. Since someone needs to manually turn the pump on and off, labor charges are high as well.

Mechanical timers to automate pump schedules can help lower electricity costs, but do not produce significant labor savings. Some growers rely on mechanical timers to shut off irrigation pumps, but these timers have reliability problems. Similar to Altrac's experience with wind machine AutoStart systems, there is no confirmation provided on equipment status or alerts for exceptions. If an issue occurs while a pump is running on a mechanical timer, the grower will not find out until hours after the event. Growers sometimes station a worker at the pump to watch for issues, but many times, the labor cost outweighs the TOU electricity cost savings.

Remote control and scheduling of pumps facilitates both electricity savings and labor savings. By allowing for growers to adjust their pumps remotely and view pump status, remote telemetry provides low barriers for TOU scheduling as well as reduced labor costs. At the beginning of an irrigation set, a worker is needed to check for breakages in drip tubing or clogged water emitters, but otherwise the system can be monitored and controlled remotely.

## Electricity Cost Savings

The charts below are derived from a Pump Energy Savings spreadsheet we developed based on our understanding of current utility rate plans. One scenario considers an irrigation system with spare capacity, and compares the cost to operate a 50 horsepower pump running for 12 continuous hours 8a-8p, vs stopping the engine at 12p and restarting it at 6p to take advantage of Off Peak rates. For simplicity, we have not included the SCE Mid Peak rate for weekends, and used Off Peak pricing. Also excluded are meter fees and other miscellaneous charges. The calculated savings are compelling for all utility rate plans.

### PG&E Rate

Avoiding the Peak rate of 12p to 6p for PG&E AG4A plan provides a 30% reduction in electricity costs; saving \$61.32 per weekday, ~\$1,350 per month (22 weekdays + 4 weekends) and ~\$8,100 for the 6 month irrigation season.

Pacific Gas & Electric	Demand	Peak	Off Peak								
PG&E AG-4A Rate	8.89	0.48	0.206								
	Wk Day (22)	Wk End( 4)	Demand	Month (30)	Summer (6)	8a-12p	12p-6p	6p-8a	Weekend		
Schedule 1	\$153.53	\$184.41	331.597	\$4,446.83	\$26,680.99	\$30.74 4	\$107.42 6	\$15.37 2	\$184.41 24		
Schedule 2 Off Peak	\$92.21	\$184.41	331.597	\$3,097.77	\$18,586.59	\$30.74 4	\$0.00 0	\$61.47 8	\$184.41 24		
Savings	-\$61.32	\$0.00	-30.34%	-\$1,349.07	-\$8,094.40	Off Peak	Peak	Off Peak	Off Peak		

## SCE Rate

The next figure compares three popular SCE plans. Many southern California ranch operations choose the Option D plan by default, which includes the expensive monthly Demand and Time Related (\$21.60) charge in order to minimize the Peak (\$.122) and Off Peak (\$.070) rate differential. Even with the minimal cost difference between the two rates, shifting Peak hours for Option D saves 9% per month and ~\$700 for the 4 month summer season.

The CPP Option D saves about \$100 per month due to lower Demand fees, but the grower must commit to cut electrical usage on 12 days per season when notified by the utility of a power event. TOU rates are identical and provide a 9% savings by maximizing Off Peak irrigation.

Pumping Off Peak with Option E can reduce electricity usage by \$925 per month, a savings of 42% or ~\$3700 for the 4 month season. Growers with spare capacity and the appropriate TOU discipline, could select Option E instead of D and benefit from the lower monthly Demand Charge (\$7.19). This produces the lowest electricity bill: \$1,289 (E) vs \$1,916 (D) a net savings of \$627 per month.

SoCal Edison	Demand	Peak	Off Peak								
SCE TOU-PA-2 D	21.6	0.122	0.07								
	Wk Day (22)	Wk End( 4)	Demand	Month (30)	Summer (4)	8a-4p	4p-9p	9p-8a	Weekend		
Schedule 5	\$39.09	\$62.66	805.68	\$1,916.32	\$7,665.30	20 888 8	18 2024 4	\$0.00 0	\$62.66 24		
Schedule 6 Off Peak	\$31.33	\$62.66	805.68	\$1,745.64	\$6,982.56	20 888 8	0 0	\$10.44 4	\$62.66 24		
Savings	-\$7.76		-8.91%	-\$170.68	-\$682.74	Off Peak	Peak	Off Peak	Off Peak		
SoCal Edison	Demand	Peak	Off Peak								
SCE TOU-PA-2 D CPP	18.76	0.122	0.07								
	Wk Day (22)	Wk End( 4)	Demand	Month (30)	Summer (4)	8a-4p	4p-9p	9p-8a	Weekend		
Schedule 7	\$39.09	\$62.66	699.748	\$1,810.39	\$7,241.57	20 888 8	18 2024 4	\$0.00 0	\$62.66 24		
Schedule 8 Off Peak	\$31.33	\$62.66	699.748	\$1,639.71	\$6,558.83	20 888 8	0 0	\$10.44 4	\$62.66 24		
Savings	-\$7.76		-9.43%	-\$170.68	-\$682.74	Off Peak	Peak	Off Peak	Off Peak		
SoCal Edison	Demand	Peak	Off Peak								
SCE TOU-PA-2 E	7.19	0.358	0.076								
	Wk Day (22)	Wk End( 4)	Demand	Month (30)	Summer (4)	8a-4p	4p-9p	9p-8a	Weekend		
Schedule 3	\$76.09	\$68.04	268.187	\$2,214.35	\$8,857.41	\$22.68 8	\$53.41 4	\$0.00 0	\$68.04 24		
Schedule 4 Off Peak	\$34.02	\$68.04	268.187	\$1,288.72	\$5,154.86	\$22.68 8	\$0.00 0	\$11.34 4	\$68.04 24		
Savings	-\$42.07		-41.80%	-\$925.64	-\$3,702.55	Off Peak	Peak	Off Peak	Off Peak		

## Peak EvapoTranspiration and Time-of-Use Scheduling

Many growers do not embrace TOU scheduling because their peak irrigation capacity is designed to match peak EvapoTranspiration (ET) irrigation rates. Since the irrigation system capacity is matched to peak ET, the pumps must run 24/7 during peak irrigation (July, August, September) to provide enough water to the crop. However, any reduction in pumping during the summer months provides huge cost savings, and it is worth exploring potential reductions in usage.

The cost per hour of Peak and Off Peak usage for a 50 HP motor is shown below.

<b>Rate Plan</b>	<b>Peak Cost Per hour</b>	<b>Off Peak Cost Per hour</b>	<b>Savings per Month</b>	<b>Savings per Season</b>	<b>Percent Reduction</b>
PG&E AG4A	\$17.90	\$7.68	\$455.36	\$2,732.07	6.31%
SCE Option D	\$4.55	\$2.61	\$121.00	\$484.00	4.17%
SCE Option E	\$13.35	\$2.83	\$316.45	\$1,265.81	9.13%

Each hour of less than 24/7 irrigation saves \$.27 to \$.36 per unit of horsepower for the most popular plans. With remote pump control, growers can save ~\$121 to ~\$455 per month (50 HP Motor) for eliminating just one hour of Peak pumping time per day with no attendant labor costs. The energy savings are linear for higher horsepower motors.

### **Surface Water and Time-of-Use Scheduling**

Growers who rely on district supplied water have limited control over irrigation scheduling. Water is typically ordered 24 hours in advance and all water supplied in a 24 hour period must be used by the grower. The booster pumps that divert water onto the field must operate when the water is available, regardless of TOU schedule constraints.

### **Ground Water Pumps**

High horsepower groundwater pumps consume 42% of agricultural electricity usage and are ideal candidates for TOU automation, especially when they are associated with a reservoir. The energy intensive well pumps can be scheduled to run at Off Peak hours to fill the reservoir, which can be drained on Peak by lower horsepower booster pumps.

### **Frost Water**

Frost water scheduling provides another opportunity for remote pump control. As an alternative to wind machines, certain orchards apply water when the ambient temperature reaches the right level relative to the dew point. These conditions are normally achieved in early morning and timing of pump operations are critical for frost mitigation. Remote pump operation provides many benefits in these situations.



## The Altrac Pump Scheduling Solution

Altrac has developed a generic cellular control device for agricultural equipment. The system enables you to monitor engine status, send alerts via phone call, email or SMS text message, remotely start or stop equipment, and schedule runtime. Our first product targeted wind machines used in the Citrus and Stone Fruit industries. We have adapted the system to provide remote control of pumps and the first generation of the device has been in operation at Blue Heron Vineyard, Zirkle Fruit, and other clients for over two years.

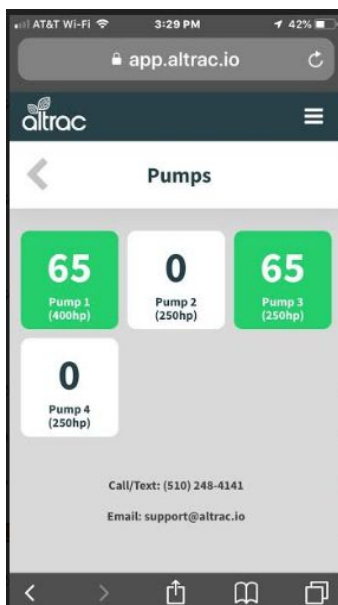


The adjacent image shows the rugged NEMA enclosure and UL listed components of the Pump Station controller. The system mounts to the pump panel and is connected to the pump's relay, VFD, or soft start with a 12 conductor cable. An external omnidirectional antenna acquires signal for the cellular modem chip.

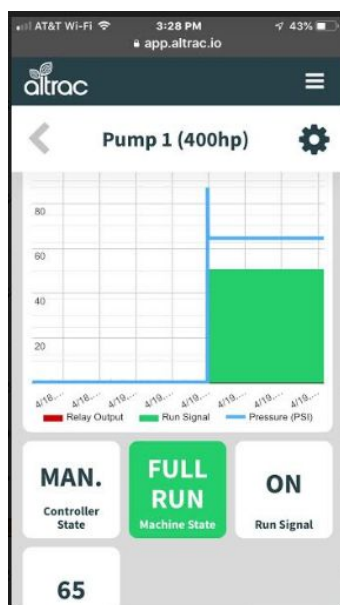
We can pair the Pump Station with a downstream pulse output flow meter or pressure sensor, from vendors like [McCrometer](#) or [Prosense](#) to display PSI or GPM. While the main benefit of the Pump Station is to provide positive confirmation and control of your equipment, additional sensor data can help in many situations.

## Smart Phone Interface

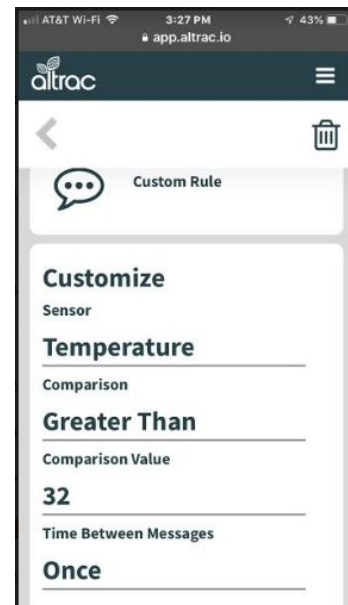
Pump Station has an intuitive smart phone interface. The Ranch Dashboard presents a tile for each pump in the orchard. White is OFF, green indicates FULL RUN, and red indicates an ERROR. In the screenshots below, we are connected to a pressure sensor and the downstream line pressure in PSI is displayed for the pumps in operation.



Ranch Dashboard



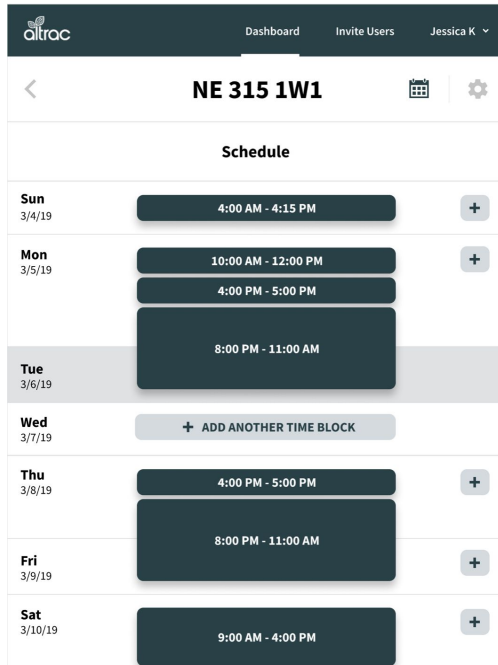
Pump Control



Alerts

When an individual pump tile is selected, the interface displays the Pump Control screen. This screen provides confirmation the pump is ON and users with appropriate permissions can turn the equipment ON/OFF. A 24 hour window of sensor activity is displayed, along with current sensor value, in this case 65 PSI. You can view up to 2 years worth of data which is useful for maintenance reporting and analysis.

You can also set up alerts in the device settings screen. Currently the application supports custom alerts based on sensor value. You can receive a phone call, email or SMS text message that PSI exceeds a certain threshold or the pump is ON for example.



## TOU Scheduling Application

Many pumps are situated in remote locations and the ability to start or stop the machine from a distance is a major time saver.

Our research indicates that while 99% of CA growers are subject to TOU rate plans, very few actively schedule irrigation cycles to minimize utility spending. It is too difficult to achieve without an automated scheduling application.

For the 2019 irrigation season we are upgrading the interface to include a TOU Scheduling screen. This screen enables growers to schedule blocks of irrigation hours which coincide with utility TOU rate periods to help them maximize OFF Peak electrical usage.

We are seeking progressive California growers to work with us to add useful features and practical alerts. Pricing for

the Pump Station is less than \$2,000 including installation and can easily be cost justified by electricity savings in a single growing season.

We are especially interested to work with growers in the Almond, Pistachio, Walnut, and Avocado industries that may have unique irrigation requirements. We would also appreciate referrals to pump and irrigation vendors interested in distribution opportunities.

For more information, pricing, or dealer info contact:

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