Final Report Presentation

Wexus (Water-Energy Nexus) Energy Management
Mobile Software for the Agricultural Industry Project

EPIC, Energy Research & Development Division
PON-14-304
Contract Number: EPC-14-070

Presenter: Wexus Technologies, Inc.
Date: February 20, 2019
Prepared For: California Energy Commission

WEXUS
Empowering Farmers

Overview

- The California Energy Commission's Energy Research and Development Division supports energy research and development programs to spur innovation in energy efficiency, renewable energy and advanced clean generation, energy-related environmental protection, energy transmission and distribution and transportation.

- In 2012, the Electric Program Investment Charge (EPIC) was established by the California Public Utilities Commission to fund public investments in research to create and advance new energy solution, foster regional innovation and bring ideas from the lab to the marketplace. The California Energy Commission and the state's three largest investor-owned utilities – Pacific Gas and Electric Company, San Diego Gas& Electric Company and Southern California Edison Company – were selected to administer the EPIC funds and advance novel technologies, tools, and strategies that provide benefits to their electric ratepayers.

- The Energy Commission is committed to ensuring public participation in its research and development programs that promote greater reliability, lower costs, and increase safety for the California electric ratepayer and include:
  - Providing societal benefits.
  - Reducing greenhouse gas emission in the electricity sector at the lowest possible cost.
  - Supporting California's loading order to meet energy needs first with energy efficiency and demand response, next with renewable energy (distributed generation and utility scale), and finally with clean, conventional electricity supply.
  - Supporting low-emission vehicles and transportation.
  - Providing economic development.
  - Using ratepayer funds efficiently.

- **This presentation summarizes the final report for *the Wexus Energy Management Mobile Software for the Agricultural Industry project (Contract Number EPC-14-070)* conducted by Wexus Technologies, Inc. The information from this project contributes to Energy Research and Development Division's EPIC Program.**

- All figures and tables are the work of the author(s) for this project unless otherwise cited or credited.

Introductions

- CEC Team
- Wexus Team

Chris Terrell
CEO
Co-founder

Chris Vines
Operations
Co-founder

Introductions: Why Wexus?

Wexus Technologies, Inc was originally founded in response to:

- a lack of energy management technologies in the agri-food industry
- the severe California drought which began in 2011
  - Drought was driving some farms out of business due to a lack of surface water, tight labor markets & high utility costs associated with pumping more groundwater

Introductions: Company History

2010-2014

Ag DR programs

2014

Smart meter tech multiplies

Wexus is born

2015

CEC project launched with farmer feedback

2016

Customer growth & partnerships

2017

PG&E Ag Energy program

2018

Solar products

On Bill Financing program

2019

EE Programs & Partnerships

Introductions: Customers & Verticals

Wexus software is crop agnostic & easily integrates into many food & ag verticals
Some of the largest farms in the world are our customers

Hancock Agricultural Investment Group
Olam
Jackson Family Wines
Rocket Farms
Reiter Affiliated Companies
Batth
Campos Brothers Farms
Gills Onions
The Wine Group
Maddox Dairy
Muller Ranch
Simonian Fruit Company
Amaral
Fresh Harvest
Scheid Vineyards
Berberian Nut Company
Crain Walnut Shelling, Inc.
terranova Ranch Inc.
Hansen Ranches
Producers Dairy
Lagorio Family of Companies

OUTDOOR GROWERS

INDOOR GROWERS

FOOD PROCESSING

IRRIGATION DISTRICTS

Contents

Executive Summary & Background

Executive Summary & Background

Agriculture & the "Water-Energy Nexus"

- California farms are some of the largest in the world; fruits & vegetables grown in CA ***feed half of the United States*** - food security is critical to national security
- California's agricultural industry is one of the state's largest users of energy and water
- 8 million ag acres annually consume ***80% of total water pumped*** and ***8% of total energy*** in California
- California's ag industry has been ***historically underserved*** with a ***lack of effective efficiency technologies & utility programs*** to meet its unique needs

Photo Credit: Wexus Technologies Inc

Executive Summary & Background

Ag industry needs for new energy and water efficiency solutions are driven by:

Labor Shortages	• Farmers under pressure to source low-skilled labor for difficult jobs • Immigration reform is needed to legalize current workforce • Technology & automation is needed to fill labor gaps
"Electrification of Everything" + Rising Energy Costs	• Farms are already adopting renewable energy sources and electrified equipment: e-pumps, e-tractors & e-trucks • Energy jargon & "time of use" rates are not transparent • CPUC approved energy rate increases of $3.4bn through 2019
Water Regulation & Reporting	• SGMA: new, punitive water reporting requirements for farmers with few tools to ease the process
Droughts, Water Shortages + Lower Yields	• Groundwater is being depleted faster than its being recharged • Droughts are getting longer & more unpredictable which ultimately hurts crop yields

Background: Labor Shortages

CNBC

U.S. NEWS

California Farm Labor Shortage 'Worst It's Been, Ever'

Jane Wells | @janewells

Published 1:17 PM ET Mon, 20 Aug 2012 | Updated 4:01 PM ET Tue, 21 Aug 2012

CNBC

There's a different sort of drought plaguing California, the nation's largest farm state. It's $38 billion agricultural sector is facing a scarcity of labor.

High-tech answers sought for farm labor shortages

Labor shortages cause at least one grower to abandon some tree fruit this year Higher labor costs lead push to automate harvest, processing of more crops High-tech business incubator in Salinas hopes to address labor challenges

Harold McClarty, left, Samuel Duda, center, and Tom Nassif discuss the challenges of agricultural labor shortages at the Forbes AgTech Summit in Salinas, Calif.

Todd Fitchette 2 | Jul 21, 2016

Background:
"Electrification of Everything"

Expert: Energy revolution coming in next decade

Ex-Tesla Motors official believes electric tractors, other innovations will virtually eliminate growers' fuel costs.

Transformative innovation expert David Deak speaks at the Almond Conference Dec. 5 in Sacramento, Calif.

Tim Hearden | Dec 06, 2018

Disruptive change is likely coming to California agriculture in the next decade, as technological improvements will lead to electric tractors and alternative-energy storage that will virtually eliminate farms' energy costs.

CNN BUSINESS

Ford to make all-electric version of its F-150 truck

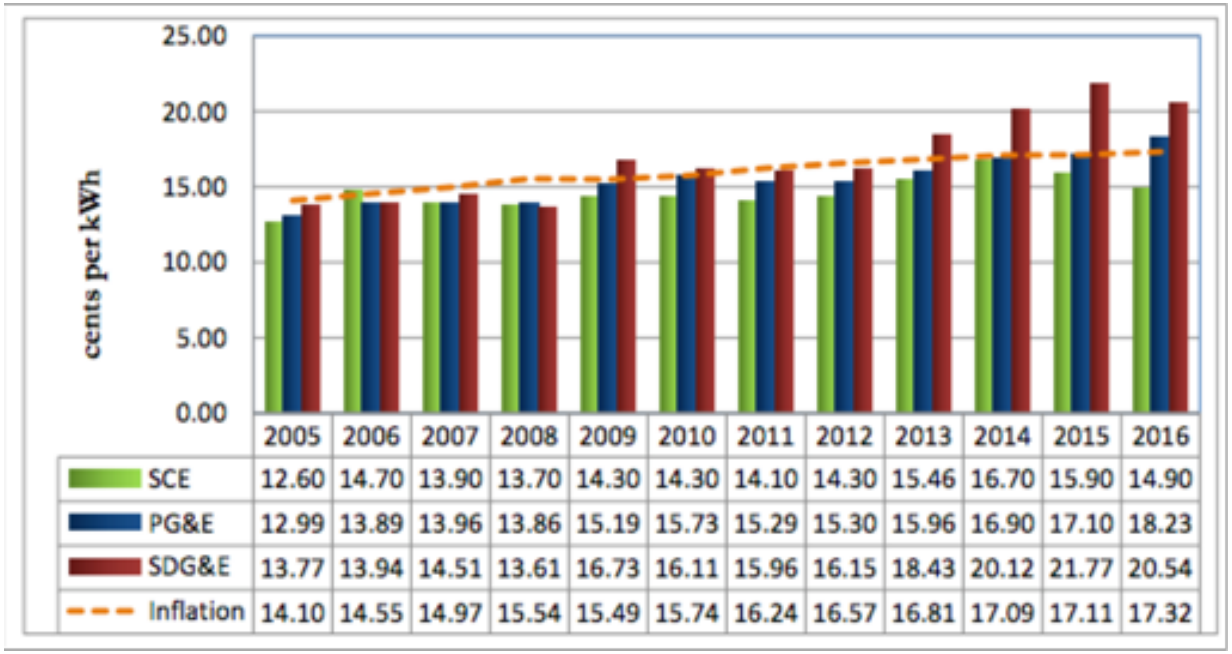
By Peter Valdes-Dapena and Chris Isidore, CNN Business

Updated 12:21 PM ET, Thu January 17, 2019

An electric pickup would be ideal for customers with the right needs, said Jim Farley, President of Global Markets at Ford. A gasoline-powered truck is shown here.

Background: Rising Energy Rates

”Electric rates in California have increased by 3.44% per year since 2012, above the annual inflation rate of 1.3%.”

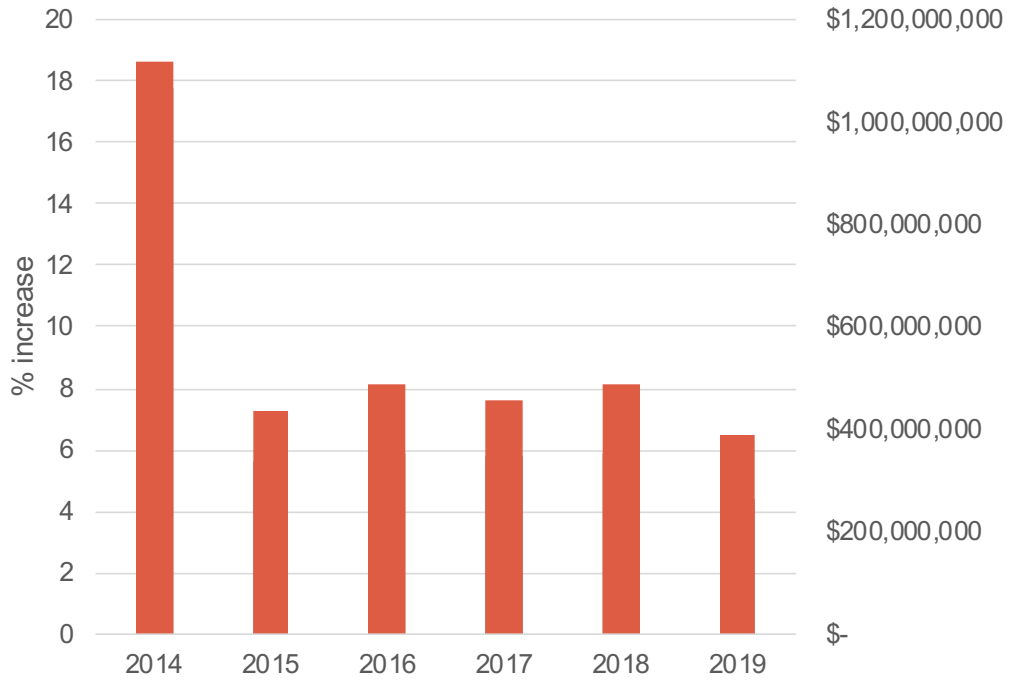


	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
SCE	12.60	14.70	13.90	13.70	14.30	14.30	14.10	14.30	15.46	16.70	15.90	14.90
PG&E	12.99	13.89	13.96	13.86	15.19	15.73	15.29	15.30	15.96	16.90	17.10	18.23
SDG&E	13.77	13.94	14.51	13.61	16.73	16.11	15.96	16.15	18.43	20.12	21.77	20.54
Inflation	14.10	14.55	14.97	15.54	15.49	15.74	16.24	16.57	16.81	17.09	17.11	17.32

Source: CPUC

Background: Rising Energy Rates

- PG&E rate increases average +7.6% per year
- $3.4 billion increase from 2014 – 2019



Source: CPUC

Background: Rising Energy Rates


AgAlert
THE WEEKLY NEWSPAPER FOR CALIFORNIA AGRICULTURE

Farmers urge commission to cut PG&E rate request

Issue Date: June 16, 2010

Christine Souza

"The increases would affect thousands of farmers and ranchers in Northern and Central California... **average agricultural rates could increase between 13.5 and 19.4 percent."**

*"…(rates are) going to **increase my cost of electricity anywhere from 13 to 20 percent**…let me put those numbers into perspective…Our utility costs each year are about $55,000 to $80,000…you are looking at increased cost of $8,000 to $16,000."*

*"I have one child in college and one that is about ready to start… **this is one year's college education** that is going to be eaten away every year."*

"We converted from a diesel engine to wells and electric motors. We believed electricity was a little cleaner energy,"

*…**electricity represents his third-highest input on the farm.***

***"It feels…punitive to someone like me who made the investment to build wells and stop using diesel engines**…keep that in mind when you are looking at how these rate increases affect local farmers who are trying to grow a quality product for a hungry world."*

Background:
Water Regulation & Reporting

EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

The groundwater manager's dilemma: How to comply with new California law without changing water rights

By Christina Babbitt / Bio / Published: September 4, 2018

by Christina Babbitt and Daniel M. Dooley, New Current Water and Land

Over the next two years, more than 100 groundwater sustainability agencies in California will have to hammer out a plan to make their groundwater basins sustainable.

But as mangers in many areas work to combat decades of over-pumping, they face a major dilemma: In dividing the groundwater pie to avoid overuse, they can't change Byzantine groundwater rights that date as far back as 1903.

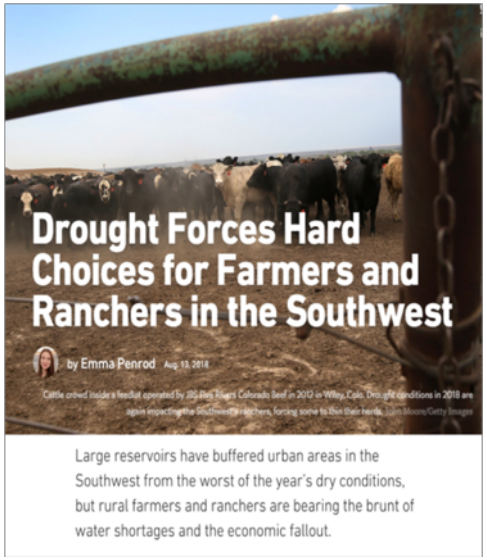
Groundwater pumping restrictions expected to further dampen once-hot market for local farmland

BY JOHN COX jcox@bakersfield.com Jan 16, 2019 0

In this file photo, a farmworker selectively picks blueberries at a field east of McFarland.
The Californian

A new report on Kern's agricultural real estate market suggests upcoming restrictions on groundwater pumping could drag down farmland values that have only recently stabilized after coming off peaks a few years ago.

Background:
Drought & Water Shortages



Drought Forces Hard Choices for Farmers and Ranchers in the Southwest

by Emma Penrod Aug. 13, 2018

Cattle crowd inside a feedlot operated by JBS Five Rivers Colorado Beef in 2012 in Wiley, Colo. Drought conditions in 2018 are again impacting the Southwest's ranchers, forcing some to thin their herds. John Moore/Getty Images

Large reservoirs have buffered urban areas in the Southwest from the worst of the year's dry conditions, but rural farmers and ranchers are bearing the brunt of water shortages and the economic fallout.

Drought in Northern China Is Worst on Record, Officials Say

The Tengger desert in Inner Mongolia. Government efforts to halt the expansion of deserts have included tree-planting projects and restrictions on grazing. Josh Haner/The New York Times

By Edward Wong

June 29, 2017

NEWSWEEK MAGAZINE

India's Drought Is Killing Crops —And Pushing People to Suicide

BY MARY KAYE SCHILLING ON 8/16/18 AT 10:47 AM

Rasathi's husband, a rice farmer, took his life in 2017. She is from Tamil Nadu, the southernmost district of India, which is experiencing its lowest percentage of rainfall in 140 years.

PHOTOGRAPH BY FEDERICO BORELLA

CBS NEWS / *January 19, 2018, 7:45 AM*

Cape Town, on verge of running out of water, braces for "chaos"

Share / Tweet / Reddit / Flipboard / Email

CAPE TOWN, South Africa -- Surrounded by beautiful stretches of ocean, it's hard to believe Cape Town could become the first major city in the world to run out of water. Ominously named "day zero," April 21 – 92 days from today – is when the taps will be turned off.

At the Voëlvlei Dam, water levels are critically low, sitting at less than 20 percent, reports CBS News' Debora Patta. It's one of Cape Town's main sources of water – a source that it is on the brink of running completely dry within a matter of weeks.

Three years of successive drought have devastated the city's water supplies. The local government has brought in severe restrictions forcing people to look for alternative supplies like a natural spring tapped for public use.

"It has changed our lives dramatically. But it is also a lesson for us not to waste water," Mogamat Allie said.

Background:
Drought & Water Shortages

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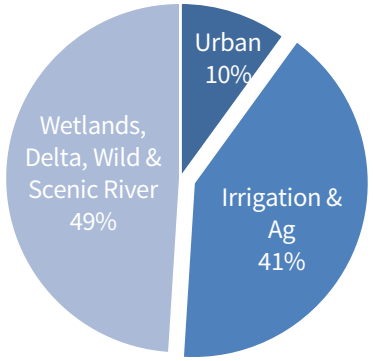
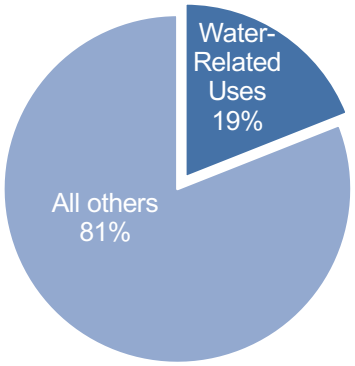
Executive Summary & Background

The Water-Energy Nexus in California

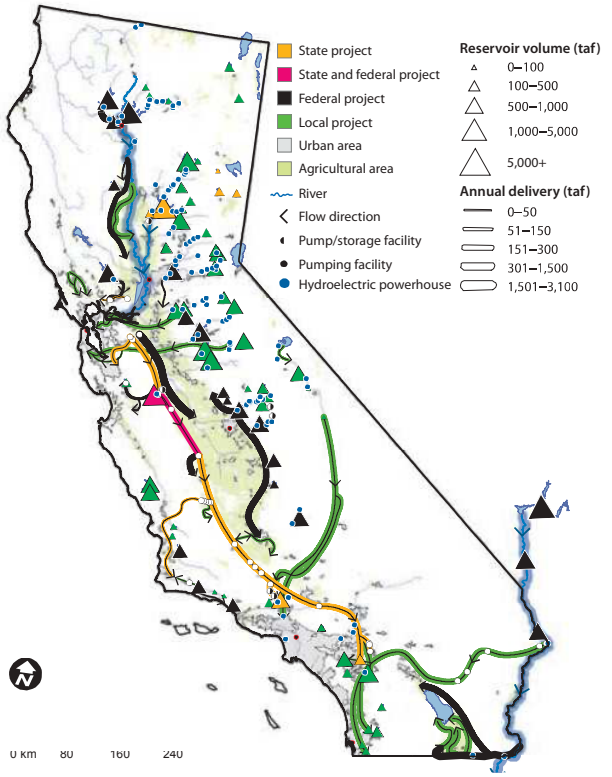
Who Uses Water?



How Much Electricity Does Water Use?

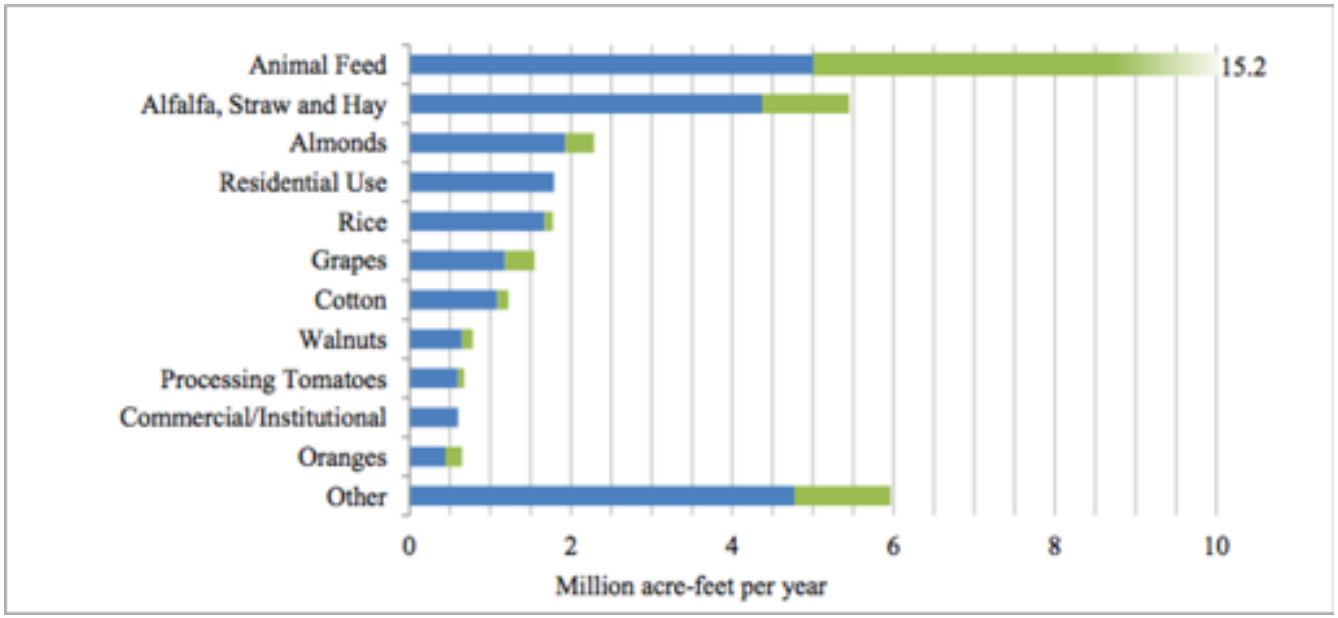


Sources: CEC, DWR, CA Water Plan 2013 Update



Executive Summary & Background

Agricultural Crops & Water Usage in California



Source: Pacific Institute

Executive Summary & Background

Majority of CA agricultural energy use is for water pumping & irrigation during growing season, typically summer months

- Many farmers rely on groundwater, most energy-intensive source of water
- Uses **on average between 170 & 600 kilowatt hours (kWh) per acre-foot (AF)** of water

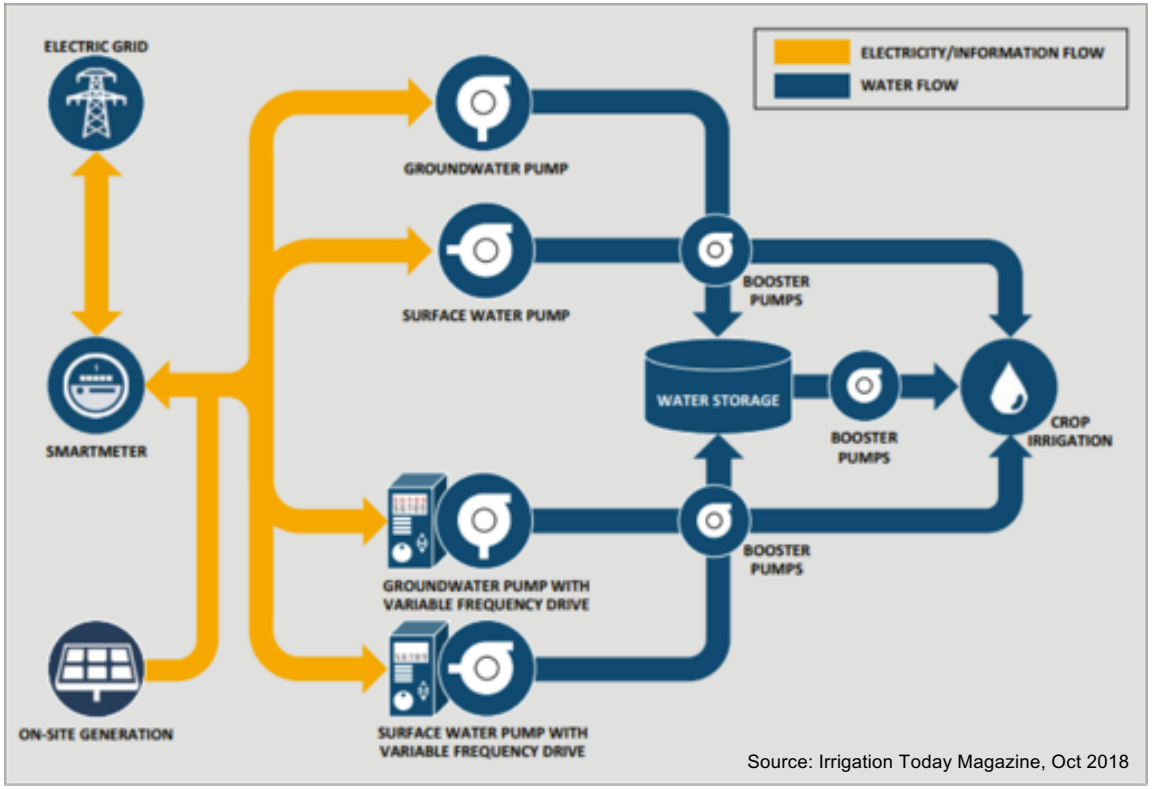
Energy-intensive pumping for irrigation water in turn causes farmers to be heavily impacted by energy costs

- **33% of on-farm water usage coincides with peak energy usage & peak energy pricing**
- Results in farmers paying high prices on their energy bills in **excess of $100,000 PER MONTH**

Photo Credit: Wexus Technologies Inc

Executive Summary & Background

The Water-Energy Nexus on a Farm



Source: Irrigation Today Magazine, Oct 2018

Executive Summary & Background

Potential Impacts of Efficiency Technology in Agriculture

Source: NRDC, Pacific Institute

Project Goals & Objectives

Project Goals & Objectives

Goals:

1. Engage agricultural deployment sites in California Investor Owned Utility (IOU) territories to participate in the Wexus mobile software project
2. Identify energy (and water) efficiency measures at these sites
3. Provide wider proof-of-concept and use cases for scaling the Wexus mobile software platform throughout IOU regions in California
4. Fully assist & train deployment sites in the effective use of the Wexus mobile software platform to quantify actual energy (and water) savings after measures have been implemented

Project Goals & Objectives

Objectives:

1. Engage agricultural deployment sites in California Investor Owned Utility (IOU) territories to participate in the Wexus mobile software project
2. Aid agricultural deployment sites in reducing their overall energy usage by providing actionable energy and cost data, including at peak times of day
3. Target potential energy reductions by up to 10%from baseline usage
4. Continue to develop & refine the Wexus cloud-based software platform through deep analysis of utility electric meter data, utility tariff and rate data, utility bills, water usage data, greenhouse gas emissions data and continued agricultural customer feedback at the site level
5. Engage agricultural deployment sites in continuing education & training on the effective and efficient use of the proposed technology to reduce their energy usage by up to 10%, to identify potential energy savings measures in the field, and to quantify actual energy savings after savings measures have been implemented

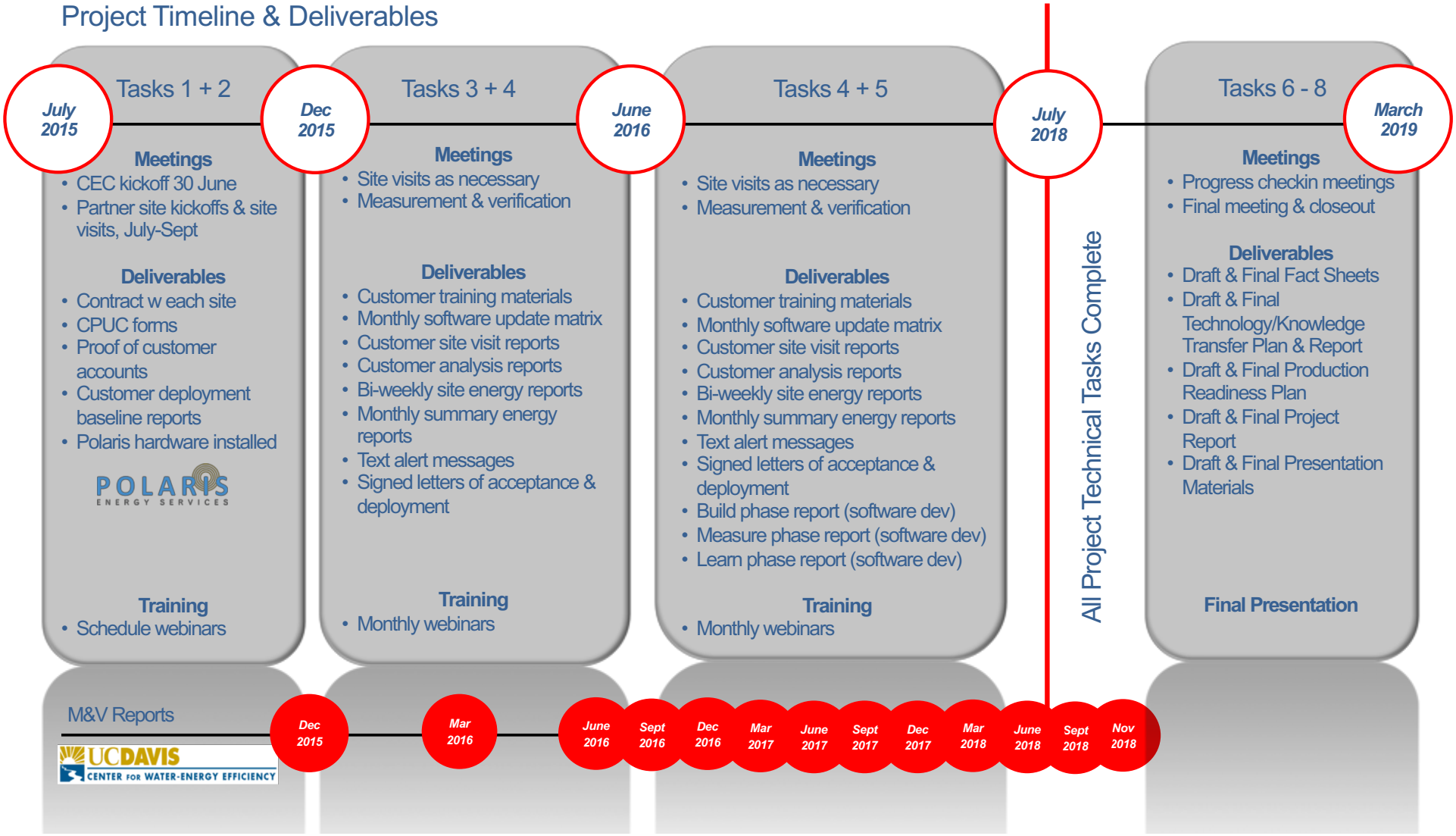
Technical Approach

Technical Approach

Scope of Work:

1. Confirm partner farms, visit sites to audit equipment and operations, and conduct baseline energy usage analysis.
2. Provide energy savings analysis and recommendations to partner farms.
3. Implement the hardware and software deployments and continuously engage customers.
4. Develop the energy software product.
5. Evaluate the project benefits. Collaborate with a third party, University of California Davis' Center for Water-Energy Efficiency (CWEE), on the measurement and verification for the project.
6. Transfer technology/knowledge to key stakeholders, the public and policy decision makers.
7. Prepare for production readiness to ensure the commercialization of the project results.

Project Timeline & Deliverables



Technical Approach

Partner Farm Sites:

- Wexus selected 4 partner farms with a variety of crop types with different planting and harvesting schedules and different irrigation requirements
  - spread **across 3,700 total acres**
  - **11 ranches** with **47 irrigation pumps** connected to **36 electric utility meters**
- Each partner farm was a highly engaged, early adopter with a commitment to participate in the project for multiple years. They made time for the project for regular check-ins, equipment installations, and periodic surveys/interviews:

1. **Berry Grower:** 870 acres / 4 ranches/ 12 pumps in Salinas CA (PG&E Territory)
2. **Row Crop Grower:** 1600 acres / 2 ranches / 16 pumps in King City CA (PG&E Territory)
3. **Vineyard:** 508 acres / 2 ranches / 5 pumps in Soledad CA, (PG&E Territory)
4. **Dairy & Almond Grower:** 725 acres / 3 ranches / 16 pumps in Hanford CA, (SCE Territory)

Technical Approach

Project Subcontractors:

- **Polaris Energy Services, Inc.**
  - Hardware and sensors for real-time data
- **University of California at Davis**, Center for Water Energy Efficiency (CWEE)
  - Measurement and verification reports

Technical Approach

Build-Measure-Learn (BML) Product Development:

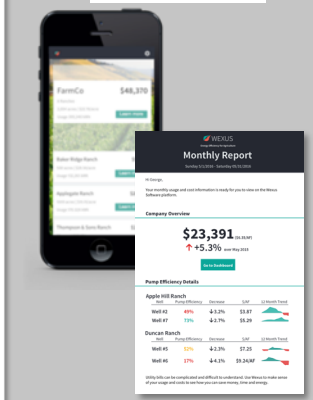
- BML is a process to achieve continuous software product development
  - Build Phase: Develop ideas & hypotheses
    - about key problems facing agribusinesses & potentially useful product solutions
    - validated with market research, partner farm interviews & testing in the field
  - Measure Phase: Code & tests
    - tested prototypes of product features with partner farm users
    - deployed IoT hardware devices & sensors in the field
    - released software features into production
    - built user metrics
  - Learn Phase: Data & KPI's
    - gathered data & insight from regular customer interviews
    - operational feedback from the field
    - remote monitoring of ongoing user metric reports & key performance indicators (KPIs)

Technical Approach

Technical Approach: Road Map

July 2015 — Tasks 1 + 2

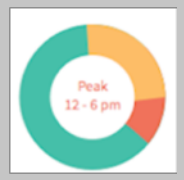
Customer Engagement



Dec 2015 — Tasks 3 + 4

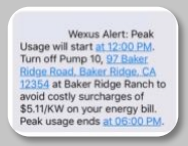
Utility Bill Management

Demand Management



June 2016 — Tasks 4 + 5

Real Time Insights & Alerts



Energy Efficiency

July 2018 — All Project Technical Tasks Complete

March 2019 — Tasks 6 - 8

Build-Measure-Learn Phases

Usability testing

- The Wexus team gathered feedback from 4 partner farms through a series of moderated testing sessions
- Presented users with various software prototypes to gauge effectiveness
- Goals of these sessions were to:
  - Discover basic usability problems
  - Gauge user understanding of core software feature concepts
  - Understand how the data being presented is used & acted upon
  - Gauge the value of data & users' understanding of data visualizations
  - Gauge user understanding of software interface and graphics

Build-Measure-Learn Phases

Figure 31: Word Cloud of Positive Partner Farm User Feedback

Build-Measure-Learn Phases

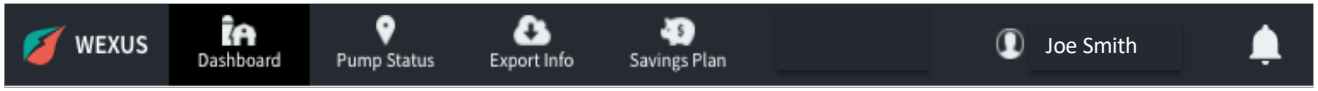
Figure 32: Word Cloud of Partner Farm User Recommendations

Build-Measure-Learn Phases

Development of User Personas (Figure 10)

- The Wexus platform is designed for 4 distinct user personas which were rigorously tested in the field

Build-Measure-Learn Phases



Dashboard

- Owners/C Level
  - General Managers
  - Portfolio Managers

Pump Status

- Ranch Managers
  - Irrigators
  - Consultants

Export Info

- CFOs
  - Accountants
  - Admins

Savings Plan

- Owners/C Level
  - Sustainability Mgrs
  - Accountants & Admins

Build-Measure-Learn Phases

Figure 9: Storyboard for the “GM George” & “Reporting Rachel” user personas

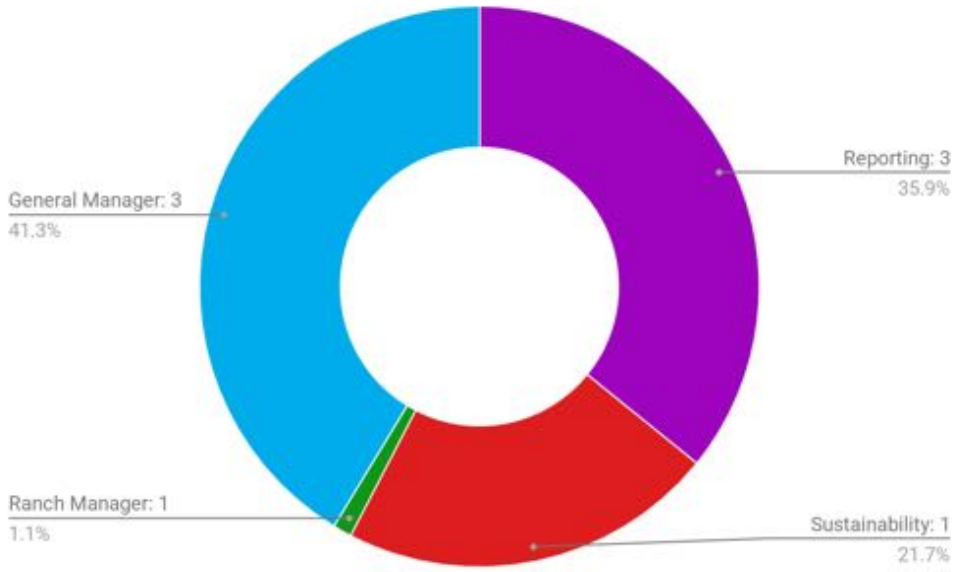
Build-Measure-Learn Phases

Storyboard for the “GM George” & “RM Ralph” user personas

Build-Measure-Learn Phases

Logins by User Persona Type (Figure 37)

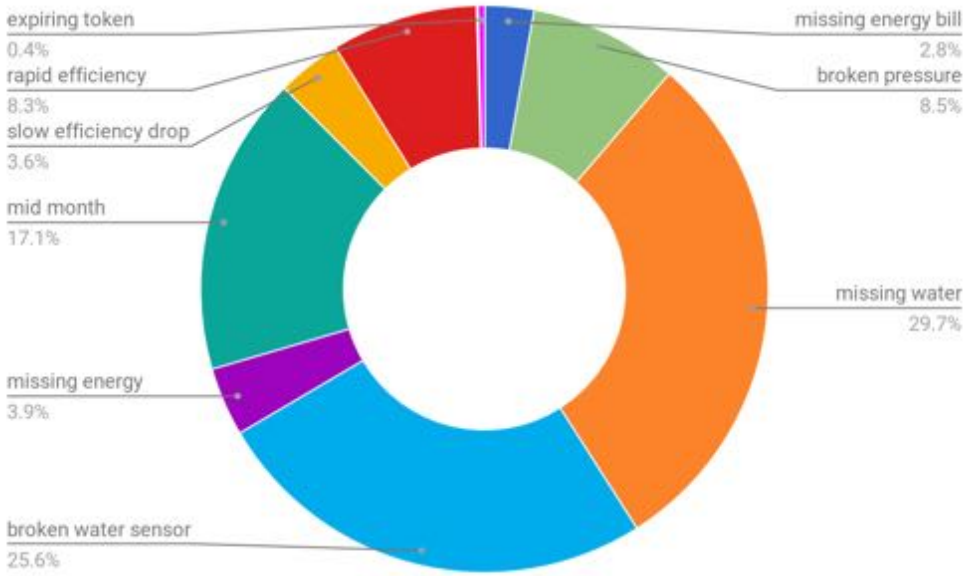
- General Managers & Reporting users had the most logins



Build-Measure-Learn Phases

In-app Alerts by Type (Figure 51)

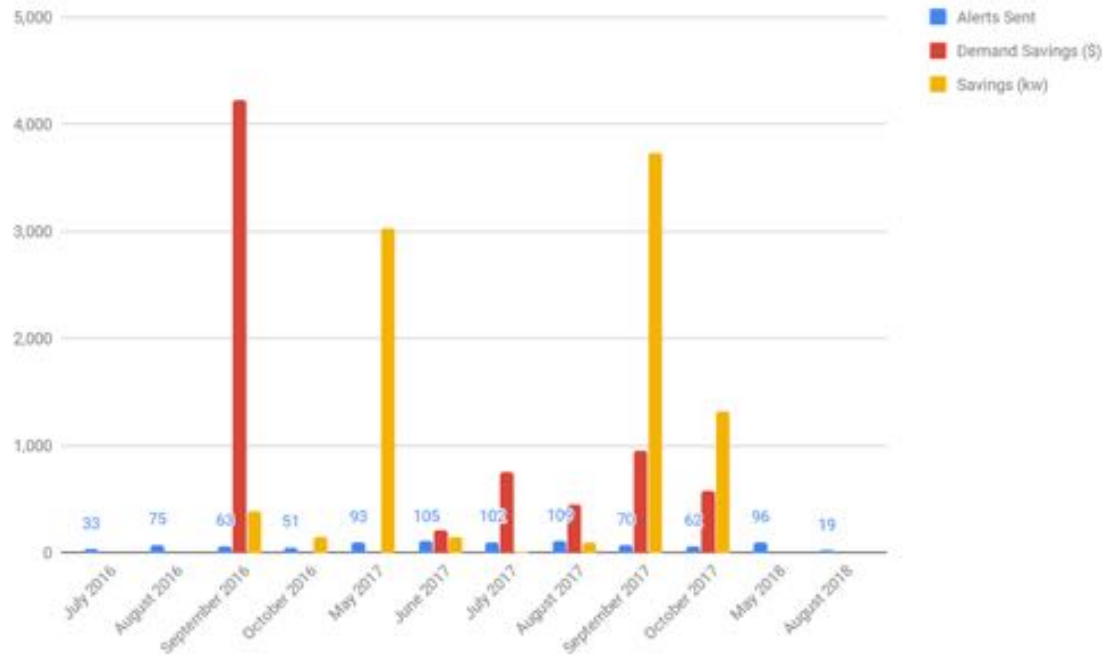
- Broken sensors & missing data had the most alerts



Build-Measure-Learn Phases

SMS Peak Demand Alerts (Figure 52)

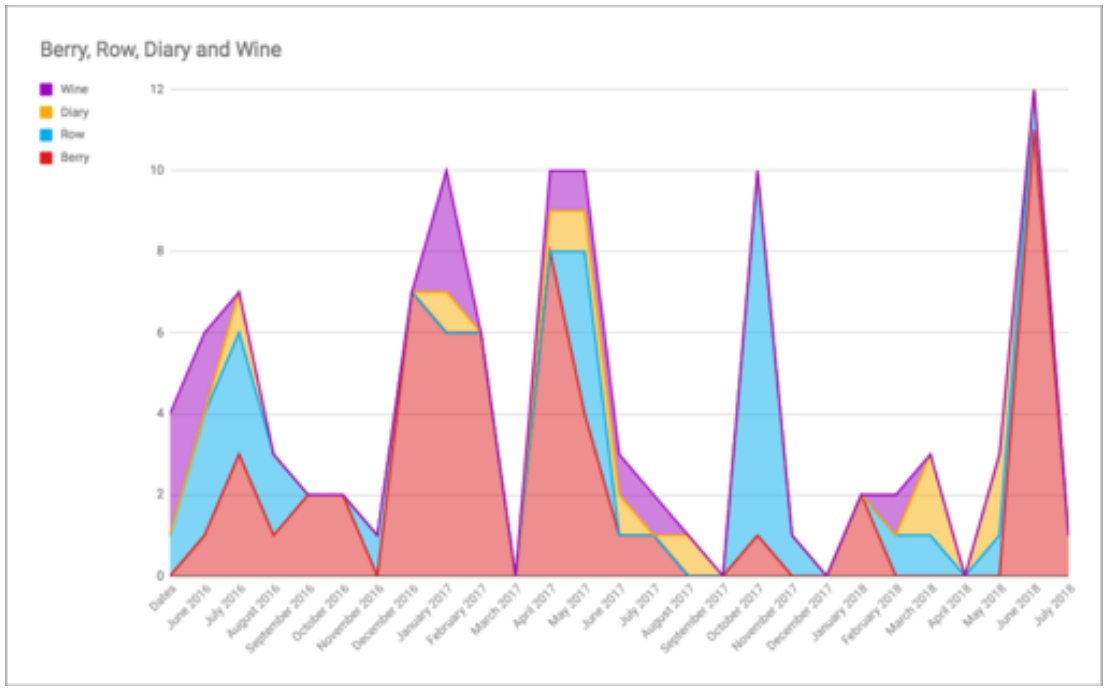
- Alerts were sent during summer months to avoid peak usage & costs



Build-Measure-Learn Phases

Monthly logins by partner farm (Figure 62)

- There was more user activity during the less busy late spring-early summer & winter months

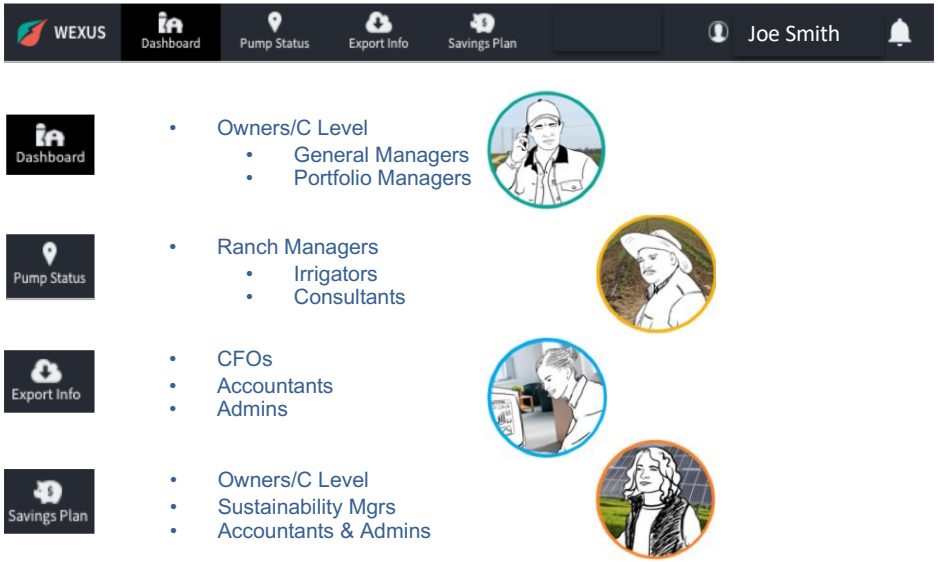


Build-Measure-Learn Phases

Feature Development

Wexus Software Version 3.0 release

- Simpler, more intuitive user interface
- Dashboard, Data Export, Alerts, Reports
- Geolocation & Weather data
- Add'l user types & alert settings



How does Wexus work?

- Wexus' IoT cloud software platform **uses what's already there: on-site utility infrastructure**
- **No additional equipment is needed** for a customer to get a proposal, get started & realize ROI
- Remotely connects with a farm's irrigation pumps, buildings & solar arrays through **existing, on-site** utility smart meters & billing systems
- Customers sign up & release their data online. Wexus remotely provides all onboarding & support
- Software continuously monitors & alerts customers to anomalies & automates reporting
- Utilities provide financing to pay for efficiency equipment upgrades & sensors
- **Wexus then unlocks an entire ecosystem of vendors/partners** with our Enterprise plan for hardware/sensor upgrades, solar tracking, irrigation dealer maintenance

Features that drive continuous value

Reports + Alerts

Get monthly bill reports with year-over-year trends, pump health status & text alerts to your phone to avoid high costs + labor & equipment problems.

Dedicated Support

Customized analysis, savings advice & continuous support from a Wexus energy engineer who's **not on your payroll.**

Utility Bill + Water Data Management

All of your information in one place. A "whole farm" approach to energy usage & costs with year-over-year trends, ranch & equipment breakdown. **Easily export your energy & water usage data.**

Savings Plan

We automatically create a plan for your & track money & energy saved every month. Easily find & apply for utility rebates & incentives. Quickly get in touch with contractors & your utility.

Pump Health Monitor

Remotely track irrigation pump efficiency. Get alerted to pumps that need maintenance or wells that are at risk of failure & crop loss.

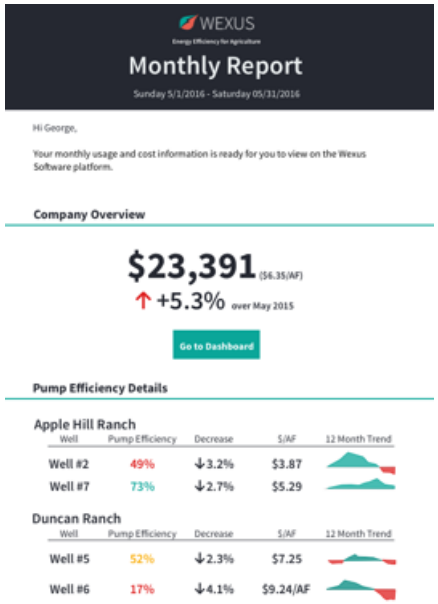
Real Time Insight + Submetering

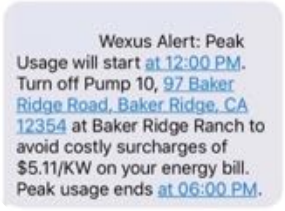
Stream your energy & water data via hardware installed at your irrigation pumps (**Enterprise plan only**). Track your energy usage + costs down to the equipment level. Split bills with tenants. Great for food processing facilities & indoor/ greenhouses.

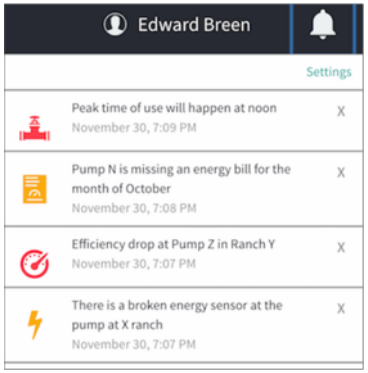
Predictive Cost Calculator

Make a more informed irrigation decision with predictive tools that forecast your estimated energy costs.

Reports + Alerts, Dedicated Support







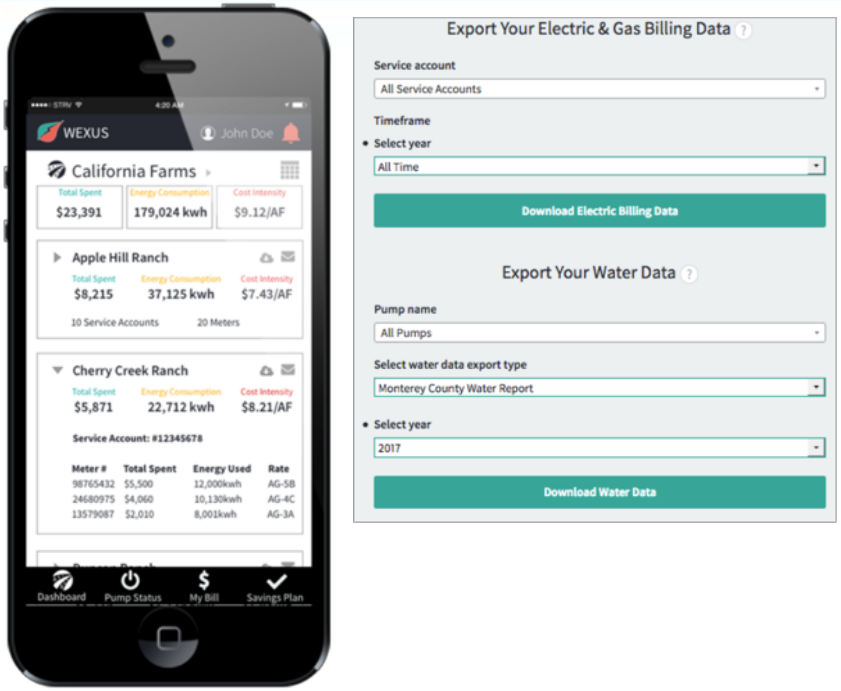
Reports + Alerts

- Reports pushed directly to your email inbox
- In-app & SMS text message alerts by ranch and by pump set up for you
- Dropping pump efficiency, energy spikes, peak usage, missing bills or meter data, broken sensors

Dedicated Energy Engineer

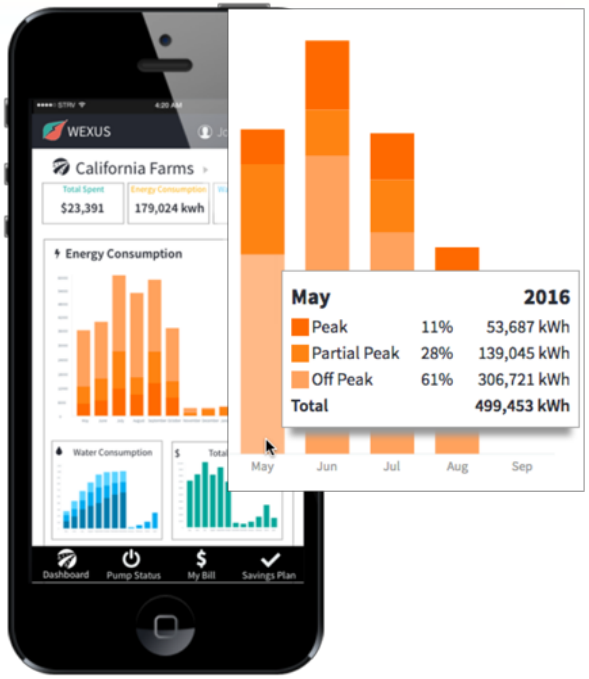
- Have a trusted energy advisor not on your payroll
- Runs customized analysis to drive savings & checks in with you monthly to help answer questions

Utility Bill Management + Data Export



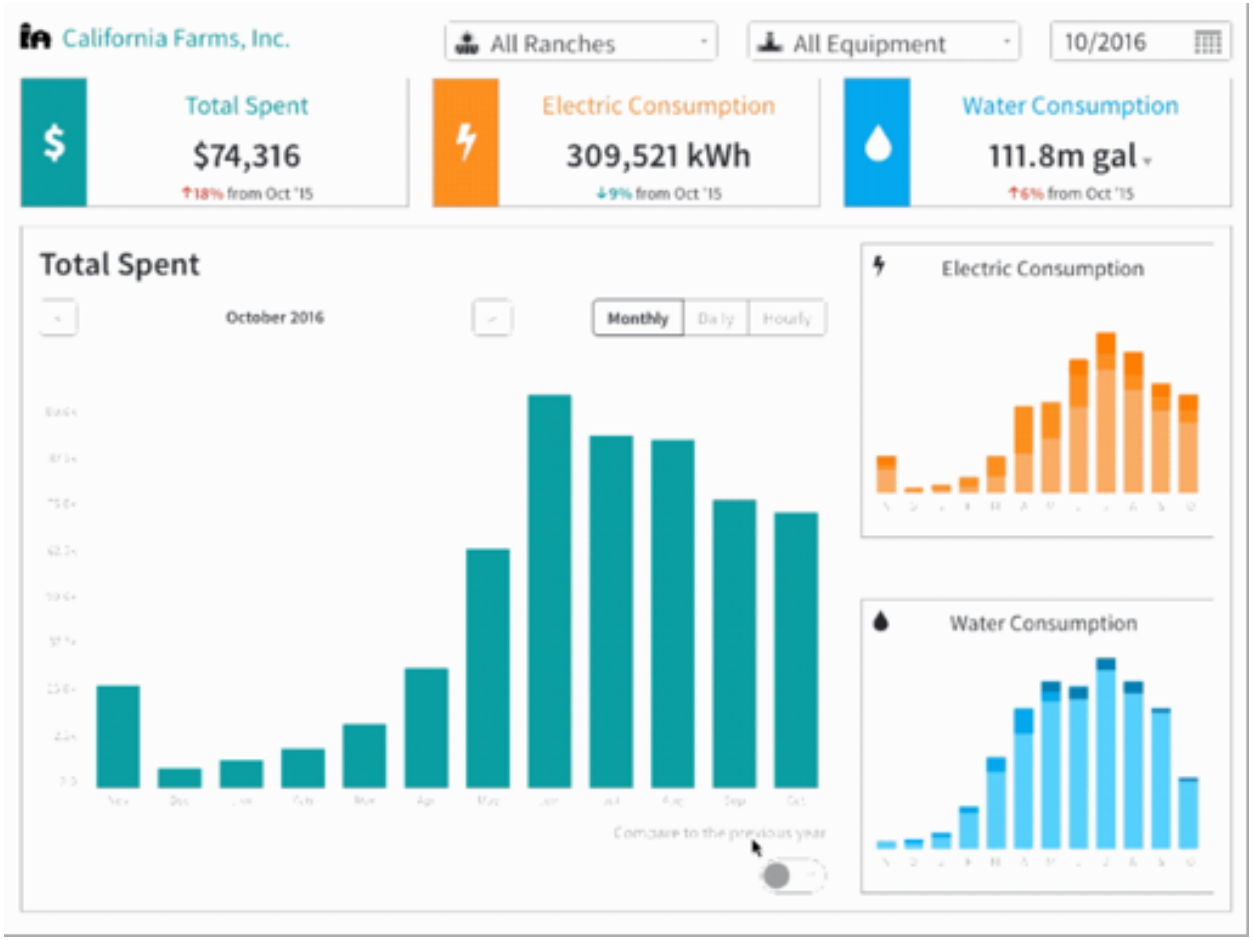
Utility Bill Management

- Know what's driving your energy & water cost & usage trends across ranches, year-over-year

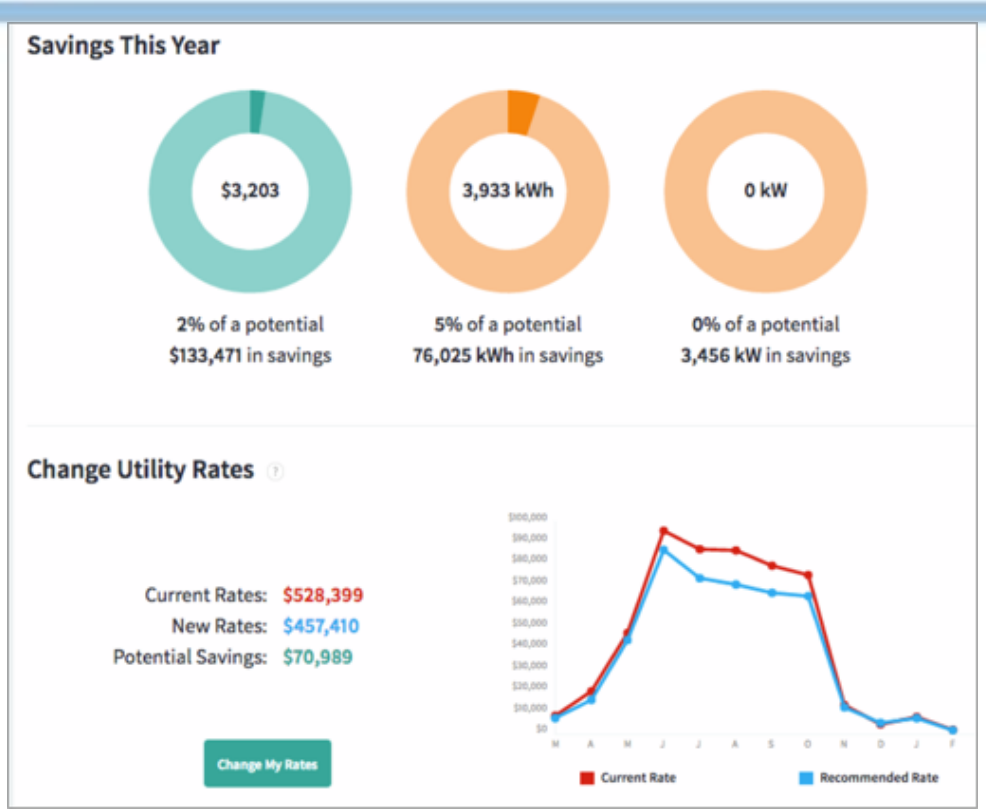


Demand Management

- Know how much peak energy usage & surcharges are costing you across each month by each meter

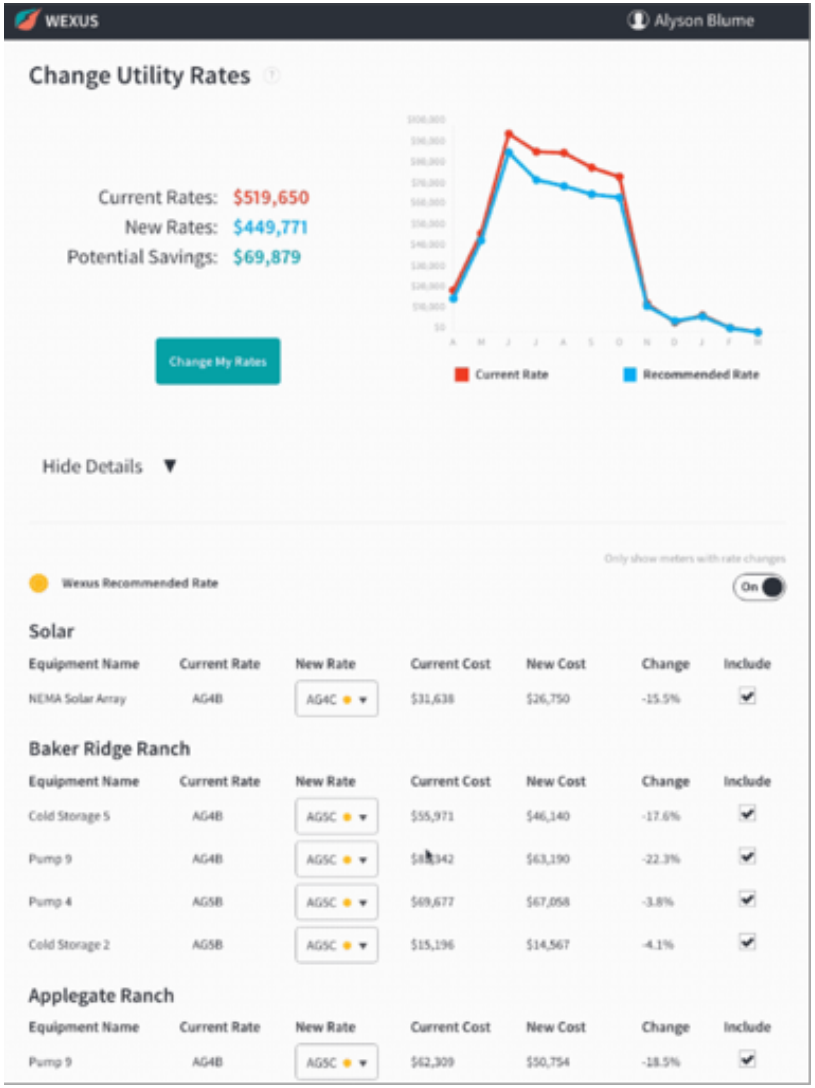

California Farms, Inc.
All Ranches
All Equipment
10/2016
Total Spent
$74,316
18% from Oct '15
Electric Consumption
309,521 kWh
9% from Oct '15
Water Consumption
111.8m gal
6% from Oct '15
Total Spent
October 2016
Monthly
Daily
Hourly
Compare to the previous year
Electric Consumption
Water Consumption

Savings Plan

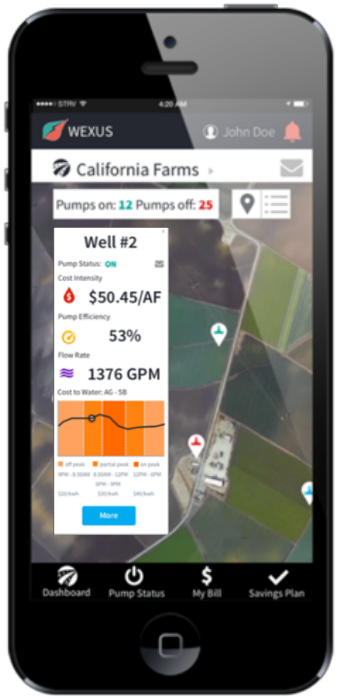


Savings Plan

- Demystifies energy rate plans, recommends better ones to suit your operations & continuously updates costs based on your actual energy usage
- Automatically tracks your cost, energy (kWh), and power (kW) savings on a continuous basis
- Identifies potential utility rebates or incentive programs to drive more cost savings


WEXUS
Alyson Blume
Change Utility Rates
Current Rates: $519,650
New Rates: $449,771
Potential Savings: $69,879
Change My Rates
Current Rate
Recommended Rate
Hide Details
Wexus Recommended Rate
On
Solar
Equipment Name
Current Rate
New Rate
Current Cost
New Cost
Change
Include
NEMA Solar Array
AG4B
AG4C
$31,638
$26,750
-15.5%
Baker Ridge Ranch
Cold Storage 5
AG4B
AGSC
$55,971
$46,140
-17.6%
Pump 9
$63,190
-22.3%
Pump 4
AGSB
$69,677
$67,058
-3.8%
Cold Storage 2
$15,196
$14,567
-4.1%
Applegate Ranch
Pump 9
$62,309
$50,754
-18.5%

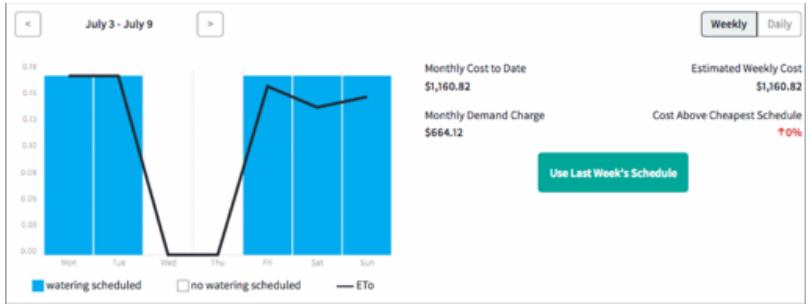
Pump Health Monitor + Predictive Cost Calculator



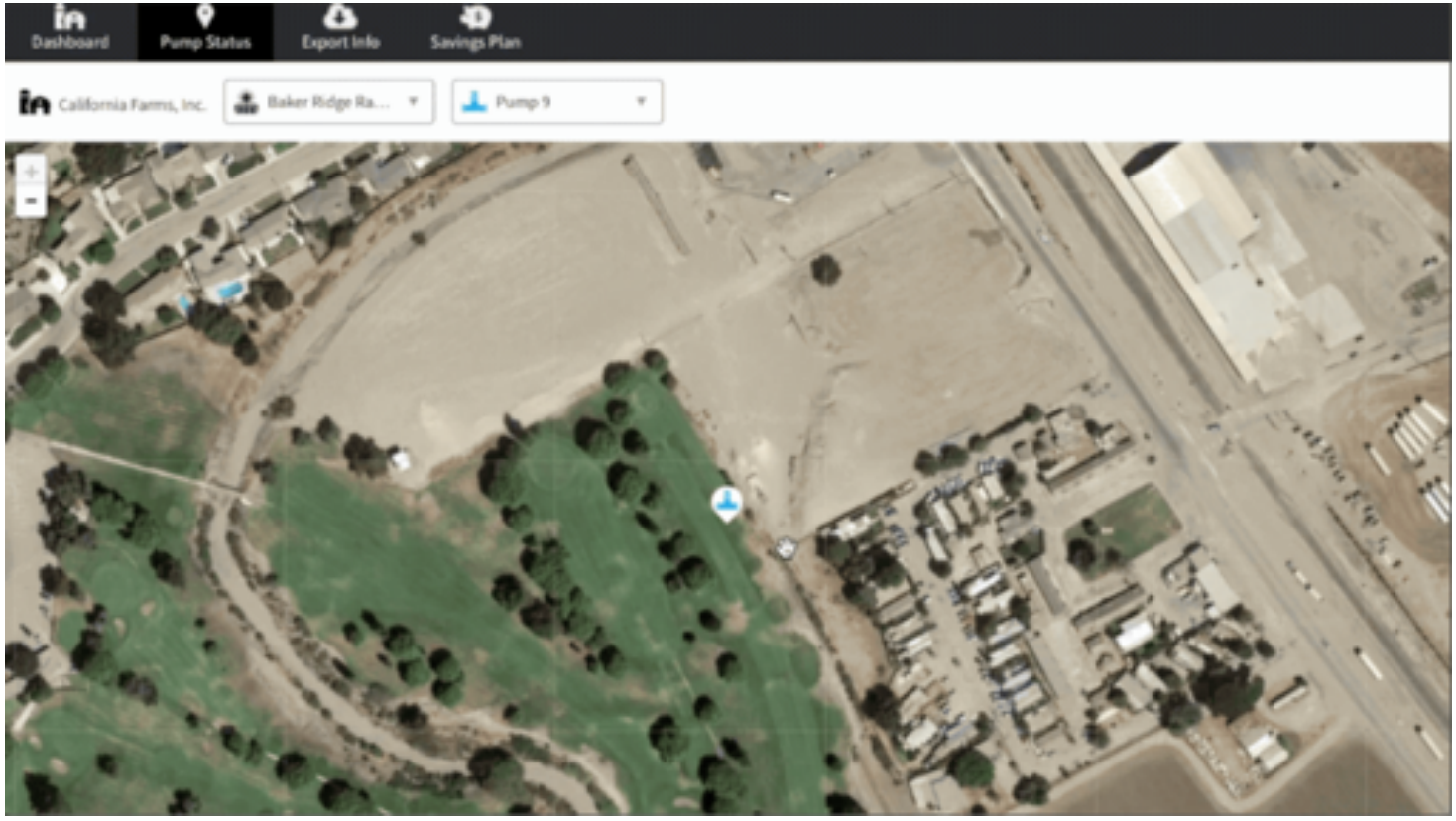
Make a more informed irrigation decision with predictive tools that forecast your estimated energy costs based on your irrigation sets, weather (ET) & how much water you need to apply

Pump Health Monitor + Predictive Cost Calculator

- Growers can irrigate during “off-peak” hours with Wexus’ Predictive Cost Calculator
- Pulls in weather data (ET), energy tariff data, pump specifications & run time
- Calculates & predicts actual energy & power demand costs by day & by week
- Growers don’t have to guess what their energy-irrigation costs will be
- Growers can potentially lose less water to evapo-transpiration by avoiding irrigation during the hottest times of the day



Pump Health Monitor + Predictive Cost Calculator



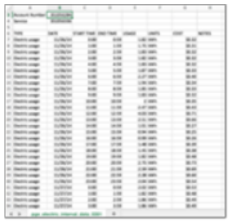
Pump Health Monitor + Predictive Cost Calculator

Calculating Pump Efficiency

$$\text{Pump Efficiency} = \frac{\text{Water Use} * \text{Depth} * 1.024}{\text{Energy Use}}$$

Symbol	Description	Source	Units	Interval
Energy Use	Energy Use at the pump or electrical panel	Energy Meter Interval Data	kWh	15 min
Water Use	Water Use at the pump	Flow Meter Interval Data	AF/Gal	15 min
1.024	Conversion Unit	Constant	kWh/(acre-ft)ft	-
Depth	Total Lift in feet	User Input or Pump Test Report	ft	-

Source: Advanced Pump Efficiency Program (APEP)



Calculating Pump Efficiency

Pump Performance Efficiency Scale*

Symbol	Description	Alert	Recommendation
> 60%	Good	No	Continue preventive maintenance.
50% < < 59%	Average	Yes	Conduct preventive maintenance.
<50%**	Poor	Yes	Pump is at risk of failure. Investigate retrofit, repair or replacement

*based on Advanced Pumping Efficiency Program (APEP) guidelines.
**Efficiency less than 5% could indicate that a pump is not operating.

Improving Pump Efficiency

Common Causes of Low Efficiency:

1. Lack of system maintenance.
2. The wrong pump for the system.
3. Pump wear from cavitation or abrasion.
4. Improperly sized or designed fittings.
5. Water source changes. Falling aquifer levels.

How to Improve Pump Energy Efficiency (for Electric Motors):

1. Rebuild older motors & gain several % points in motor efficiency.
2. Consider a premium-efficiency motor over a standard-efficiency motor when installing a new system, when replacing over or undersized motors, or when the cost of rewinding exceeds 65% of the price of a new motor.
3. Consider a variable frequency drive (VFD) if you need to produce a wide range of flows & pressures to meet varying system needs.
4. Constant-pressure valves or flow-control nozzles may be a lower-cost alternative to a VFD, (although they're less energy efficient).

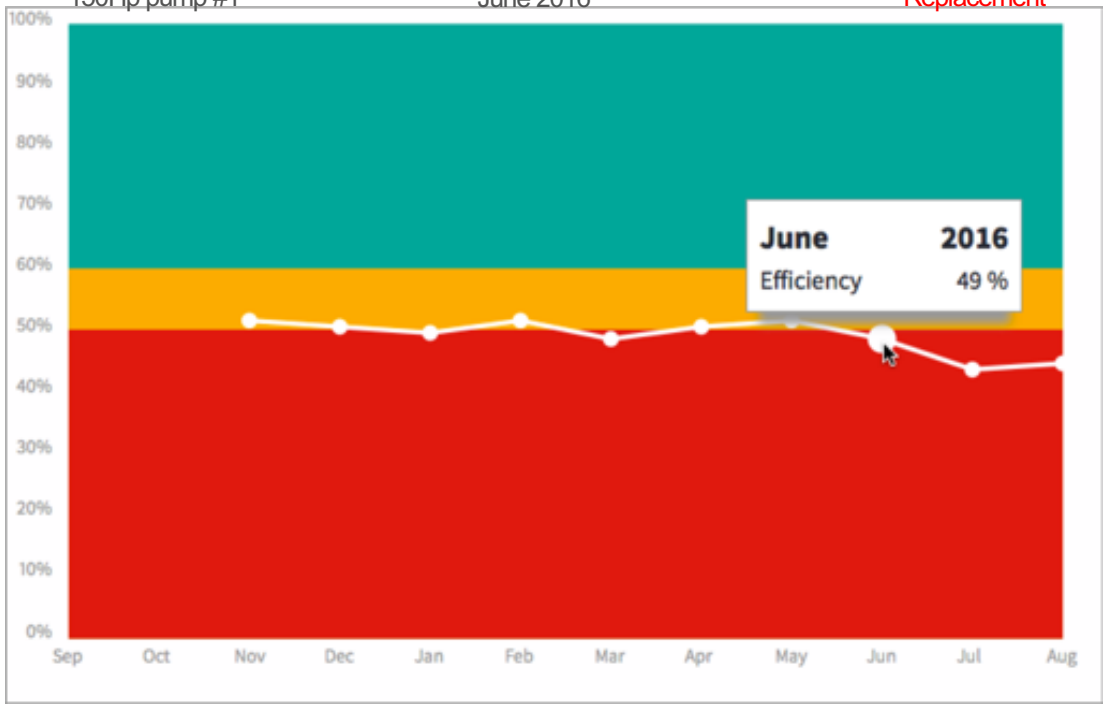
Source: Advanced Pump Efficiency Program (APEP)

Tracking Efficiency in Real Time with Wexus Pump Health Monitor

Vegetable Grower
Salinas Valley
150Hp pump #1

Average efficiency
49%
June 2016

Action to Take:
Maintenance / Repair
Replacement

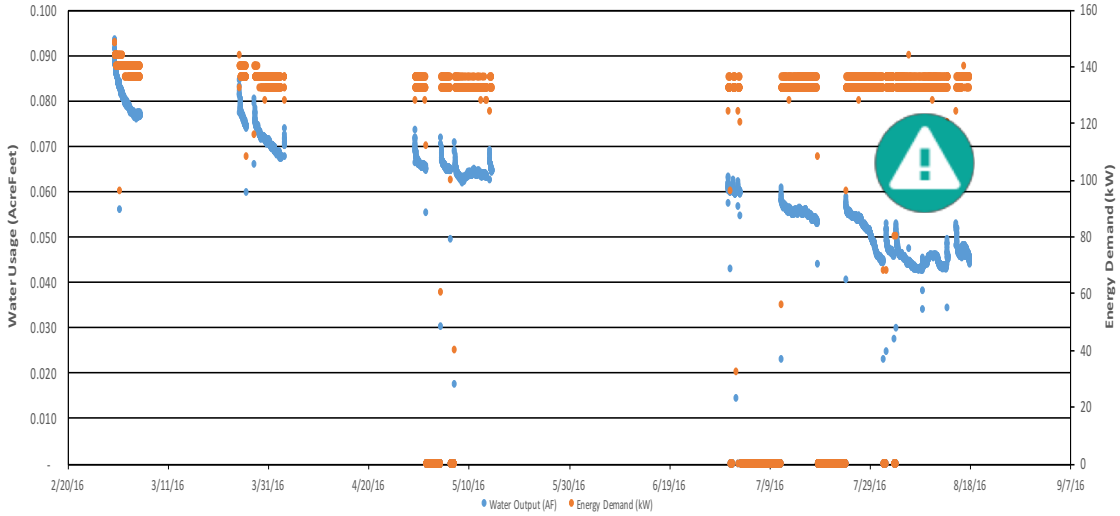


Hardware + Sensors for Real Time Monitoring

Real Time Data

- Energy & water usage tracking in real time
- Onsite data logger transmitting to cloud network
- Remote shut off capability, ADR compliant
- Reduces manual workloads with real automation

Case Study #1:
Wexus Pump Health Monitor

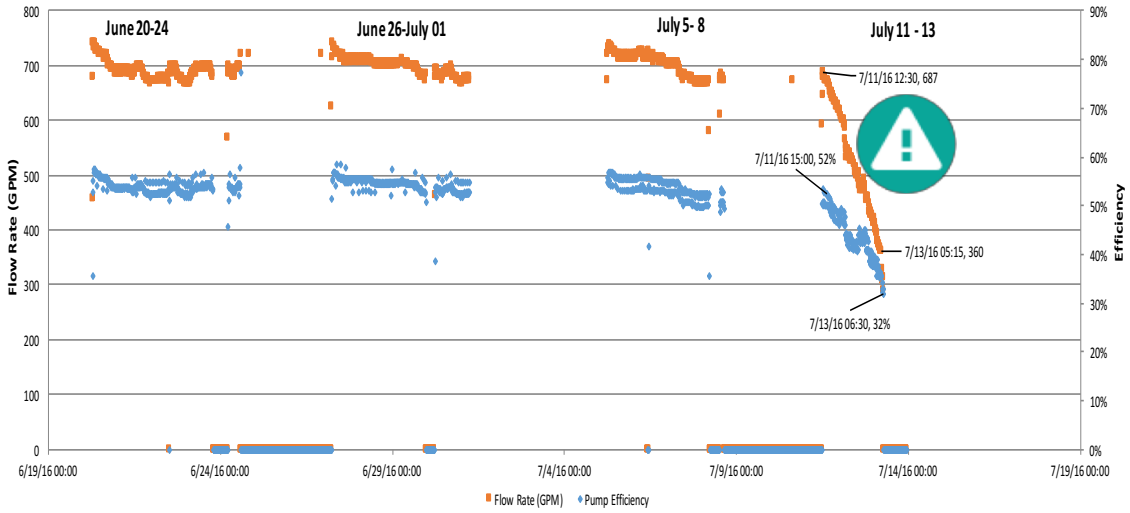


AQUIFER DEPLETION

Dairy/Alfalfa, Central Valley CA

- Wexus measured significant decreases in water output, high energy usage & dropping efficiency over several months at a recently drilled deep well
- This was caused by over-pumping & led to falling aquifer levels
- The grower pulled the pump from this well before running out of water & converted to surface water irrigation

Case Study #2:
Wexus Pump Health Monitor



PUMP FAILURE

Vineyard, Salinas Valley CA

- Wexus measured significant decreases in pump efficiency 2 days before a well pump failed & alerted the grower
- This was caused by a blowout on a 20 year old well casing which can burn out pump motors

Project Results

Project Results

Achieved the goals of the project:

1. Engaged 4 agricultural deployment sites in California Investor Owned Utility (IOU) territories to participate in the Wexus mobile software project
2. Identified energy (and water) efficiency measures at these sites
3. Provided wider proof-of-concept and use cases for scaling the Wexus mobile software platform throughout IOU regions in California
4. Fully assisted & trained deployment sites in the effective use of the Wexus mobile software platform to quantify actual energy (and water) savings after measures had been implemented

Project Results

Achieved the goals of the project:

- Aided 4 partner farms in reducing their overall energy usage by providing actionable energy & cost data, including at peak times of day
  - Project demonstrated that access to actionable, data-driven insights provided partner farms visibility & option to reduce energy usage & costs by 10% from baseline
- Developed & refined the Wexus cloud-based IoT software platform through deep analysis of:
  - utility electric meter data
  - utility tariff and rate data
  - utility bills
  - water usage data
  - geolocation data
  - greenhouse gas emissions data
  - continued agricultural customer feedback, education & training at the site level

Project Results

Achieved the Objectives of the project:

1. Engaged 4 agricultural deployment sites in California Investor Owned Utility (IOU) territories to participate in the Wexus mobile software project
2. Aided agricultural deployment sites in reducing their overall energy usage by providing actionable energy and cost data, including at peak times of day
3. Targeted energy reductions by up to 10% from baseline usage
4. Continued to develop & refine the Wexus cloud-based software platform through deep analysis of utility electric meter data, utility tariff and rate data, utility bills, water usage data, greenhouse gas emissions data and continued agricultural customer feedback at the site level
5. Engaged 4 agricultural deployment sites in:
    - continuing education & training on the effective use of the technology to reduce their energy usage by up to 10%
    - identified potential energy savings measures in the field
    - quantified actual energy savings after savings measures had been implemented

Project Results

Impact of the project:

- Total Cost Savings/Year **$164,800**
- Total Energy Savings/Year **1.14M kWh***
- Total Power/Demand Reduction **+8.9MW**
- Average Water Savings **~8%****
- Total GHG Reduction **706k lbs Co2**

Project Results

Partner Farm	Average change in electricity/ costs – unadjusted*	Average change in electricity/ costs – adjusted**	Average change in water usage	Notes
Berry	-11.3% -118,990 kWh/year -$16,800/year	-5.6% -60,225 kWh/year -$8,400/year	-8.3%	
Row	-29% -998,411 kWh/year -$141,600/year	-1.8% -61,970 kWh/year -$8,800/year	-	Solar array was installed on-site mid-project for additional energy and cost savings, impacting model and water estimates.
Dairy	+1.8% +31,725 kWh/year +$1200/year	+7.3% +128,663 kWh/year +$4,000/year	-	Increases are due to uncontrolled variables. Dairy farm had extreme variability in pump usage over time and long periods of non-use due to operational needs. Electric usage data was also unavailable in 2018 due to a utility data access issue, so the full project duration was not evaluated. Water monitoring equipment was relocated mid-project due to customer needs.
Vineyard	-15.3% -53,783 kWh/year -$7,600/year	-12.7% -44,643 kWh/year -$6,400/year	-8.9%	
TOTAL	-17.2% -1,139,459 kWh/year -$164,800/year	-1% -38,175 kWh/year -$19,600/year	-	The statistical models CWEE used to calculate the adjusted results were limited and not able to take into account all of the external variables in the agricultural industry; future studies are recommended.

- *unadjusted (i.e., directly calculated) average change in the average electricity use levels between the baseline and project time periods, and
- **adjusted results from several statistical models, which estimate the impact of factors outside the scope of the project (e.g. major farm operation/crop changes, weather, drought conditions, and EE equipment or renewable energy installations).

Technology/Knowledge Transfer

Technology/Knowledge Transfer

- The goal of Technology and Knowledge Transfer scope is to disseminate the knowledge gained, experimental results, and lessons learned from the project to the public and key decision makers.

- The Wexus team will leverage results of the project to increase the market awareness of the Wexus technology solution for the agricultural industry.

Technology/Knowledge Transfer

Activity	Schedule	General Public	Agri-business	Electric Service Provider	Hardware Provider
Blog post with summary of project and download link to final project fact sheet	By 1/30/19	X	X	X	X
Blog post follow-up with download link to final project report	By 2/28/19	X	X	X	X
Product Feature Email Update to include link to blog post	Once a month on average		X - Current Customer Only		
Ads in targeted ag trade publications	By 2/28/19		X		X
Conference for farm industry and distribute final project fact sheet	By 1/30/19		X	X	X
Conference for utility industry – distribute final project fact sheet	By 1/30/19			X	X
Participate in solicitation for 3rd party EE program implementers with CA IOUs	Estimated Q1 2019			X	

Technology/Knowledge Transfer

The Wexus team identified several new challenges in 2018-19 that policy decision makers need to be aware of as they continue to research and fund programs in the water-energy nexus.

Solving these issues for the agricultural industry will ultimately **help California achieve its long-term energy goals of 100% renewables by 2045:**

1. **Better tracking tools for solar photovoltaic (PV) system net metering.** NEM bills are difficult to interpret & farms often do not have analytics tools to determine whether PV systems (often +1MW in size) are generating as expected.

2. **Public + private financing options for IoT hardware and sensors** to help low-margin agribusinesses invest in solutions that will enable real time data-driven decision-making + energy & water conservation.

3. **Access to Community Choice Aggregators (CCA's) billing data to** provide customers with access to local & high-renewable-mix electricity. Currently unavailable through IOU's Green Button Connect platforms.

4. **Advanced Cost Calculator tools** to incorporate more agronomic data such as weather & crop type energy intensity to drive more accurate energy & cost savings.

5. **SaaS tools to educate & select the best utility time of use (TOU) rate changes** scheduled in California in 2019 and 2020 which will affect farms as they evaluate the best options for their operations. Will help farms save money while placing less stress on the utility grid.

Production Readiness Plan

Production Readiness Plan

- The Production Readiness Plan outlines the steps that will lead to further commercialization of the project's results.
- One of the primary goals of this project was to provide wider proof-of-concept and use cases for scaling the Wexus mobile software platform throughout IOU regions in California.
- Over the course of this project, Wexus has already succeeded in commercializing the product in California with particular focus on the Pacific Gas & Electric (PG&E) electric service territory.

Production Readiness Plan

The strategy for further commercialization in California will be a 4 step approach:

1. Continue to the drive growth in the PG&E service territory through an on-going Ag-Energy program

2. Expand into additional electric service territories in California, including Southern California Edison (SCE), San Diego Gas & Electric (SDG&E), various CCA's and public municipalities with advanced metering infrastructure (AMI)

3. Serve as a Third-Party Energy Efficiency (EE) Program Implementer under the new California Public Utilities Commission (CPUC) mandated rolling portfolio structure

4. Expand partnerships with local channel partners (for example, hardware providers) in targeted agricultural markets

Production Readiness Plan

Wexus Value Proposition

Reduce Costs & Reduce Waste

- Instant ROI: Saves money off energy bills , automates labor tasks
- Averaging 10% and up to 40% annual cost savings
- Drives higher energy & water efficiency, boosting net operating income

AI Detects Equipment Problems Early

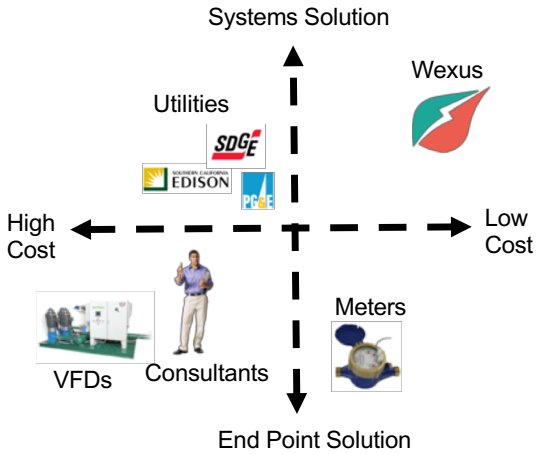
- Real time alerts of pump equipment or aquifer problems before they affect crop yields & labor shortages
- Know how much energy & cost a processing, cold storage or indoor operation is using down to the equipment level

Save Time & Automate Reporting

- Zero data entry required for customers to track bills, costs or usage
- Our Ag-Energy experts are not on a customer's payroll
- Reports directly to inboxes & real time alerts directly on a customer's phone

Stay in Compliance & Control Your Data

- Stay on top of CSR with automated cost & energy savings tracking
- Meet new water reporting regulations with automated reporting
- Securely & quickly control & export data with the click of a button



Production Readiness Plan

Wexus Flexible Pricing & Features

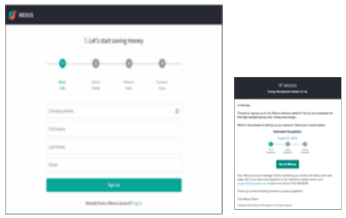
ENTERPRISE Daily Tracking, Alerts & Support	PROFESSIONAL Monthly Tracking, Reports & Support	STARTER Monthly Tracking & Reports
$179 /Meter, Per Month	$79 /Meter, Per Month	$49 /Meter, Per Month
Monthly Automated Rate Analysis with Annual Utility Change	Monthly Automated Rate Analysis with Annual Utility Change	Monthly Automated Rate Analysis with Annual Utility Change
Automated Utility Bill Tracking, Analysis & Data Export **(Daily)**	Automated Utility Bill Tracking, Analysis & Data Export **(Monthly)**	Automated Utility Bill Tracking, Analysis & Data Export **(Monthly)**
Peak Energy Load & Cost Tracking **(Daily)**	Peak Energy Load & Cost Tracking **(Monthly)**	Peak Energy Load & Cost Tracking **(Monthly)**
Pump Efficiency Tracking & Analysis **(Daily)**	Pump Efficiency Tracking & Analysis **(Monthly)**	Pump Efficiency Tracking & Analysis (Monthly)
Real Time Water Usage Tracking **(Daily)**	Real Time Water Usage Tracking (Daily)	Real Time Water Usage Tracking (Daily)
Solar Bill, Generation/Consumption & ROI Tracking **(Daily)**	Solar Bill, Generation/Consumption & ROI Tracking **(Monthly)**	Solar Bill, Generation/Consumption & ROI Tracking (Monthly)
Reports **(Bi-Monthly)**	Reports **(Monthly)**	Reports (Monthly)
In-App Alerts **(Daily)**	In-App Alerts **(Daily)**	In-App Alerts (Daily)
SMS Text Alerts **(Daily)**	SMS Text Alerts (Daily)	SMS Text Alerts (Daily)
Hardware with Real Time Insights & Controls	Hardware with Real Time Insights & Controls	Hardware with Real Time Insights & Controls
Dedicated Energy Engineer	Dedicated Energy Engineer	Dedicated Energy Engineer

Production Readiness Plan

Online Signup & Proposal

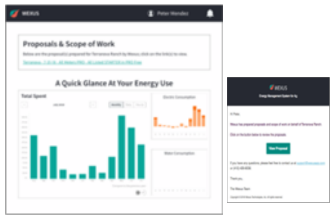
1. Wexus Marketing Page

2. Online Sign Up Page & Data Release Forms



3. Wexus Generates Online Proposal

4. Customer Reviews & Signs Online Proposal



5. Contract Closeout & Customer Onboarding

Production Readiness Plan

California Agricultural Market

- $42.6 billion
- 9 out of the top 10 U.S. ag counties including
  - Fresno ($5bn)
  - Tulare ($4bn)
  - Kern ($4bn)
  - Monterey ($3bn)
  - Merced ($3bn)

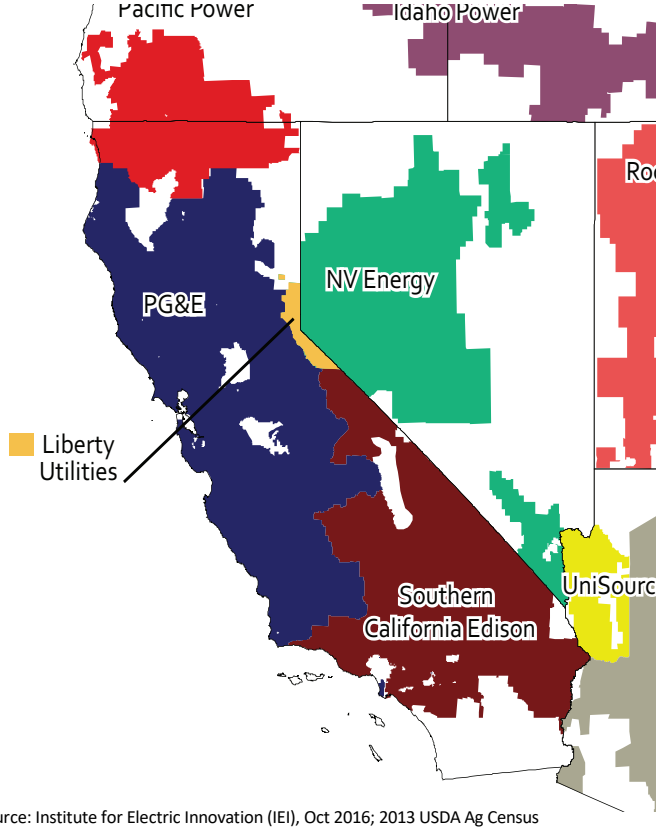
- 33-50% of U.S. fruits & vegetables are grown in CA
- Fresno County produces +400 commercial crops annually

Source: USDA

Production Readiness Plan

California Ag-Energy Market

- # Farms: 77,864
- Average size of farm: 328 acres
- # Farms that Irrigate: 53,546
- Annual Ag Electric Spend: $800m
- # Irrigation Pumps: 82,725
- Annual Irrigation Electric Spend: $545m
- # Electric Irrigation Pumps: 70,370
- **Annual Spend per Pump: $7,742**
- Major Utilities: PG&E, SCE, SDGE
- Smart meter coverage: 50-100%
- Meters installed (2016): 12,649,000



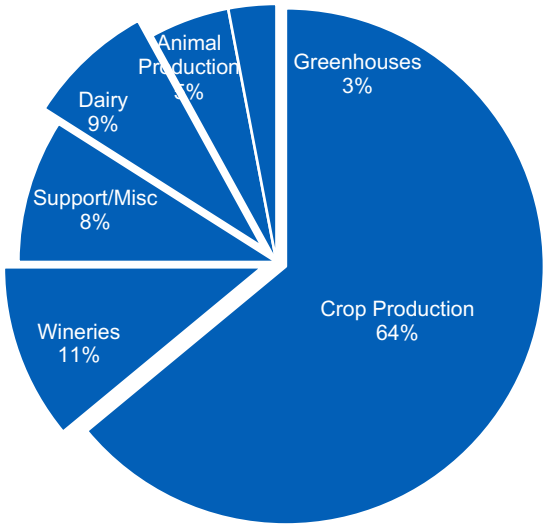
Source: Institute for Electric Innovation (IEI), Oct 2016; 2013 USDA Ag Census

Production Readiness Plan

2015 PG&E Ag Electric Usage: ~6,800 GWh/yr

- 62% of state Ag total
- ~5.5% of PG&E total load

Equivalent energy usage of
+850,000 homes or +400,000 cars



Source: PG&E, CEC

Conclusions

Conclusions

Goals & Objectives

Project achieved its goals to engage agricultural partner sites in California to use the Wexus mobile software to identify energy & costs savings

1. Wexus team provided wider proof-of-concept for several use cases & demonstrated the ability to scale the Wexus IoT software platform to help agribusinesses solve key problems including:
    - **Labor**: reduce wasted labor by remotely tracking equipment status & send real-time alerts for important labor-related events, such as irrigation pump efficiency & maintenance
    - **Regulation and Reporting**: reduce time spent & manual effort required to report on energy & water usage by aggregating paper utility bills into an easy-to-navigate dashboard & by exporting data in pre-formatted files approved by local regulatory agencies
    - **Costs**: provide growers with information about whether irrigation schedules were being followed & the associated costs; allow them to adjust and optimize irrigation equipment in the field, which may be experiencing efficiency or water aquifer problems; and reduce operational expenses due to energy costs by increasing efficiency with real time alerts before hitting peak hours.

2. Overall, results show that **3 of the 4 farms** had substantially lower average electricity usage during the project period relative to baseline values**, achieving the targeted 10% reduction from baseline values**

3. In total, **partner farms reduced electricity usage by 1.14 GWh/year or 17.2% on average (unadjusted)**

Conclusions

Key Lessons Learned

1. Critical need to **validate all product features & on-site hardware installations with continuous feedback from partner farms** to ensure the highest level of usability of features and to solve real problems for agribusinesses

2. Partner farms **grew different crops but had common issues & needs among in terms of energy & water management**
    - Were then **incorporated into scalable IoT software product features**

3. Ag industry is driven by personal relationships and networks, is very active in local communities, and **trust is a critical component of doing business**
    - **Critical for CPUC, CEC, IOUs and technology vendors to continue to listen & solicit feedback from ag industry players** in order to build effective & useful efficiency programs & technologies that actually solve problems instead of creating new ones

4. Before this project, **there were few (if any) M&V models** built specifically for the ag industry to calculate energy and water savings
    - It can be difficult to isolate & control for multiple external variables at farm sites with total confidence
    - **California farmers face multiple challenges including** unpredictable weather patterns and changes to labor and farm operations
    - **Critical to incorporate & test energy & water data from multiple years & hundreds of crop types from thousands of farms to improve these models**

Conclusions

Project Benefits to California & Next Steps

It is critical for energy policy makers to understand that farmers are running a business

Energy consumption is a cost of doing business for them, not a primary revenue driver

The Wexus team highly encourages the California Energy Commission (CEC), the California Public Utilities Commission (CPUC) and Investor Owned Utilities (IOU's) to research, provide funding, and create efficiency programs **to help solve these ongoing issues for the agricultural industry which will ultimately help California achieve its long-term energy goals of 100% renewables by 2045:**

1. Improved systems for **tracking solar photovoltaic (PV) system net metering**, bill savings and ROI
2. **Financing options for IoT hardware and sensors** that track both energy and water consumption and costs
3. Make it easier for customers to determining the ROI in advance of enrolling in **Community Choice Aggregation (CCA) programs**
4. Support **development of the Wexus Cost Calculator 2.0** to provide the next level of real time, predictive energy and cost management tools for ag irrigation & other industry sectors
5. Support education & transparency about **utility time of use (TOU) rate changes** launching in 2019 and 2020

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Appendix: Partner Farm Visits

Appendix A:
Partner Farm Site Visits

- The Wexus project team conducted several site visits at partner farms from July 2015 to March 2018 in order to meet with partner farmers and audit irrigation equipment

- Results were submitted to CAM in monthly progress reports

- Activities performed included:
  - auditing operations & equipment
  - documenting farm site/ranch names, acreages & locations
  - confirming meter names/numbers, locations & utility billing account data
  - identifying existing energy using equipment types, locations, equipment operating hours & specifications
  - site operations & working hours through one-on-one interviews with owners, facility managers & employees

Appendix A:
Partner Farm Site Visits

Partner Farm #1: Row Crop Grower, King City CA (PG&E territory)

Figure 19: Project team members surveying an irrigation pump tied to a PG&E utility pole/transformer & electric meter with old analog flow meter

Figure 23: Newly installed digital flow meter & pipe section at an irrigation pump

Figure 26: Row crop ranch survey with partner farmer and Wexus team members

Appendix A:
Partner Farm Site Visits

Partner Farm #1: Row Crop Grower, King City CA (PG&E territory)

Figure 30: PG&E electric meter, installed digital flow meter, pump motor & well

Figure 33: Installed digital flow meter

Figure 34: Installed Polaris monitoring device & associated wiring

Appendix A:
Partner Farm Site Visits

Partner Farm #2: Dairy & Almond Grower, Hanford CA (SCE territory)

Figure 35: Surveying a newly installed irrigation pump at the almond ranch adjacent to alfalfa fields

Figure 36: Surveying the almond ranch pump filtration system

Figure 46: Surveying a Polaris device, well pump, VFD & SCE meter cabinet

Appendix A:
Partner Farm Site Visits

Partner Farm #2: Dairy & Almond Grower, Hanford CA (SCE territory)

Figure 40: Newly installed SCE electric utility meter, pipe section, flow meter, pressure sensor & associated wiring

Figure 47: Polaris device & antenna installed at ranch well with variable frequency drive (VFD) enclosure

Figure 54: Almond ranch well pump in operation

Appendix A:
Partner Farm Site Visits

Partner Farm #3: Berry Grower, Salinas CA (PG&E territory)

Figure 59: Surveying an irrigation well pump house & old analog flow meter with berry grower staff

Figure 60: Strawberry fields

Figure 61: Booster pump and reservoir

Appendix A:
Partner Farm Site Visits

Partner Farm #3: Berry Grower, Salinas CA (PG&E territory)

Figure 62: Installed digital flow meter & pressure sensor

Figure 69: Ranch reservoir pumps & filtration equipment

Figure 70: Troubleshooting installation of monitoring hardware at a well pump with VFD enclosure

Appendix A:
Partner Farm Site Visits

Partner Farm #4: Vineyard, Soledad CA (PG&E territory)

Figure 81: Initial project kickoff meeting & vineyard site survey with CEC staff, partner farmers & project team members

Figure 83: Surveying a vineyard irrigation pump & filtration system with partner farmer

Figure 87: Surveying a vineyard irrigation pump

Appendix A:
Partner Farm Site Visits

Partner Farm #4: Vineyard, Soledad CA (PG&E territory)

Figure 88: Newly installed digital flow meter at an irrigation pump

Figure 89: PG&E utility meter & switchgear with newly installed Polaris monitoring hardware

Figure 90: Pre-harvest winegrapes