Using the PI System for Winery ZNE Goals and an Extensive Pinot Noir Study

Jill Brigham
Executive Director, Sustainable Wine & Food Processing Center
Ron Runnebaum
Assistant Professor, Viticulture & Enology, Chemical Engineering

A Sustainable Winery

How the PI System will Enable the UC Davis Winery to Reach Net Zero Energy & Water Goals

Jill Brigham
Executive Director, Sustainable Wine & Food Processing Center

About UC Davis

UC DAVIS
COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

Leadership in Sustainability

#1 COOL SCHOOL
SIERRA MAGAZINE

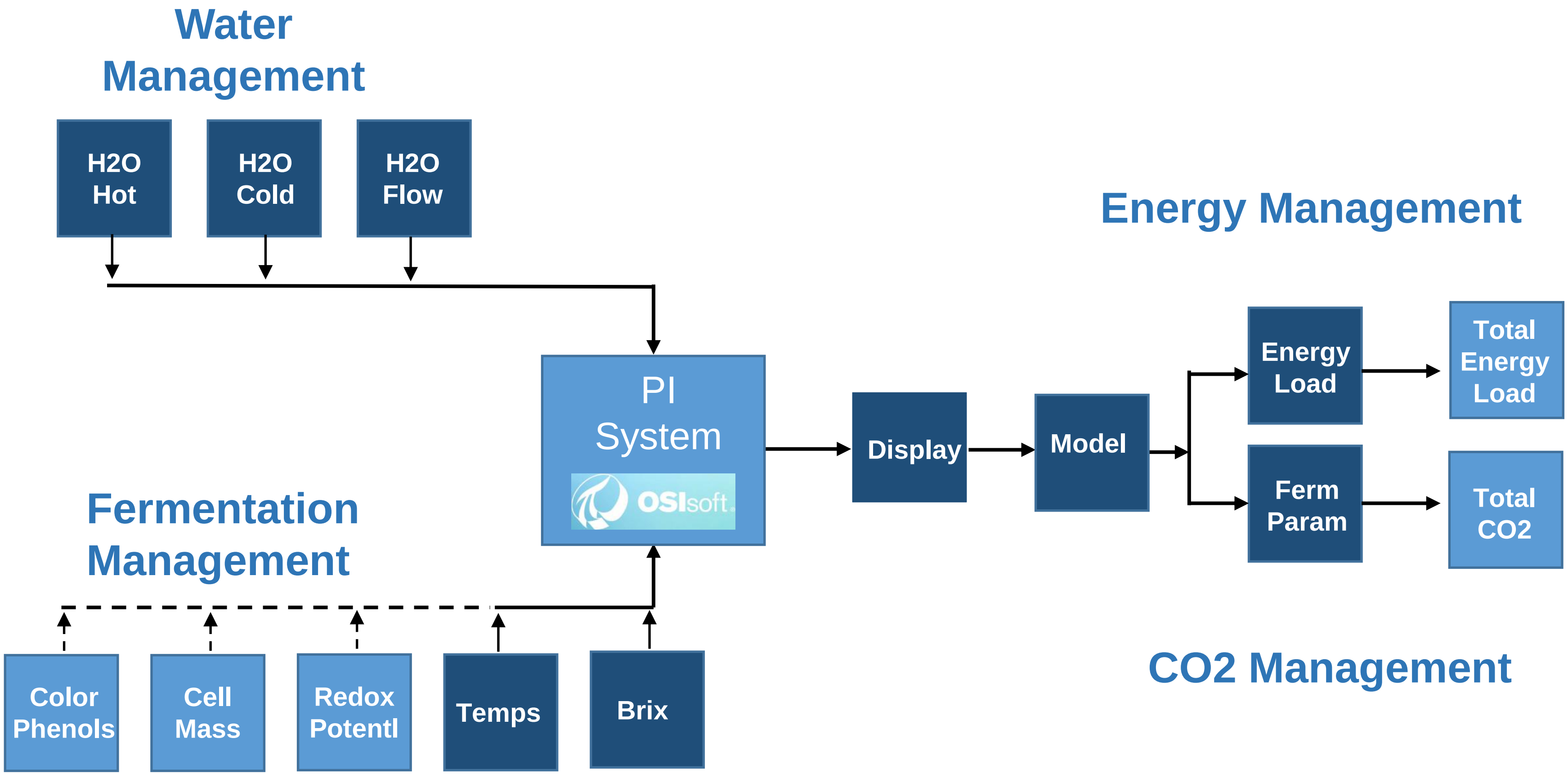
UI GreenMetric
World University Rankings

Our Vision

- **Create a sustainable research & teaching winery that is net-positive for water & energy and carbon neutral**

- **Water Positive**
  - **Rainwater Capture**
  - **Reuse process water & cleaning solutions multiple times**
  - **No wastewater pond**
- **Energy Positive (kW & kWh basis)**
  - **Renewable Power & Storage**
  - **Solar Panels**
  - **Li-Ion Batteries for Energy Storage**
- **Carbon neutral**
  - **Capture CO_2 & ethanol**

A Sustainable Winery

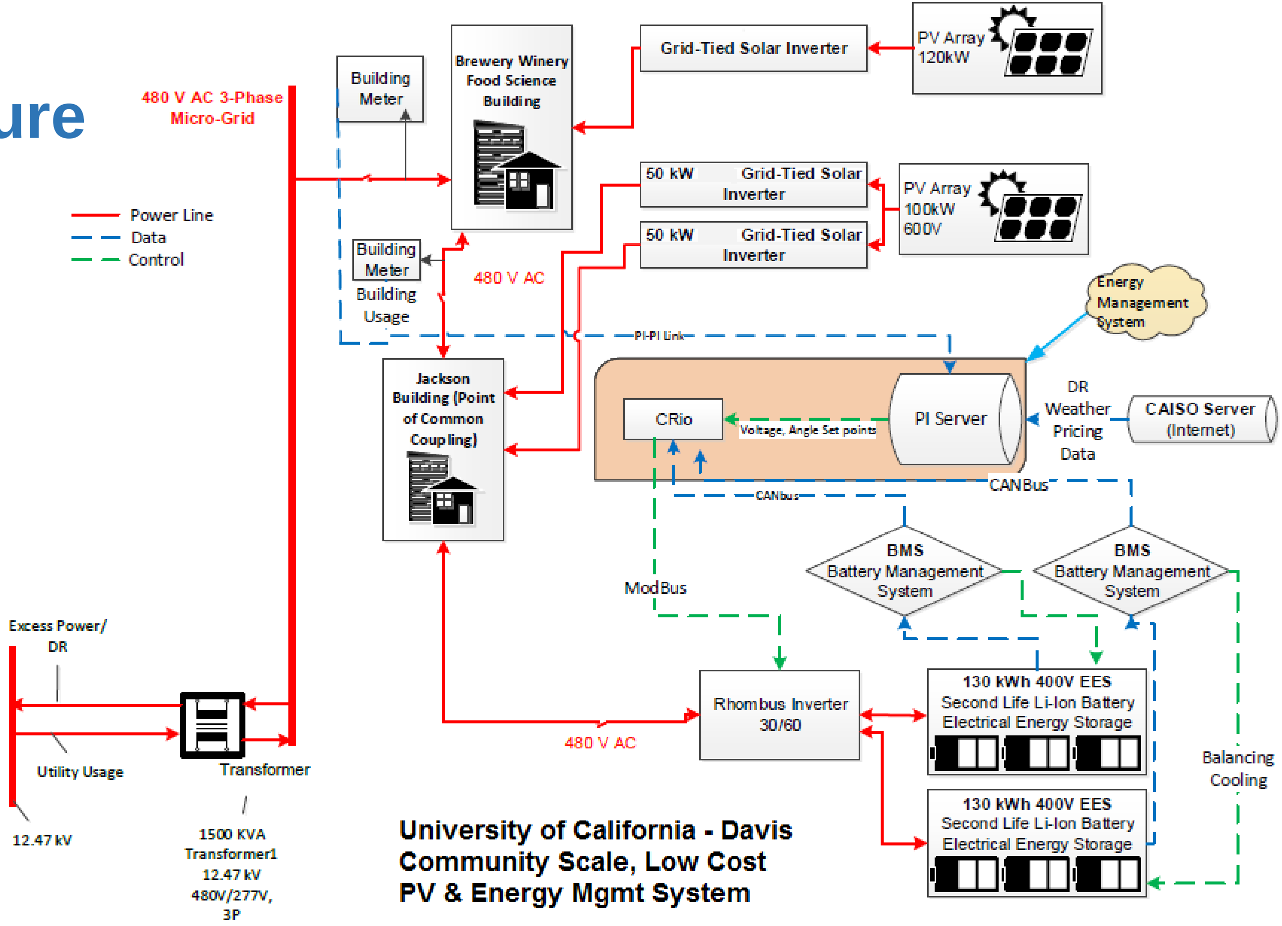

Water Management
H2O Hot
H2O Cold
H2O Flow
PI System
OSIsoft
Display
Model
Energy Management
Energy Load
Total Energy Load
Ferm Param
Total CO2
CO2 Management
Fermentation Management
Color Phenols
Cell Mass
Redox Potentl
Temps
Brix

Winery Microgrid

PV Energy
Li-Ion Battery Storage
Energy Management System

Rooftops Optimized for Capture of Solar Energy & Rainwater

Microgrid Architecture

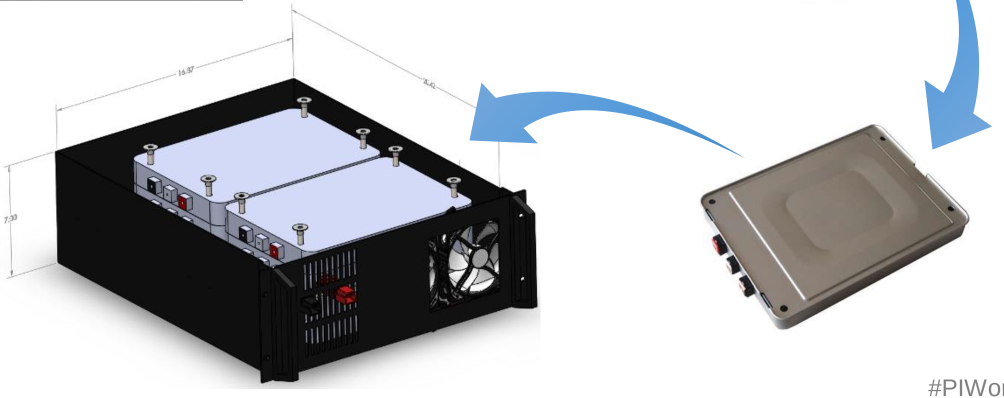


University of California - Davis
Community Scale, Low Cost
PV & Energy Mgmt System

Second Life Li-Ion Batteries

260 kWh battery storage

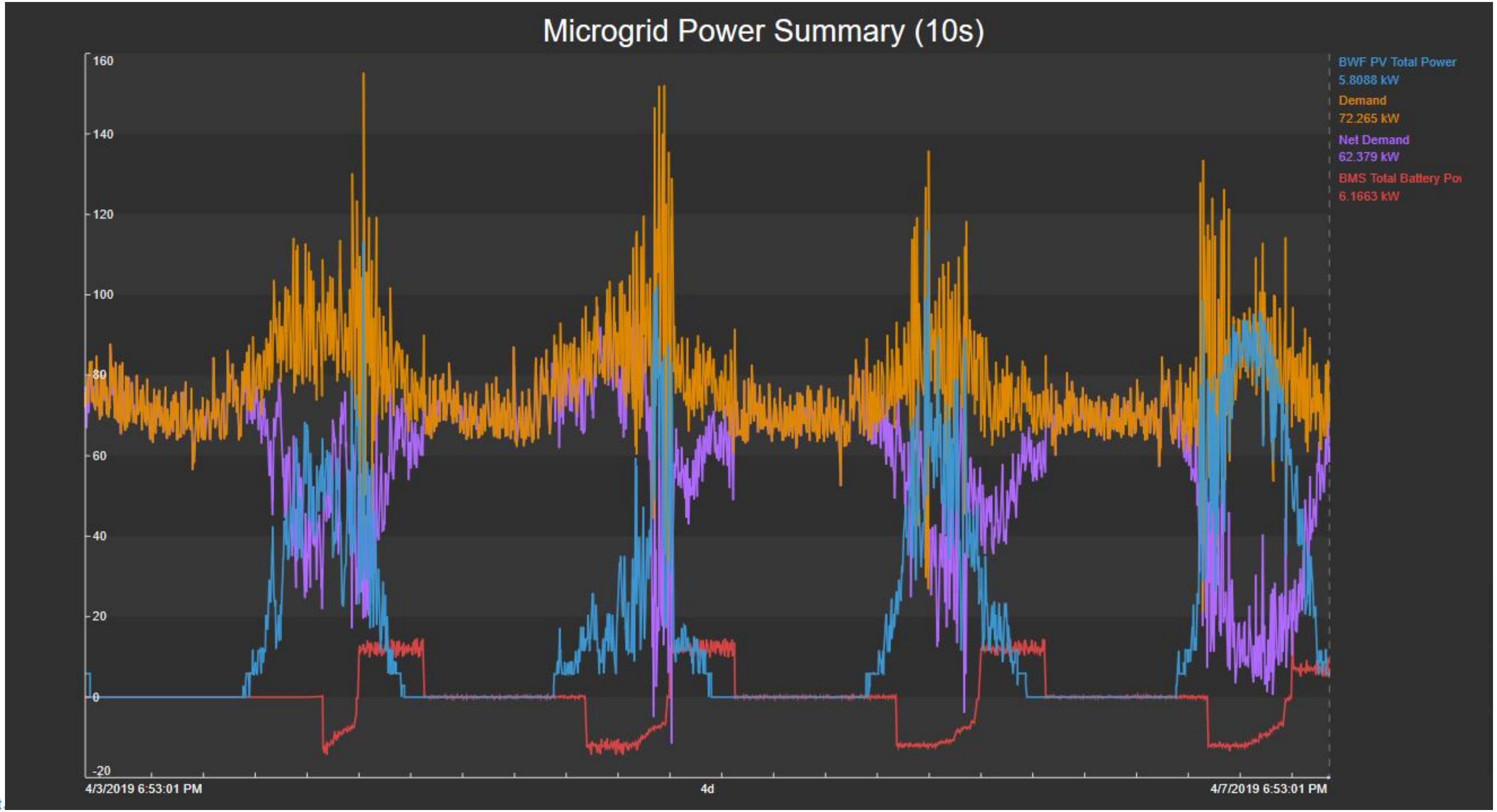
Donated by Nissan and 4R Energy



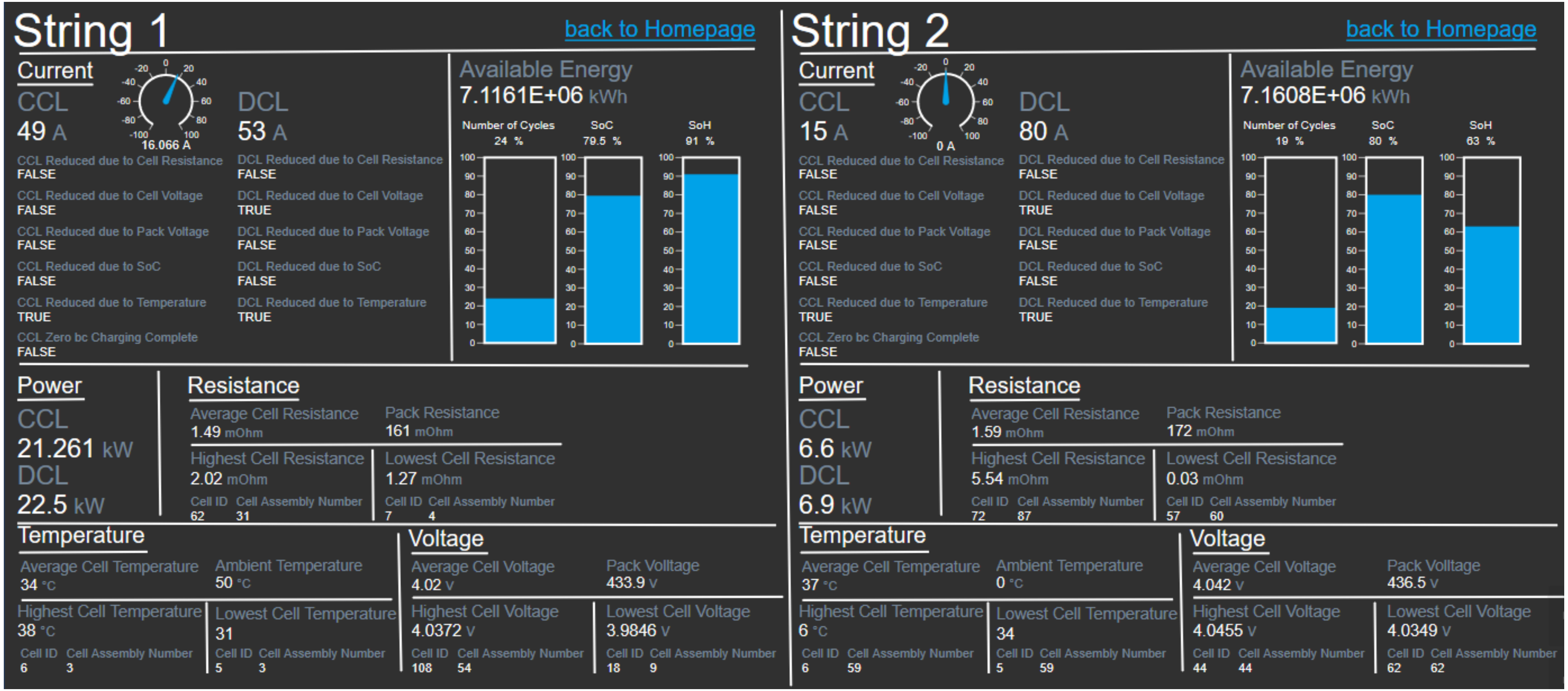
Battery Energy Storage System

Electrical Demand & Solar Generation

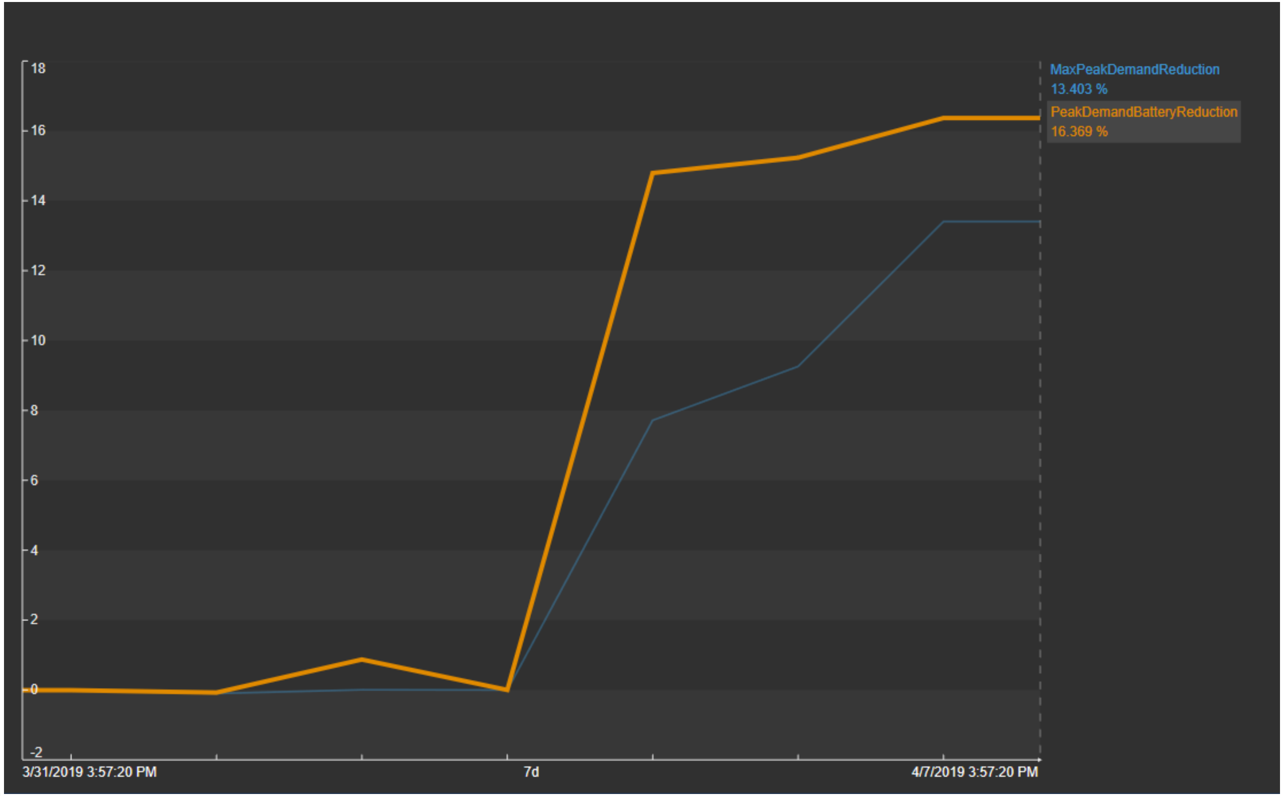
Microgrid Power Summary



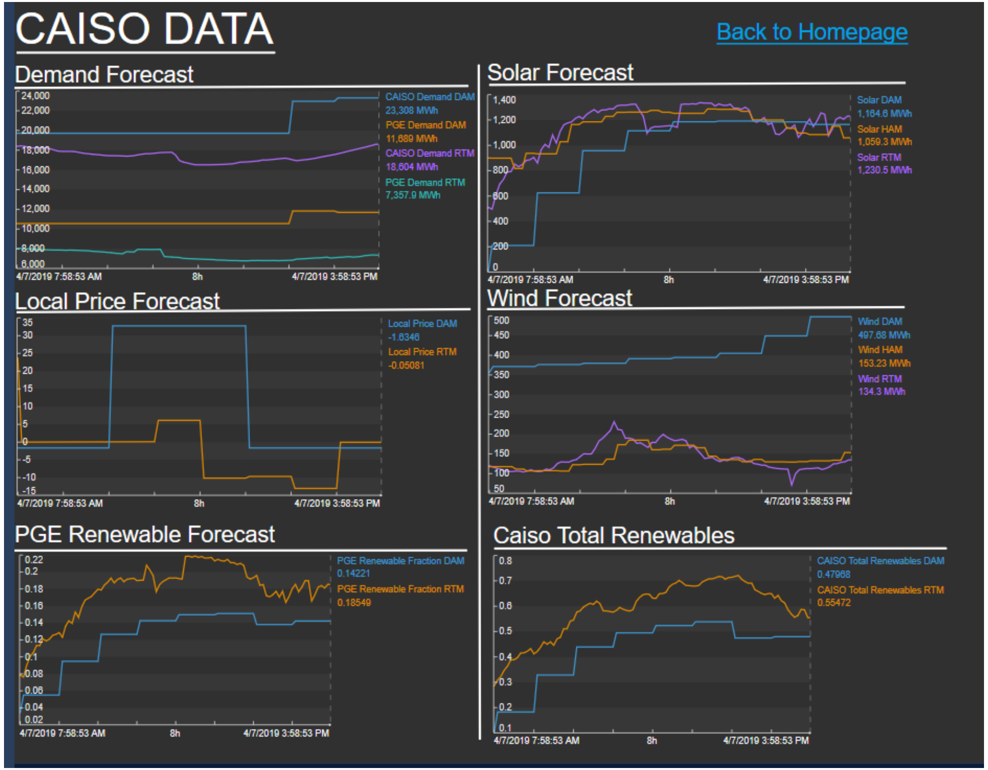
Battery Status & Safety



Project Goal: Peak Demand Reduction > 10%



CAISO Renewables Data for Demand Response



http://www.caiso.com/informed/Pages/CleanGrid/TodaysRenewables.aspx

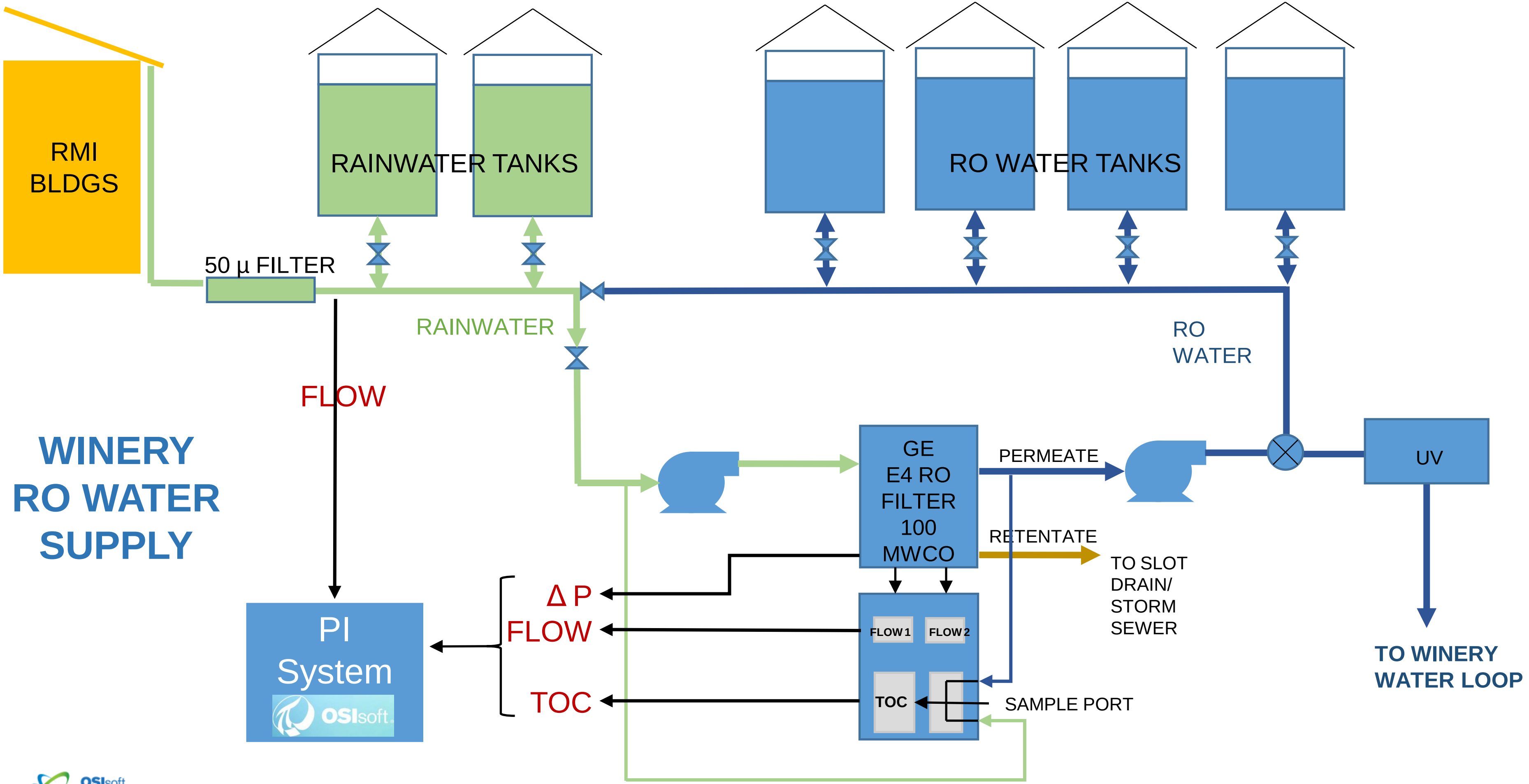
Rainwater to RO Water System

Flow Rates, Permeate and Retentate
Membrane Differential Pressures
and Total Organic Carbon (TOC)

Potable Water - Rainwater Harvest

Water Storage
Potable: 1,000K L
Non-Potable: 680K L

WINERY RO WATER SUPPLY

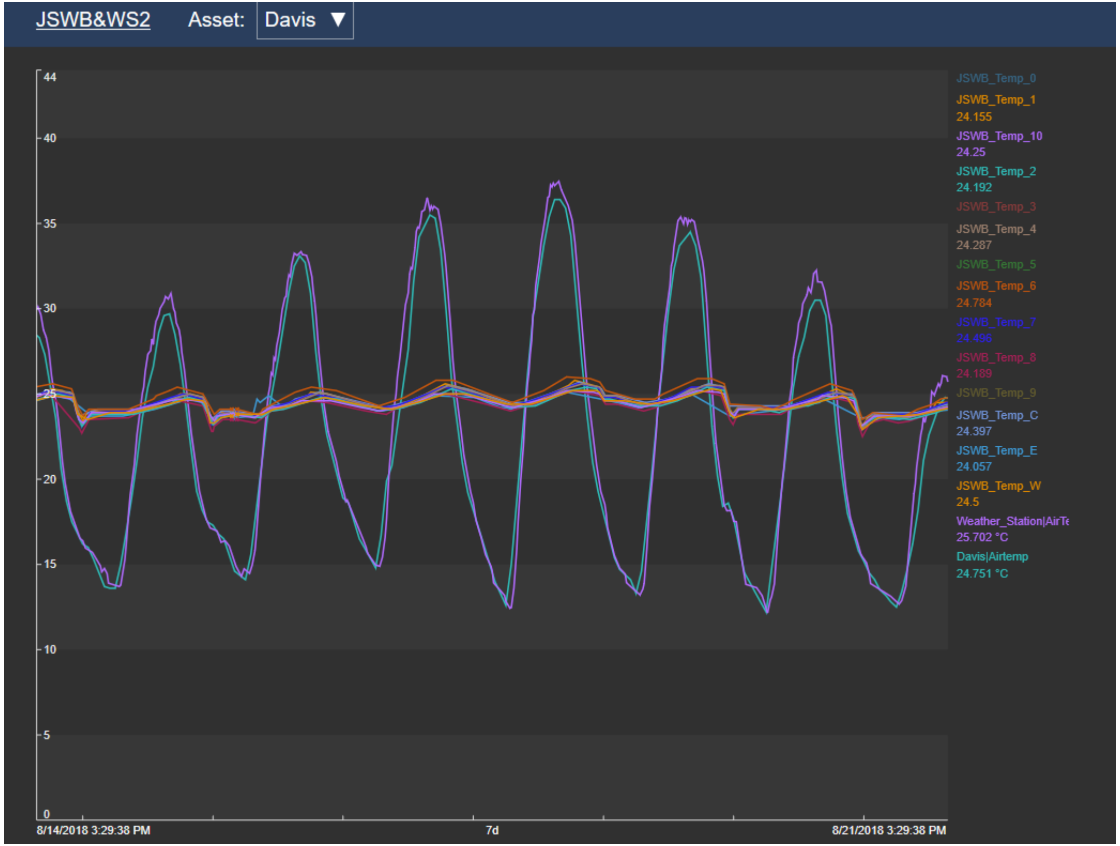


Building Performance Network

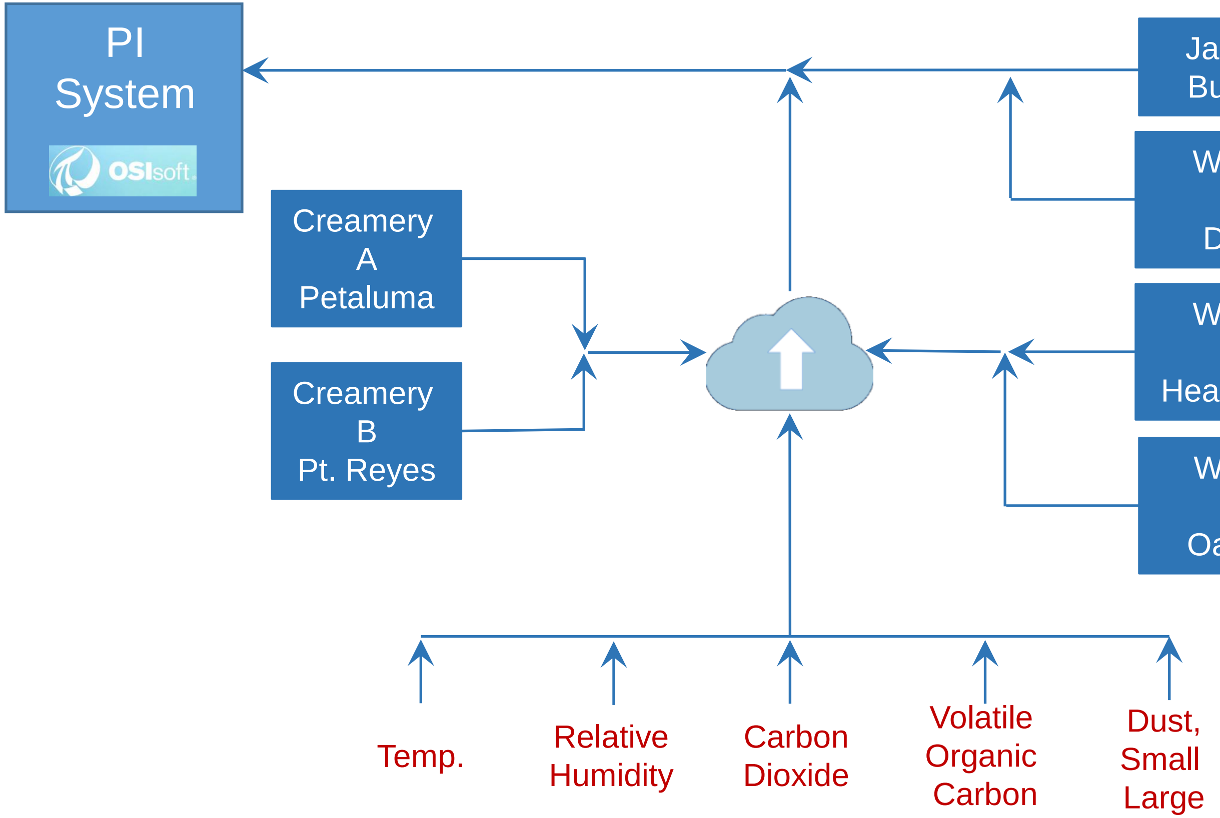
Winery & Jackson Building at UC Davis

5 Site Building Network

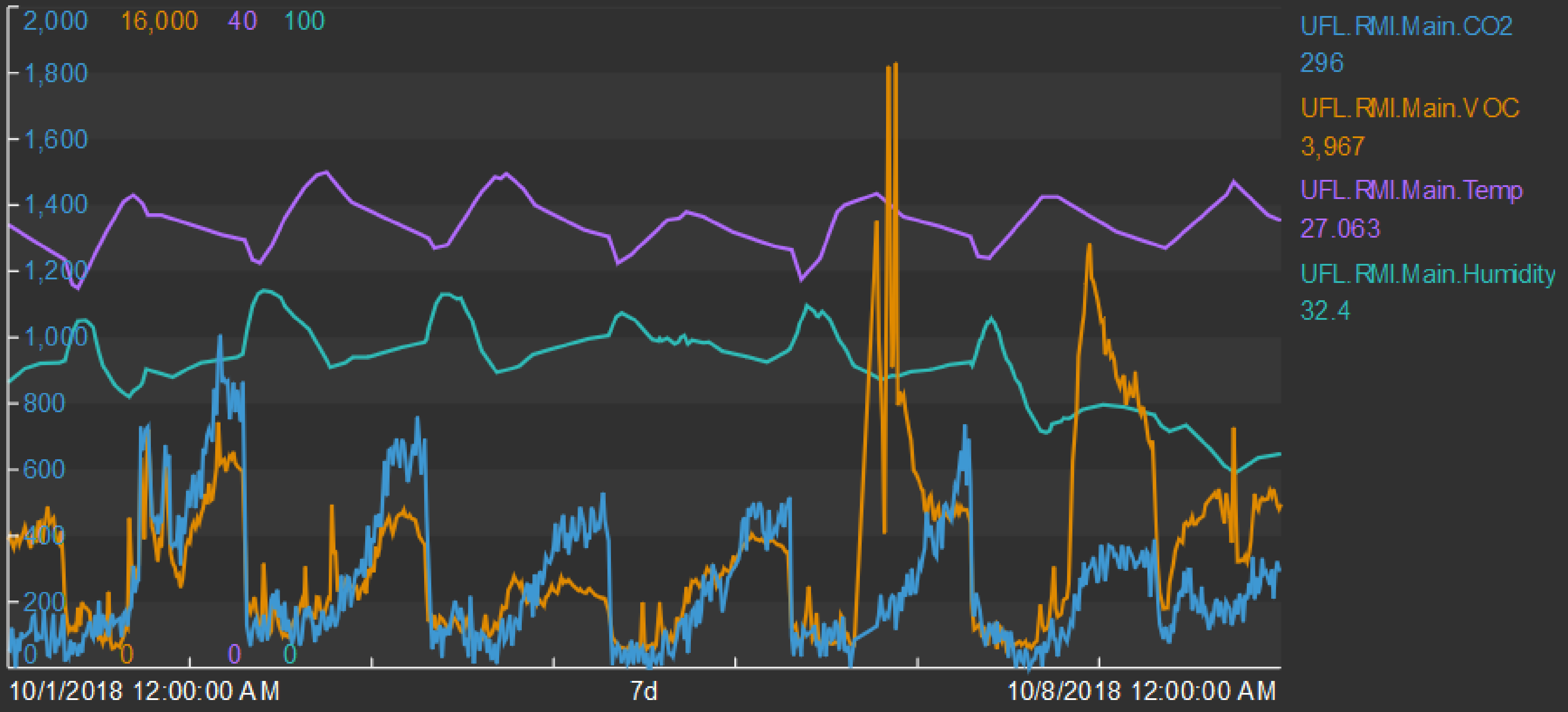
Thermal Performance of J. Jackson Sustainable Winery Bldg.



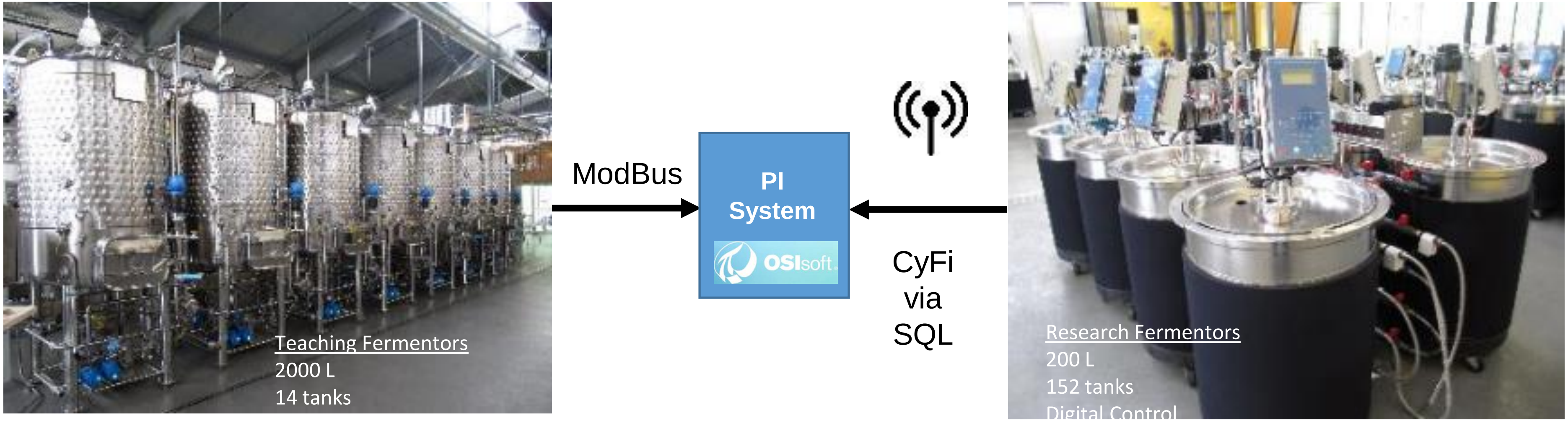
Seasonal Building Performance Monitoring



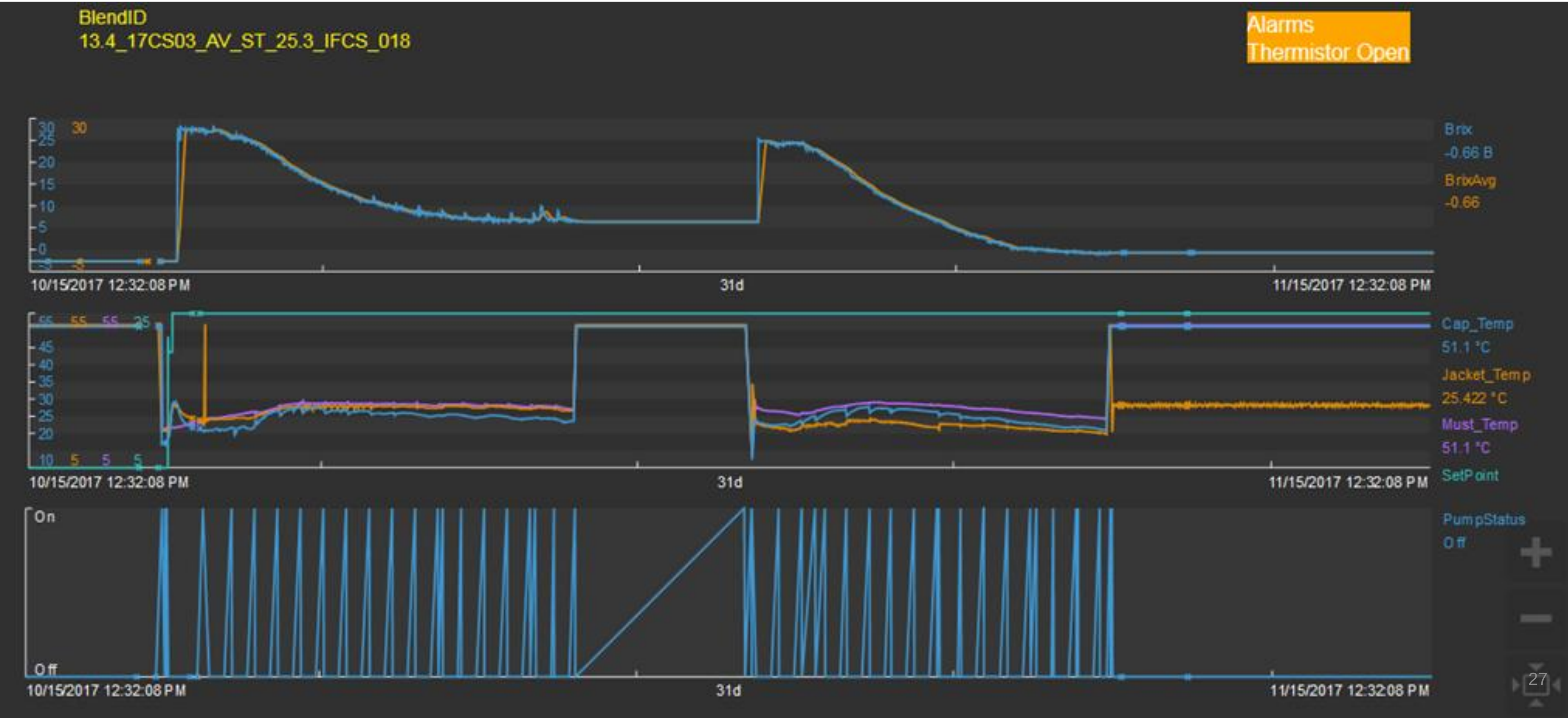
Fermentation Hall Environment



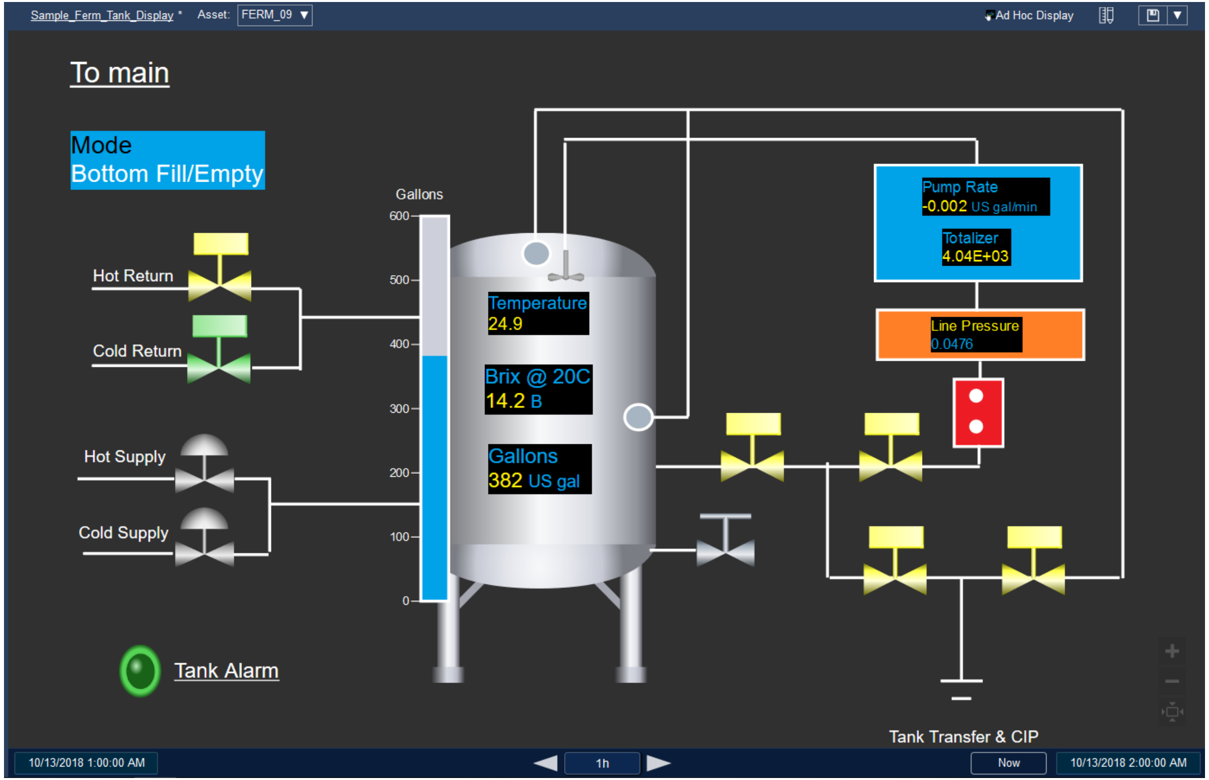
Fermentation Management



Easily monitor all key parameters of each fermentation

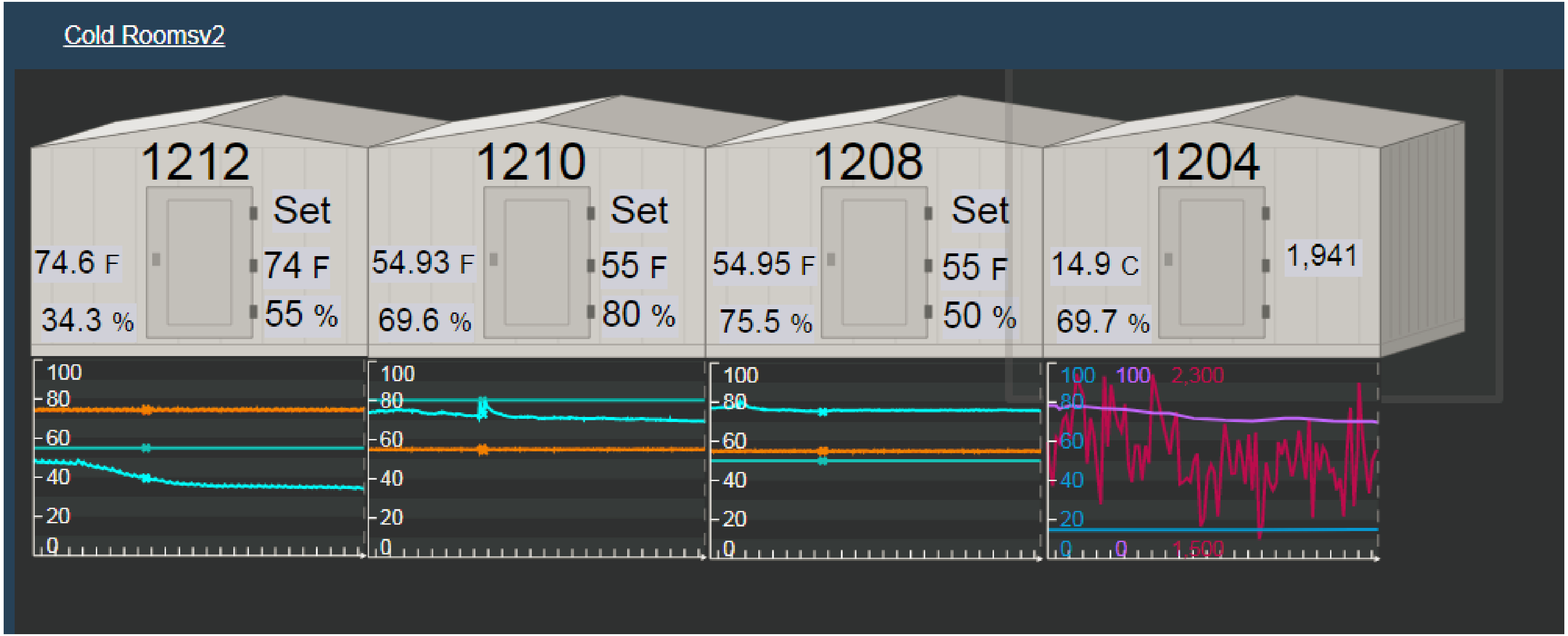


Fermentation Control Status

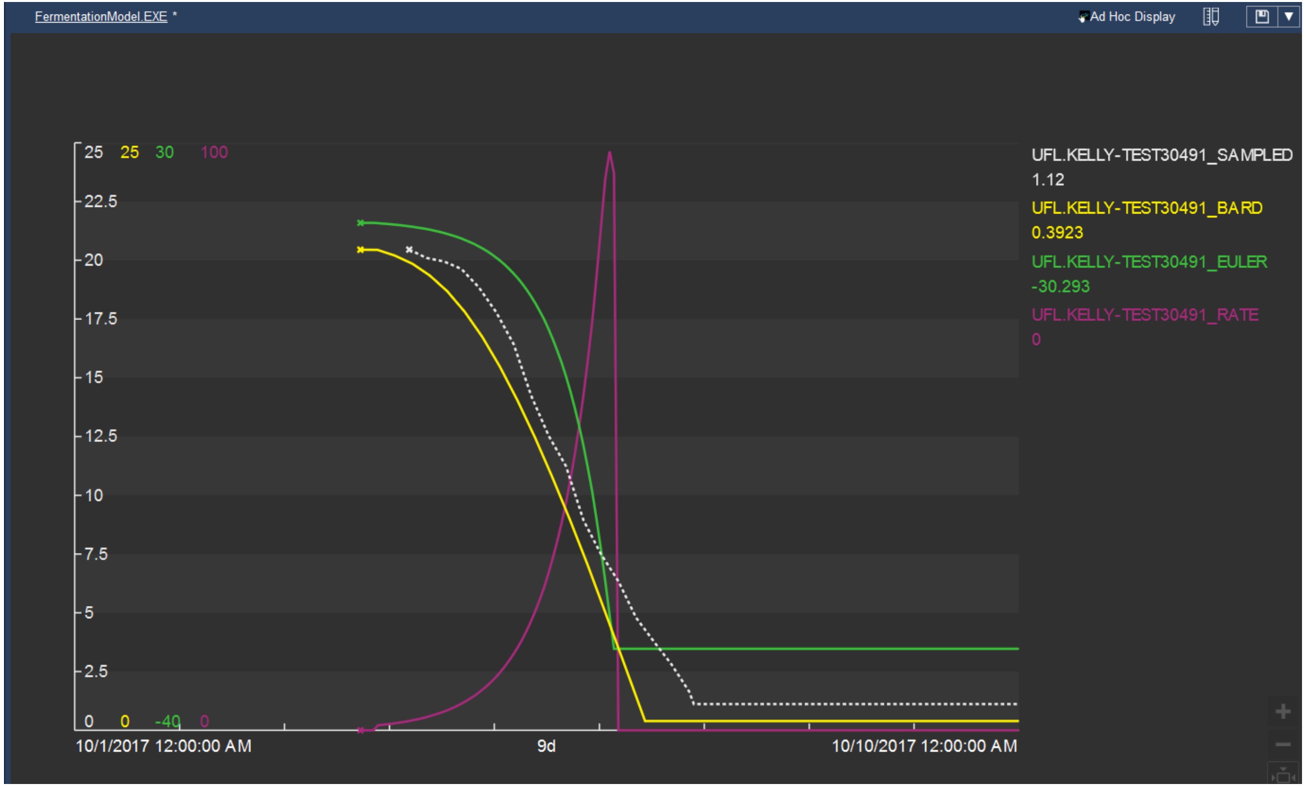


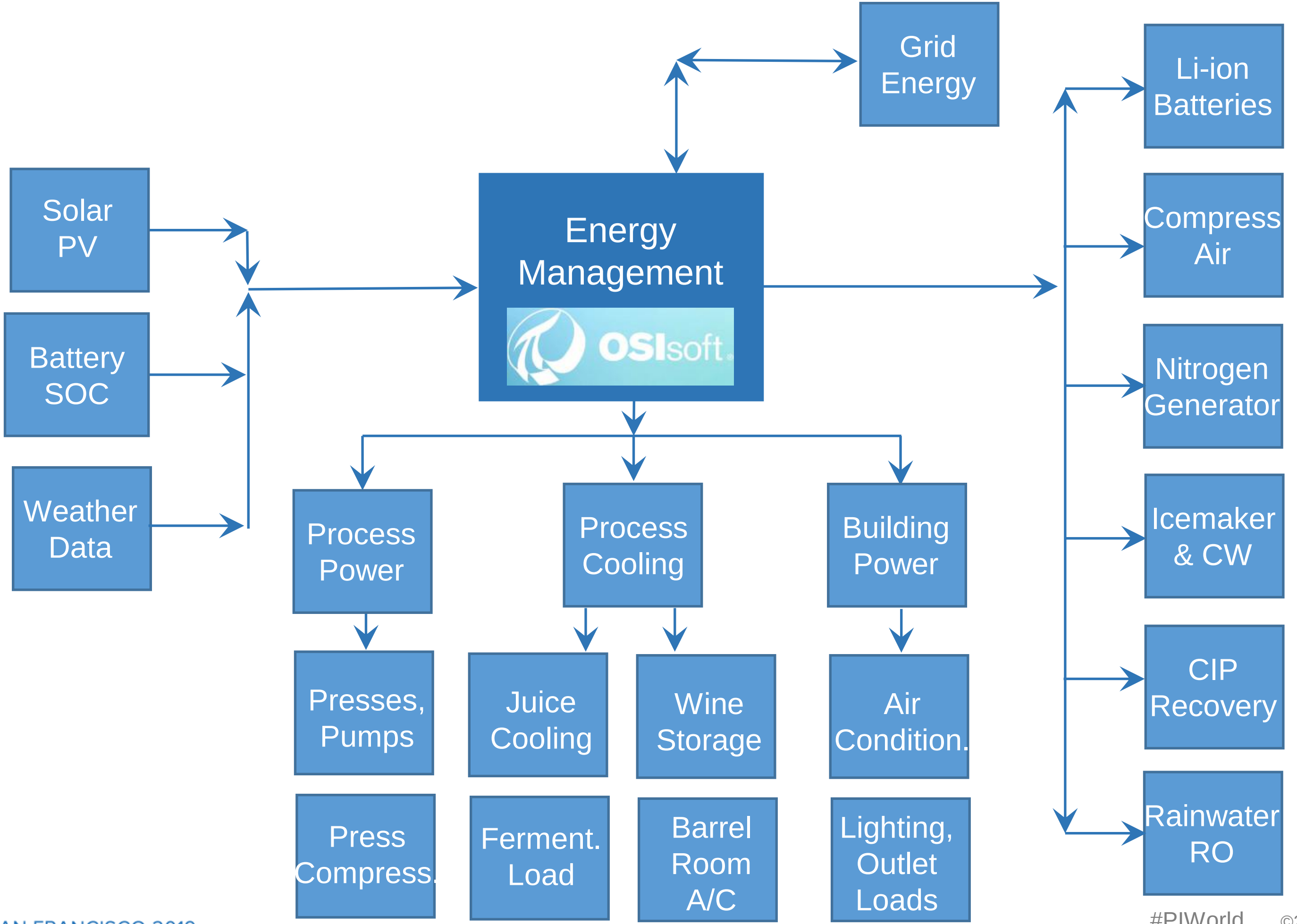
Tank Management

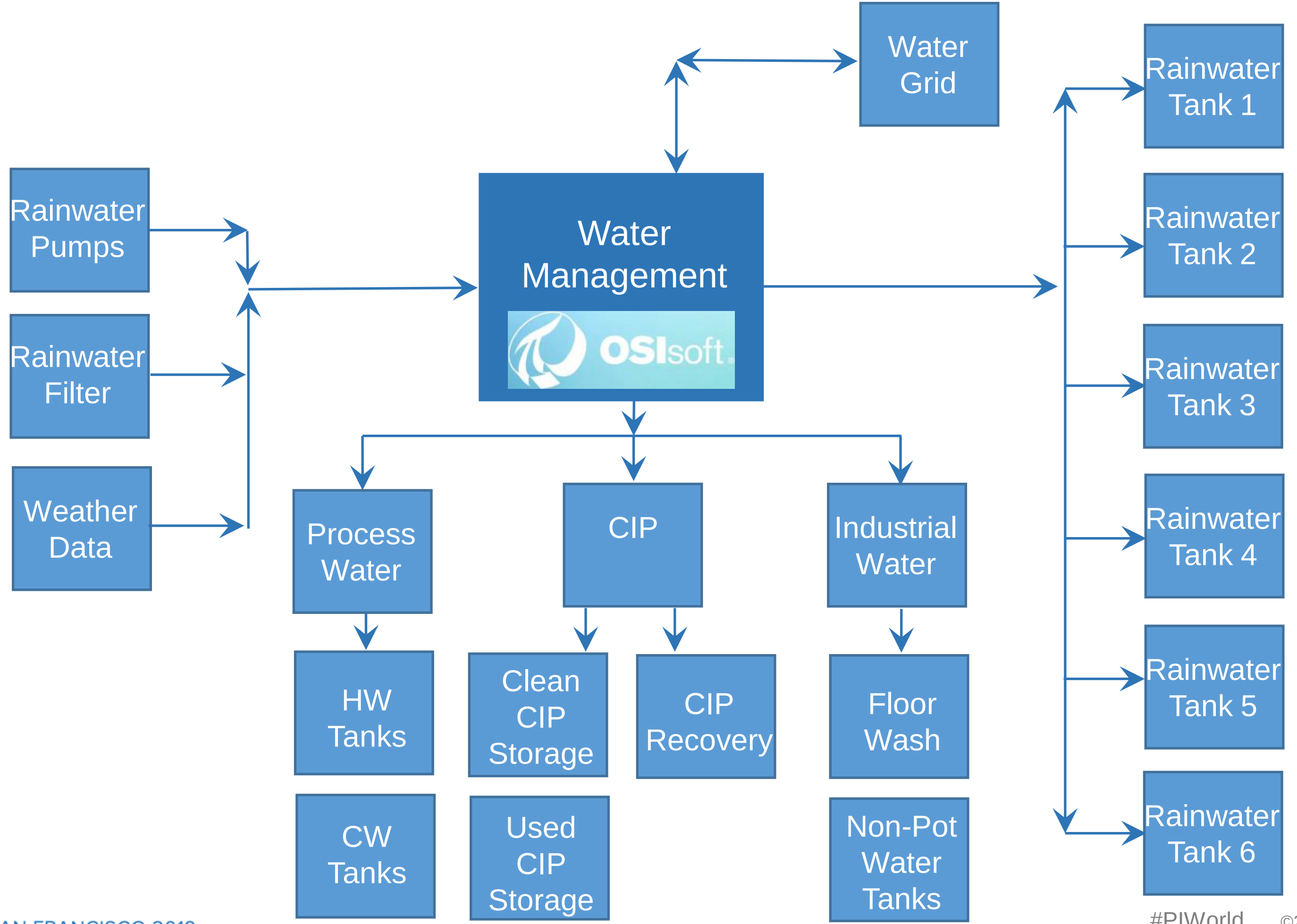
Walk-in Coolers & Barrel Room



Fermentation Model fed by PI Data




Grid Energy
Li-ion Batteries
Solar PV
Energy Management
OSIsoft.
Compress Air
Battery SOC
Nitrogen Generator
Weather Data
Process Power
Process Cooling
Building Power
Icemaker & CW
Presses, Pumps
Juice Cooling
Wine Storage
Air Condition.
CIP Recovery
Press Compress.
Ferment. Load
Barrel Room A/C
Lighting, Outlet Loads
Rainwater RO


Water Grid
Rainwater Tank 1
Rainwater Tank 2
Rainwater Tank 3
Rainwater Tank 4
Rainwater Tank 5
Rainwater Tank 6
Rainwater Pumps
Rainwater Filter
Weather Data
Water Management
OSIsoft.
Process Water
CIP
Industrial Water
HW Tanks
Clean CIP Storage
CIP Recovery
Floor Wash
CW Tanks
Used CIP Storage
Non-Pot Water Tanks

OSIsoft PI System provides UC Davis with the insight to optimize energy and water use in the Teaching and Research Winery, and enable development of the world's first

Zero Net Energy & Water Winery

An Extensive Pinot Noir Study

Elucidating Contributions by Vineyard Site on Elemental Composition of Pinot Noir Wines across Multiple Vintages

Ron C. Runnebaum
Assistant Professor, Department of Viticulture & Enology
Assistant Professor, Department of Chemical Engineering & Materials Science

Long-term Goal

To better understand the impact of features in vineyard site on wine sensory and chemical characteristics.

Wide ranges in wine chemistry can exist

- Example: Oregon Pinot noir
- Focus has often been on phenolics, anthocyanins
- Characterization of berries, commercial wines

Sub-appellation	(n)	Tannin Average	Std. Dev	Tannin Min	Tannin Max
Chehalem Mountains	21	219[a]	139	32	439
McMinnville	12	623[d]	216	329	918
Eola Hills	40	386[bc]	182	46	739
Dundee Hills	18	320[ab]	164	44	738
Ribbon Ridge	17	390[bc]	213	32	763
Yamhill-Carlton	16	389[bc]	152	96	648
Willamette Valley	9	519[cd]	164	184	686
Total	**133**	**382**	**208**	**32**	**918**

All units in mg/L catechin equivalents (CE).
Values sharing the same superscript do not differ significantly at $P<0.05$.

Hodgins, R. Master's Thesis. University of California Davis, 2004

How much of this variation is attributed to differences in the vineyard site and not winemaking, clone, vintage

Pinot noir: vineyard site – wine relationships

Vineyard site AVAs

- Willamette Valley
- Anderson Valley
- Russian River Valley
- Sonoma Coast
- Carneros
- Arroyo Seco
- Santa Maria Valley
- Santa Rita Hills

Single clone

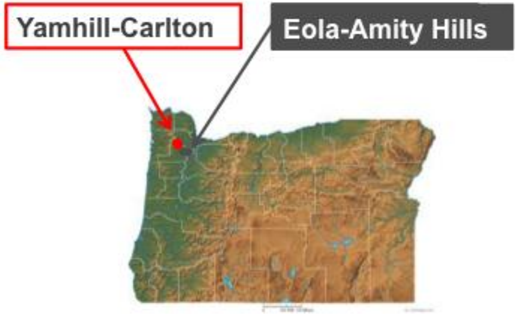
Single rootstock

At least 5 vintages from same vines

Repeatable Winemaking

Goal: Better understand impact of features in vineyard site on wine sensory and chemical characteristics

Vineyard sites located across several American Viticultural Areas (AVAs)



- Santa Maria to Yamhill-Carlton: 1400 km
- Santa Maria to Anderson Valley: 650 km
- Yamhill-Carlton to Eola-Amity Hills: 40 km

Structure–Function in Winemaking
Vineyard site (soil, climate) to Wine characteristics

Vineyard site:
- Below: composition, conditions, microbiome
- Above: climate, microbiome

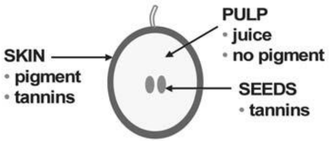
Grapevine:
- Identical clone: Pinot noir 667

Winemaking:
- Identical small-scale fermentations
- Multiple vintages

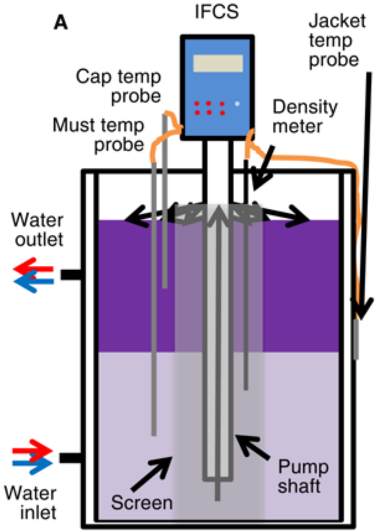
Characterization:
- Volatile compounds, phenolics, sensory

Standardized winemaking procedure

24-25 Brix



Destem



Cold-soak

Inoculate
Ferment

(quadruplicate, 200 L each)

Press

9 days

Lerno, L.;…;Block, D. E., Oberholster, A., Am. J. Enol. Vitic. 2015, 66 (4), 444-453.

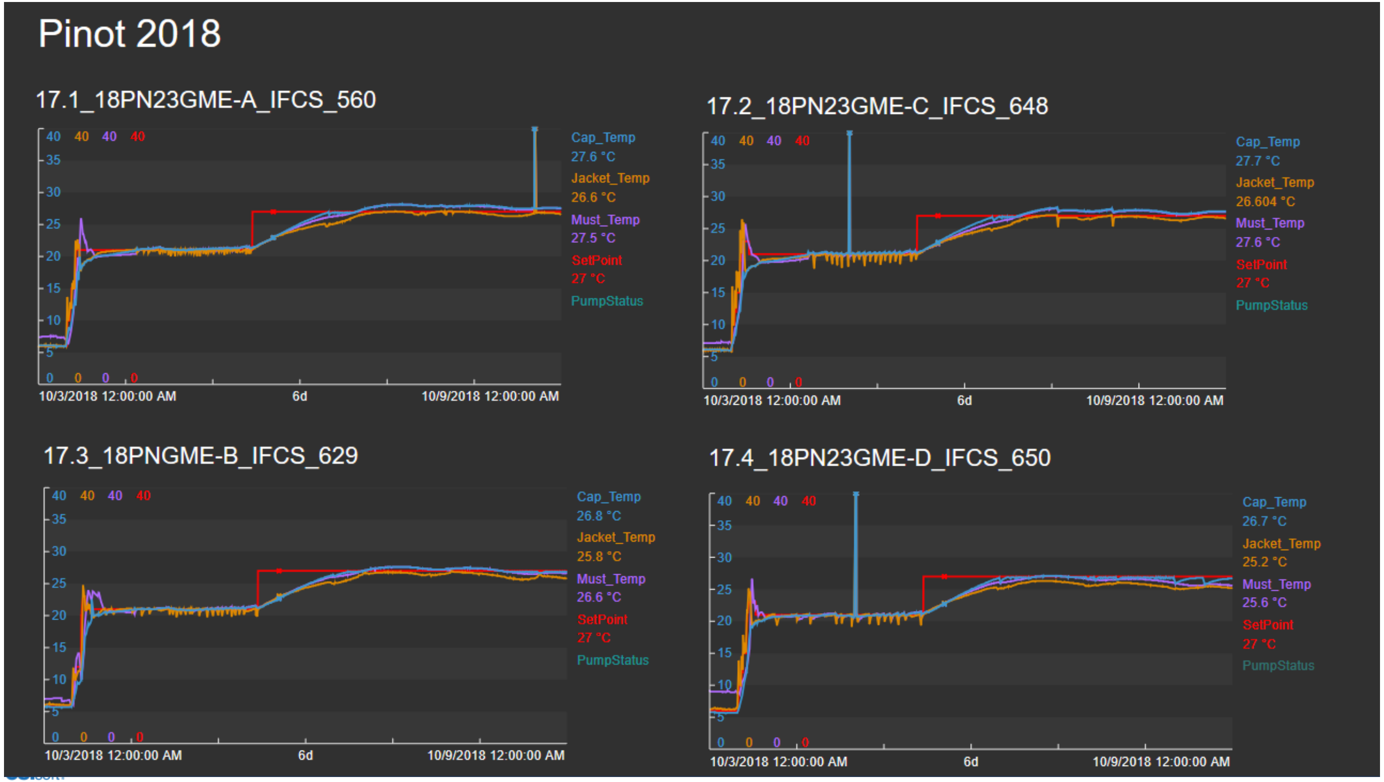
PI System Enables Precise Fermentation Tracking and Improvements

CyFi via SQL

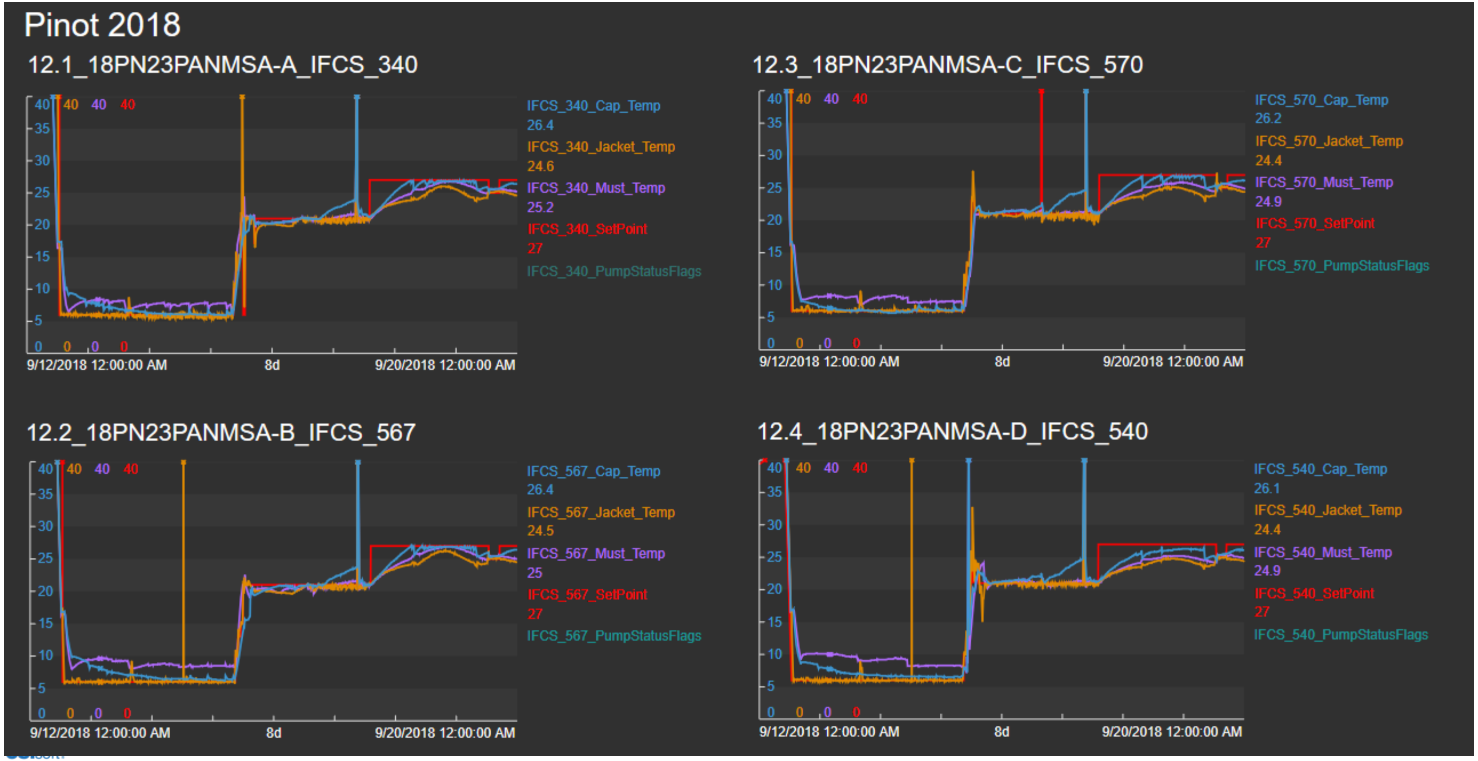
PI System

OSIsoft

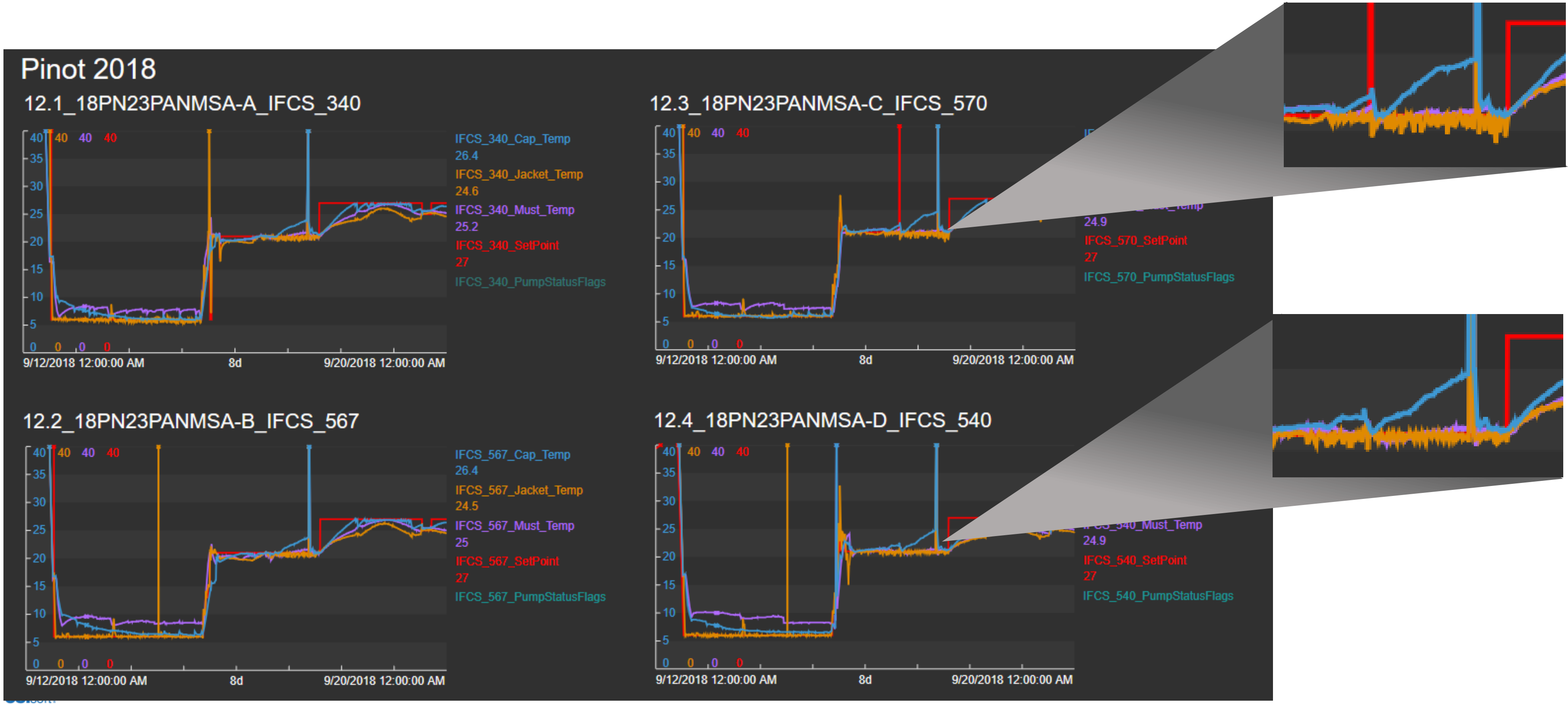
Easily Monitor 60 Fermentations for Precision Winemaking



Cap Temp Rise Indicates Filter Fouling

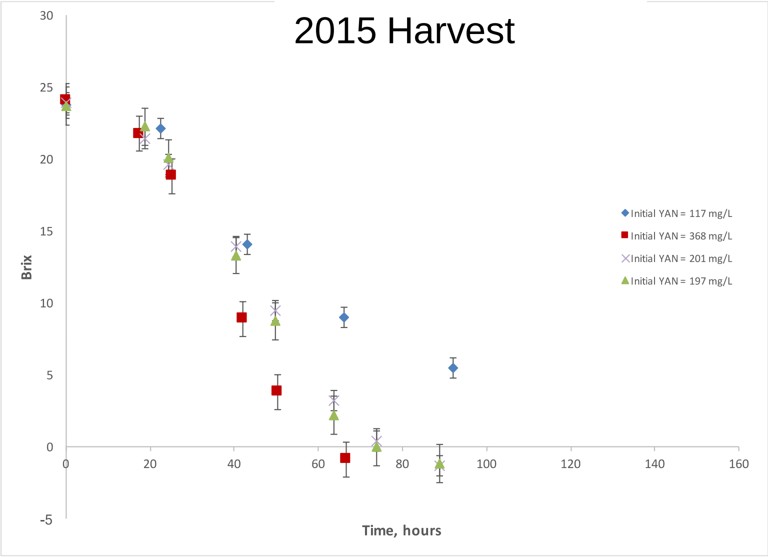


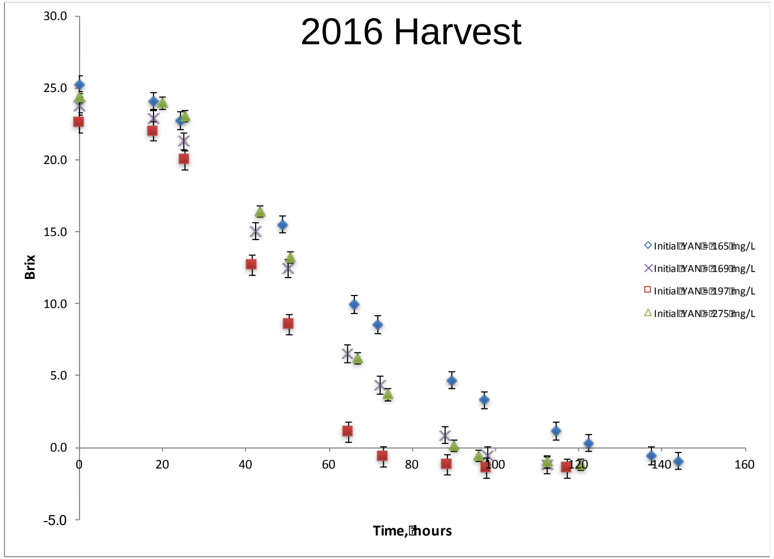
Cap Temp Rise Indicates Filter Fouling



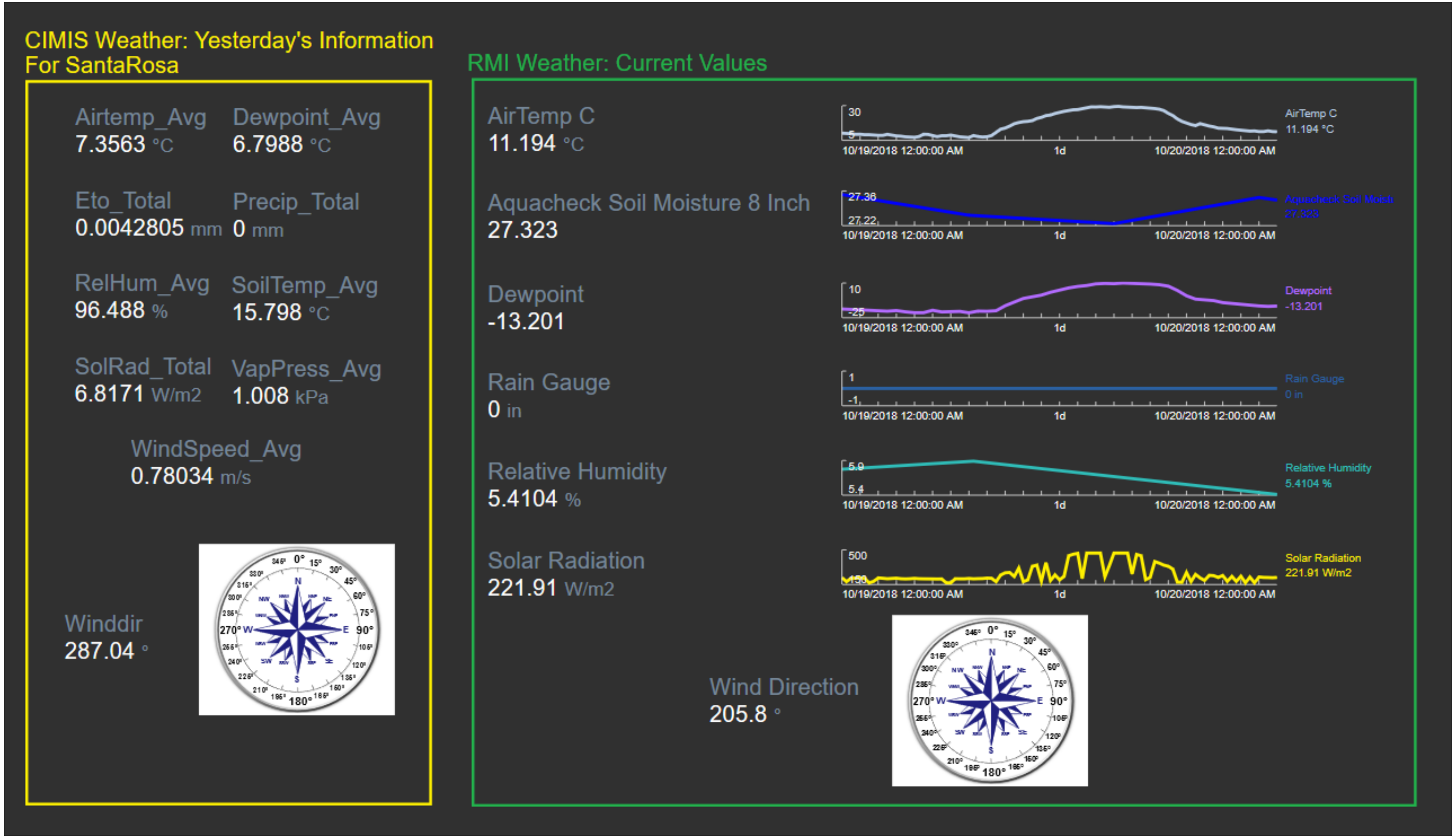
Fermentations were Reproducible

- Showed trends across vintages
- Active data monitoring enables improved fermentations
- Understand initial conditions that lead to reproducible fermentation trends





Monitor Weather & Soil Conditions for each Vineyard



Summary

The PI System has provided the Pinot Noir Research Team with real-time monitoring to ensure precision fermentations while enabling insights which provide lessons learned and improved processing.

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- University of California Davis
- jbrigham@ucdavis.edu

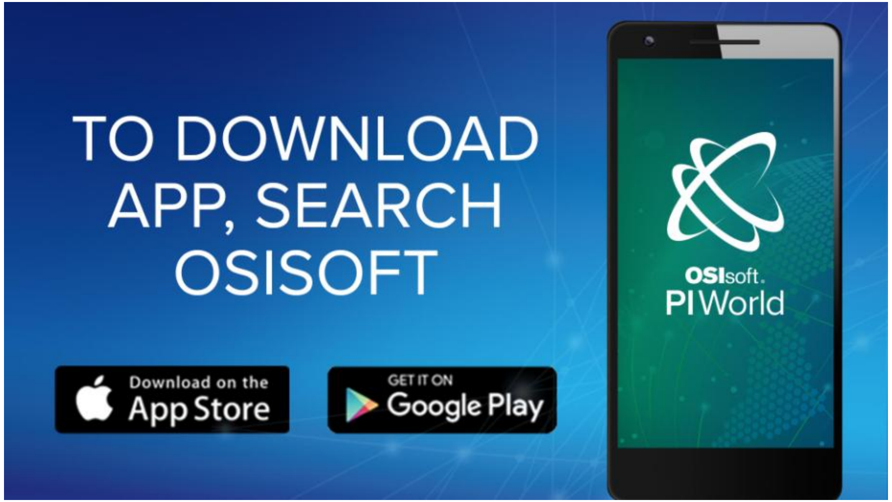
- Ron Runnebaum
- Assistant Professor, Viticulture & Enology and Chemical Engineering & Materials Science
- University of California Davis
- rcrunnebaum@ucdavis.edu

Questions?

Please wait for the **microphone**

State your **name & company**

Please remember



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DZIĘKUJĘ CI
GRÀCIES
TAPADH LEIBH 고맙습니다
БАЯРЛАЛАА MISAOTRA ANAO
NGIYABONGA
TEŞEKKÜR EDERIM
OBRIGADO شكرا
SALAMAT
DANKIE TERIMA KASIH
DANKON TANK TAPADH LEAT
KÖSZÖNÖM
СПАСИБО
MULȚUMESC
РАКМЕТ СІЗГЕ
HVALA
FAAFETAI
ESKERRIK ASKO
GO RAIBH MAITH AGAT
MAHADSANID
OSIsoft PI World
THANK YOU
HVALA ХВАЛА ВАМ
БЛАГОДАРЯ GRACIAS
TEŞEKKÜR EDERIM
ТИ БЛАГОДАРАМ
DANK JE ΕΥΧΑΡΙΣΤΩ GRATIAS TIBI
ДЗЯКУЙ
GRAZIE
TAK DANKE
AČIŪ SALAMAT MAHALO IĀ ʻOE TAKK SKAL DU HA
DI OU MÈSI
RAHMAT MERCI
GRAZZI ÞAKKA ÞÉR
FALEMINDERIT
ありがとうございました
ĎAKUJEM
HATUR NUHUN
РАХМАТ САҒА
SIPAS JI WERE TERIMA KASIH
MATUR NUWUN
CẢM ƠN BẠN
UA TSAUG RAU KOJ
WAZVIITA
ТИ БЛАГОДАРАМ
СИПОС