



Efficient Asset Management of a Large and Distributed DG Solar Portfolio

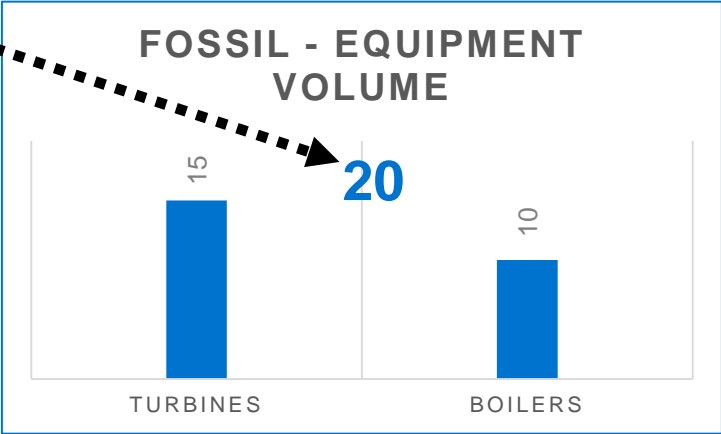
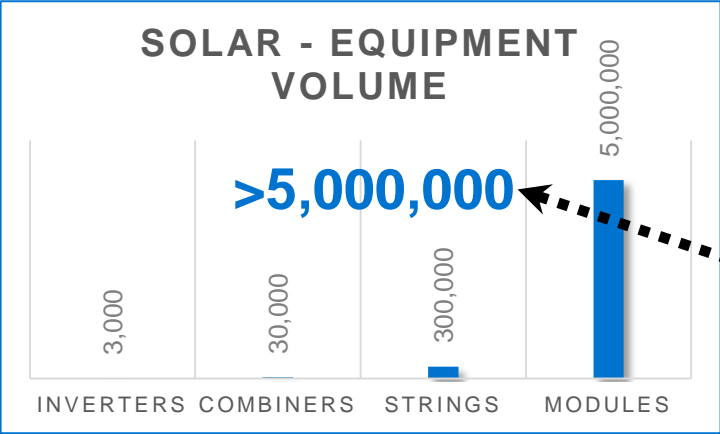
Presented by **Steve Hanawalt**

POWER
FACTORS
DRIVE

Agenda

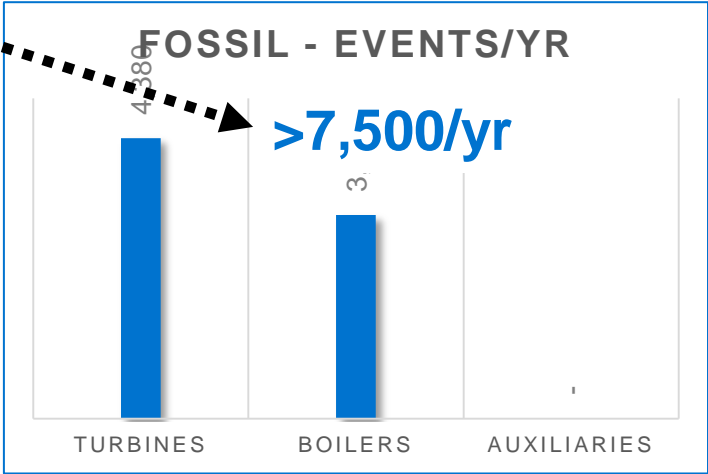
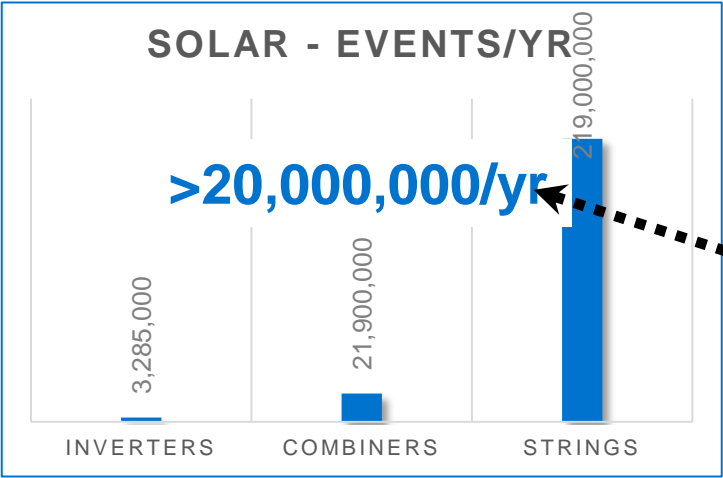
- Power Factors Overview
- The Problem we are Trying to Solve
 - High Volume
 - High Velocity
 - High Geographic Dispersion
 - Low Cost
- The Solution
 - IT
 - Automation
 - Event Management
- Applications and Use Case / How the PI System was Applied
- Challenges
- Conclusion

Fossil and Solar Asset Classes – Volume



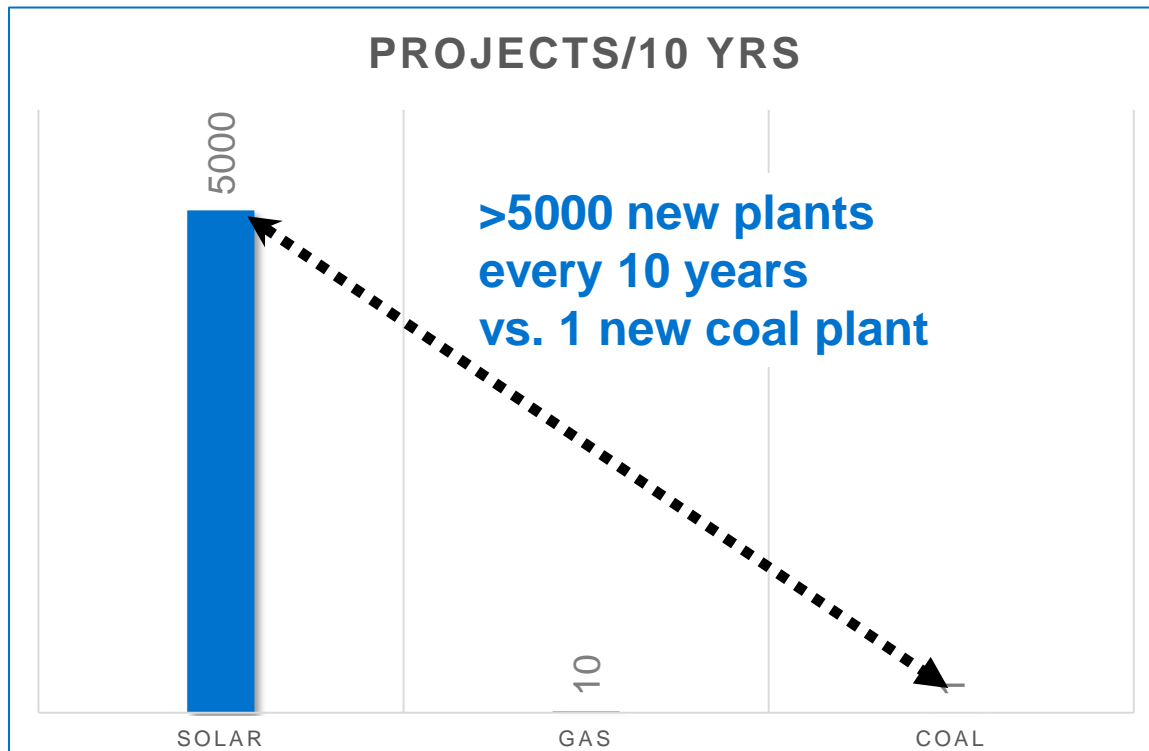
EQUIPMENT

Fossil and Solar Asset Classes - Volume



EVENTS

Fossil and Solar Asset Classes - Velocity

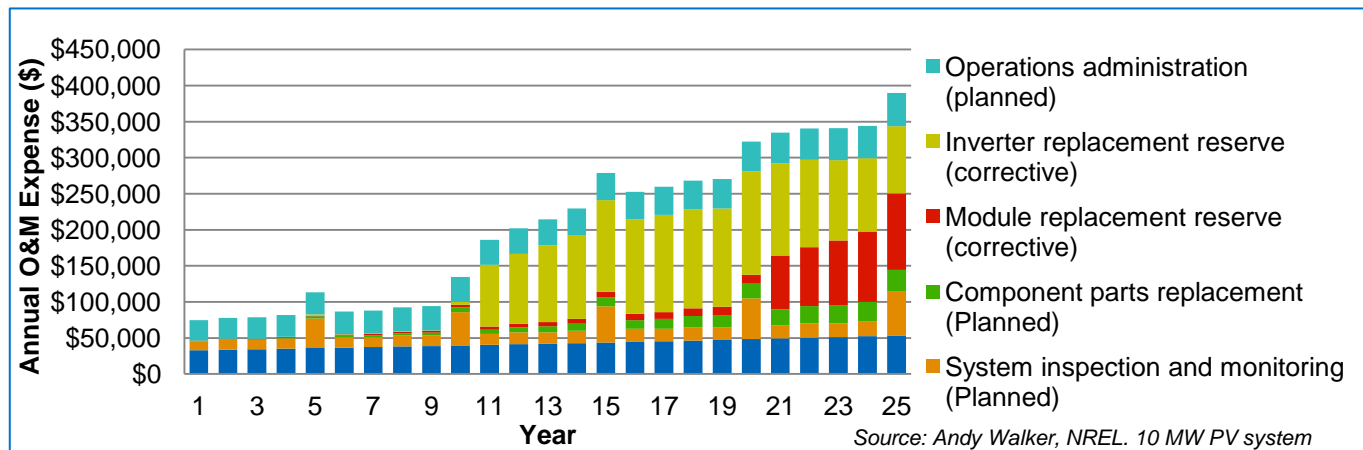


Geographic Dispersion



Low Cost O&M

- Developers have sold a myth--“solar power system don't require any maintenance...”



Annual O&M costs range

1st year: \$7.00/kW

By year 25: \$39.00/kW

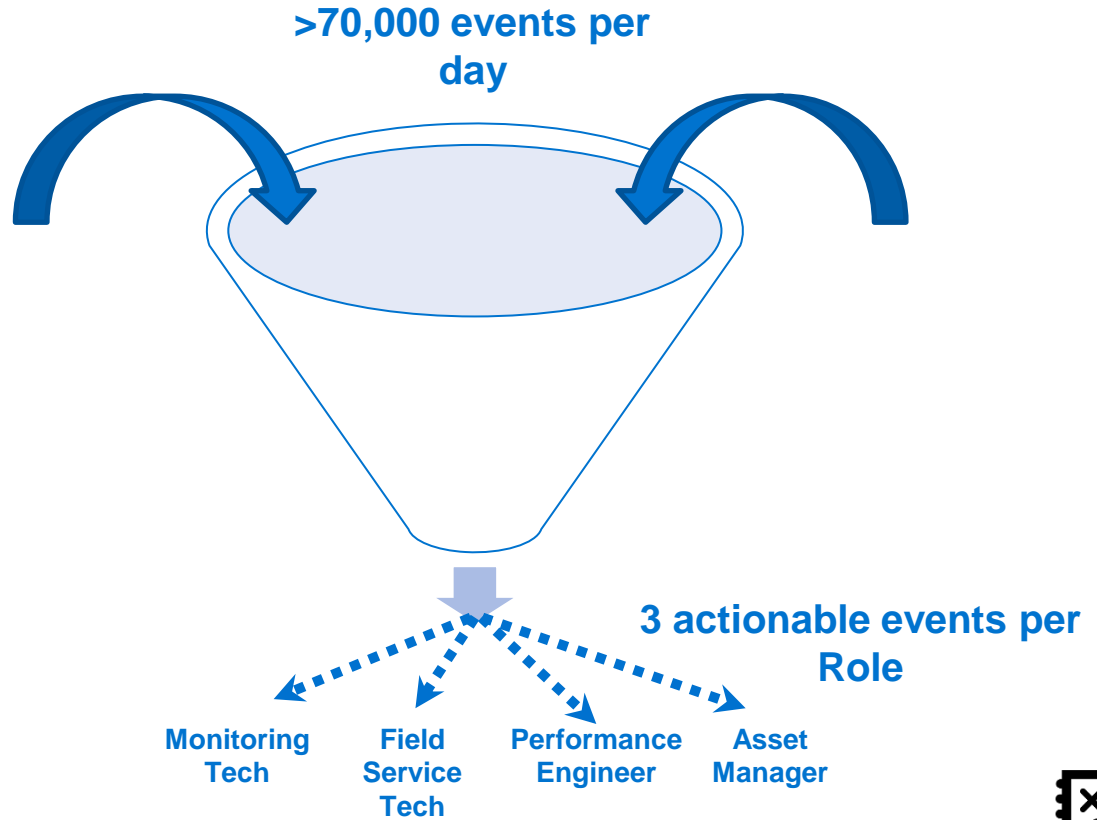
Summary

- Traditional O&M approaches don't work
- Problem needs to be solved with a high degree of:
 - Technology
 - Centralization
 - Automation




Event Management

**Reduce 70,000
events to 12 role-
based actions per
day**



Day-in-the-Life: Monitoring Technician - Respond

 info@powerfactorscorp.com
Today, 7:45 AM
steve hanawalt

Alert from Power Factors Network Operations Center

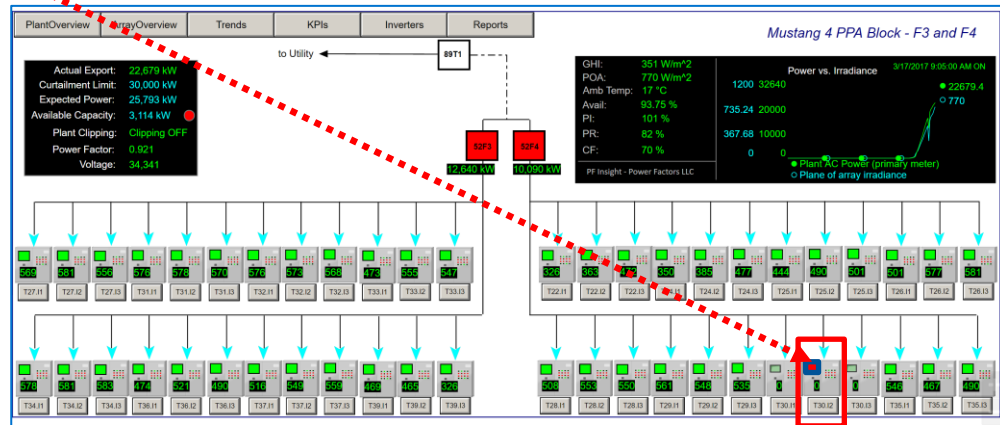
Plant: Mustang 4 PPA Block - F3 and F4
PF Asset Name: 1012.46.Inverter087
Customer Asset Name: Block30.Inverter 2
Failure Class: Failure Class 3 - single inverter off-line
Database: PF-PV-Database
Start Time: 3/17/2017 7:45:00 AM Pacific Daylight Time (GMT-07:00:00)
Trigger Time: 3/17/2017 7:45:00 AM Pacific Daylight Time (GMT-07:00:00)
Target: 1012.1012.46.Plant\1012.46.Switch05\1012.46.Circuit04\1012.46.Transformer30\1012.46.Inverter087
State: OutsideControl
Priority: Normal

Actions:
Update AssetOptics work order, as appropriate

Event detection and notification

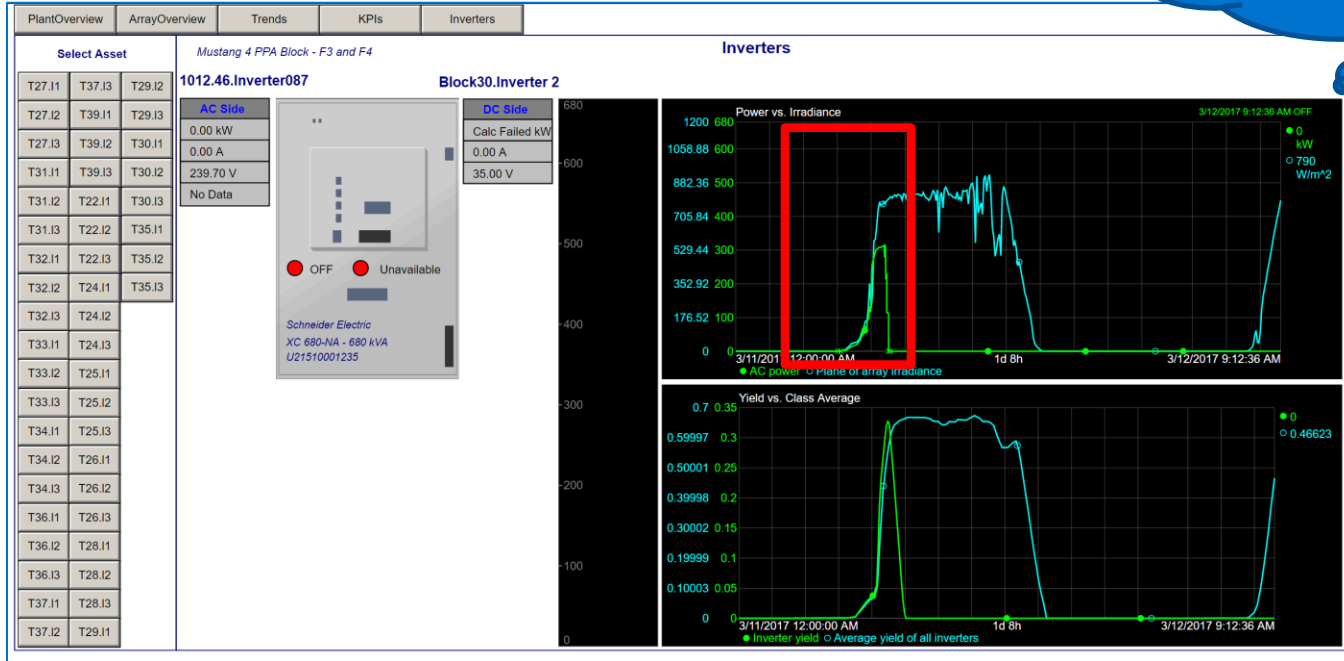
Technician acknowledges
Event
and verifies its accuracy

Verification



Day-in-the-Life: Monitoring Technician - Diagnose

Technician diagnoses Event to determine Cause and Action



Day-in-the-Life: Monitoring Technician - Restore

POWER FACTORS DRIVE

Search...

Home Dashboards Accounts Contacts Asset Tags Entitlements PM Group Schedules PM Group Details PM

Work Order WO-0068826

Show Feed

Back to List: Work Orders

Work Tasks [1] | Work Assignments [0] | Time Entries [0] | Miscellaneous Costs [0] | Work Order Parts [0] | Operating Log Records [1] | Orders [0] | Child Work Orders [0] | Open Activities [0] | Notes & Attachments [0] | Approval History [0] | Work Order History [10+]

Work Order Detail

Information

Work Order	WO-0068826	Owner	John Jusko [Change]
Description	Block 30 Inverter 2	Status	Ready to Schedule
Asset ID	1012.46.Inverter087	Reviewed	<input type="checkbox"/>
Asset Description	Block30.Inverter 2	Field Work Status	Field Work
Plant	Mustang 4 PPA Block - F3 and F4	Field Work Completion Date	
Account	1012.30-Mustang	Priority	High
PI Event Type		PM Schedule	
PI Event Value	0.00	Entitlement Term	
PI Event UOM	kW	Entitlement Term Description	
Parent/Source Work Order		ET Assigned User	
Work Order Record Type	Work Order	Business Unit	Utility
		Service Region	Utility - CA - Central

Technician releases to Field
Service automated work
order generated by the
Event Manager



Day-in-the-Life: Asset Manager – Commercial Compliance

NOTIFICATION: Past Due 3/17/2017 for [REDACTED]

N noreply@salesforce.com on behalf of Power Factors Support
Today, 4:00 AM
rbooth@maxgenservices.com

Commercial compliance past due Event. Click link and complete compliance task

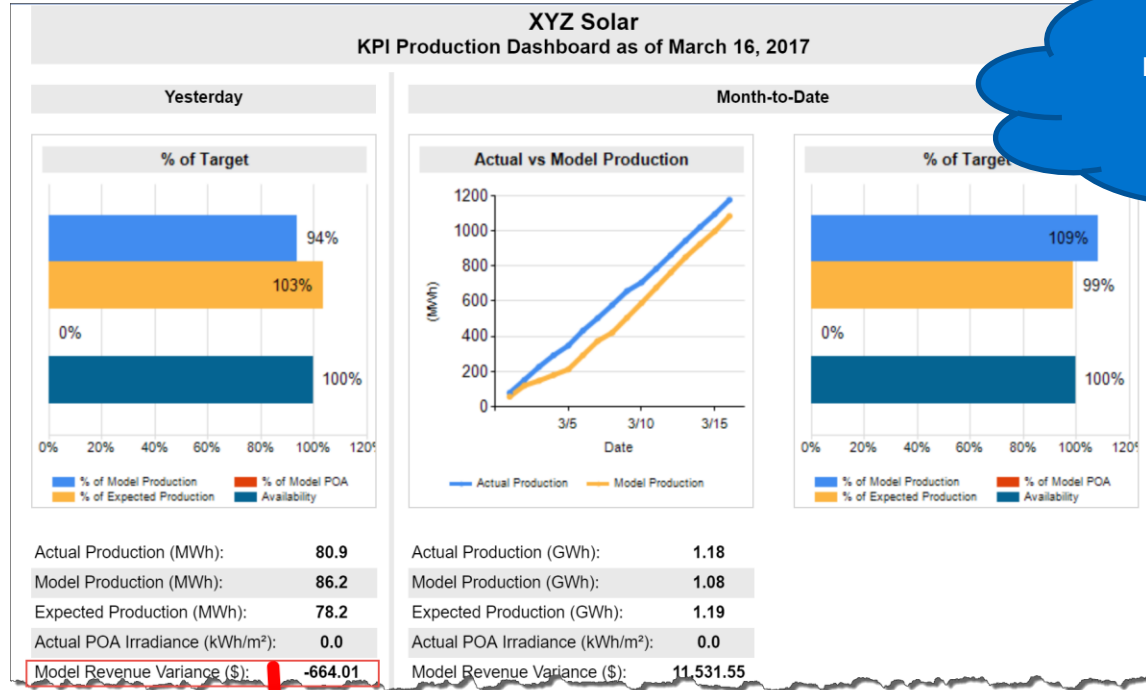
AO

NOTIFICATION: Past Due 3/17/2017

Plant #	Plant Name	Subject	Reference Information	Status	Due Date	Link to Term	Completion Variance (Days)	Special Instructions (Truncated)
1012.27	RE Barren Ridge 1 LLC	1012.27.Plant-Exhibit B - Basic Services Reporting-O&M Agreement-2.6(a)(vii) Maintenance Data and Records - Weekly Plant Performance	2.6(a)(vii) Maintenance Data and Records/ Exhibit B.38	Not Started	2/28/17	004393	-17	2.6(a) Operator shall prepare and maintain, in electronic format, the following reports relating to
1012.27	RE Barren Ridge 1 LLC	1012.27.Plant-Re-Vegetation and Landscaping Plan Preventive Maintenance: Plant	Land Lease 6.10 - Maintenance, Repair, Operations/ Exhibit B.58	Not Started	2/28/17	004464	-17	Operator shall perform all obligations of Owner (as ? Lessee?) set forth in the following provisions
1012.32	RE Garland A LLC	1012.32.Plant-Re-Vegetation and Landscaping Plan - Signal Energy Additional Services: Plant	Re-Vegetation & Landscaping Plan 7.2 - Monitoring/ Exhibit B.45	Not Started	2/28/17	012345	-17	Operator shall perform all operations and maintenance requirements of and perform the Serv



Day-in-the-Life: Asset Manager – Revenue Target



Revenue target Event missed. Click target and drill-down to production variance



Day-in-the-Life: Planner & Scheduler

Dispatchers get visualization of all field maintenance activity, in real-time

Home Dashboards Accounts Contacts Asset Tags Entitlements PM Group Schedules PM Group Details **PM Schedules** Reports Work Orders Cases

1012.01-Victor Phelan 1 PMs Edit | Delete | Create New View

New PM Schedule Change Owner

Planned outages

Action	PM Schedule	Asset Description
PM-000356	Victor Phelan Solar One Plant	
PM-000483	1012.01 Summary of all combine	
PM-000484	1012.01 Summary of all inverter	
PM-000363	Victor Phelan Solar One Plant	
PM-000354	1012.01 Summary of all modules	
PM-000347	1012.01 Summary of all modules	

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Today, 7:45 AM
steve hanawalt

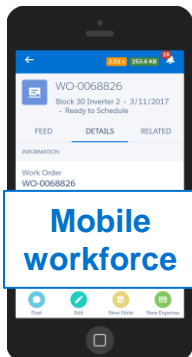
Alert from Power Factors Network Operations Center

Plant: Mustang 4 PM Block - F3 and F4
PF Asset Name: 1012.46 Inverter087
Customer Asset Name: Block3 Inverter 2
Failure Class: Failure Class
Database: PF-PV-Database
Start Time: 3/17/2017 7:45
Trigger Time: 3/17/2017 7:45
Target: 1012.1012.46 Plant
State: OutsideControl
Priority: Normal

Actions:
Update AssetOptics work order

Unplanned outages

Curtailment orders



Mobile workforce

Home Dashboards Accounts Contacts Asset Tags Entitlements PM Group Schedules PM Group Details PM Schedules Reports Work Orders Cases Operating Log Records Libraries **Dispatch Console** Opportunities

PF Insight

Work Order	Work Description	Account	Asset ID	Asset Description	Priority	Percent Complete	Est Hrs to Comp	Craft	# Techs	Duration	WO Type	WO Status	Due Date
WT-00000108	AC SwitchDC Contactor Replacement	1010.1 INVA	1010.1 INVA	Inverter 02B (C32 INVD2)	High	0	1		1	1	Corrective	Hold	02/11/2013
WT-00000107	AC SwitchDC Contactor Replacement	1010.1 INVA	1010.1 INVA	Inverter 08A (C32 INVD2)	High	0	1		1	1	Corrective	Hold	02/11/2013
WT-00000223	Calibrate pyranometers	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	1		1	1	Preventive	Hold	04/30/2014
WT-00000215	Calibrate pyranometers	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	2		1	2	Preventive	Hold	04/30/2014
WT-00000215	Inspect met station for condition, pyranometer and ref.	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	1		1	1	Preventive	Hold	04/30/2014
WT-00000215	Clean reference cells	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	4		1	4	Preventive	Hold	03/31/2014
WT-00000217	Setup LOTD	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	34		1	9	Preventive	Hold	04/06/2014
WT-00000232	Clean/replace filters	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	68		2	9	Preventive	Hold	03/31/2014
WT-00000233	Inspect inverter internal for cleanliness, corrosion, torque set.	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	2		1	2	Preventive	Hold	03/31/2014
WT-00000234	Annual Inverter PMs	1010.1 Plant	1010.1 Plant	XV2 Solar Plant	Normal	0	2		1	2	Preventive	Hold	03/31/2014

Mar 17 — 19, 2017

Crew Start Time: 8:00 AM Time Zone: America/Los_Angeles

Crew Members

Member	Start	End	Task
Brian Scott	8:00 AM	12:00 PM	WT-00000108
Carlos Rivera	8:00 AM	12:00 PM	WT-00000107
Chris Crabtree	8:00 AM	12:00 PM	WT-00000223
Christopher Gullett	8:00 AM	12:00 PM	WT-00000215
Daniel Amado	8:00 AM	12:00 PM	WT-00000215
Danny Rodriguez	8:00 AM	12:00 PM	WT-00000215
David Peck	8:00 AM	12:00 PM	WT-00000215
Dylan Patton	8:00 AM	12:00 PM	WT-00000215

Challenges

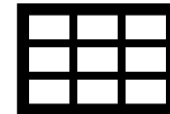
- Data Curation



- Event Management

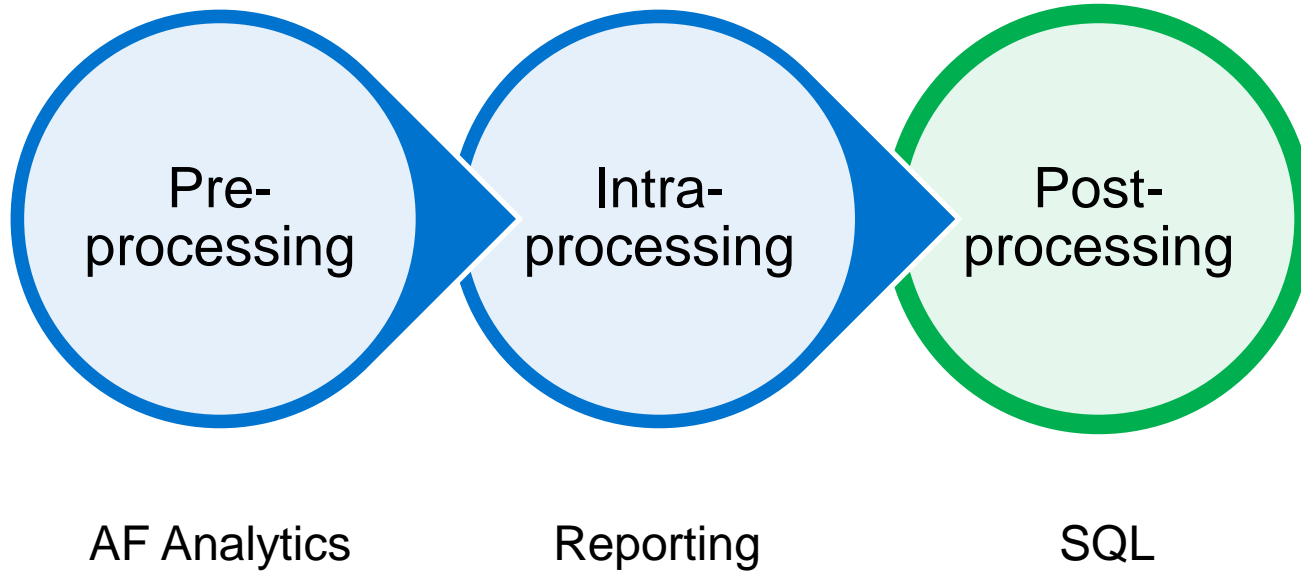


- Scalability

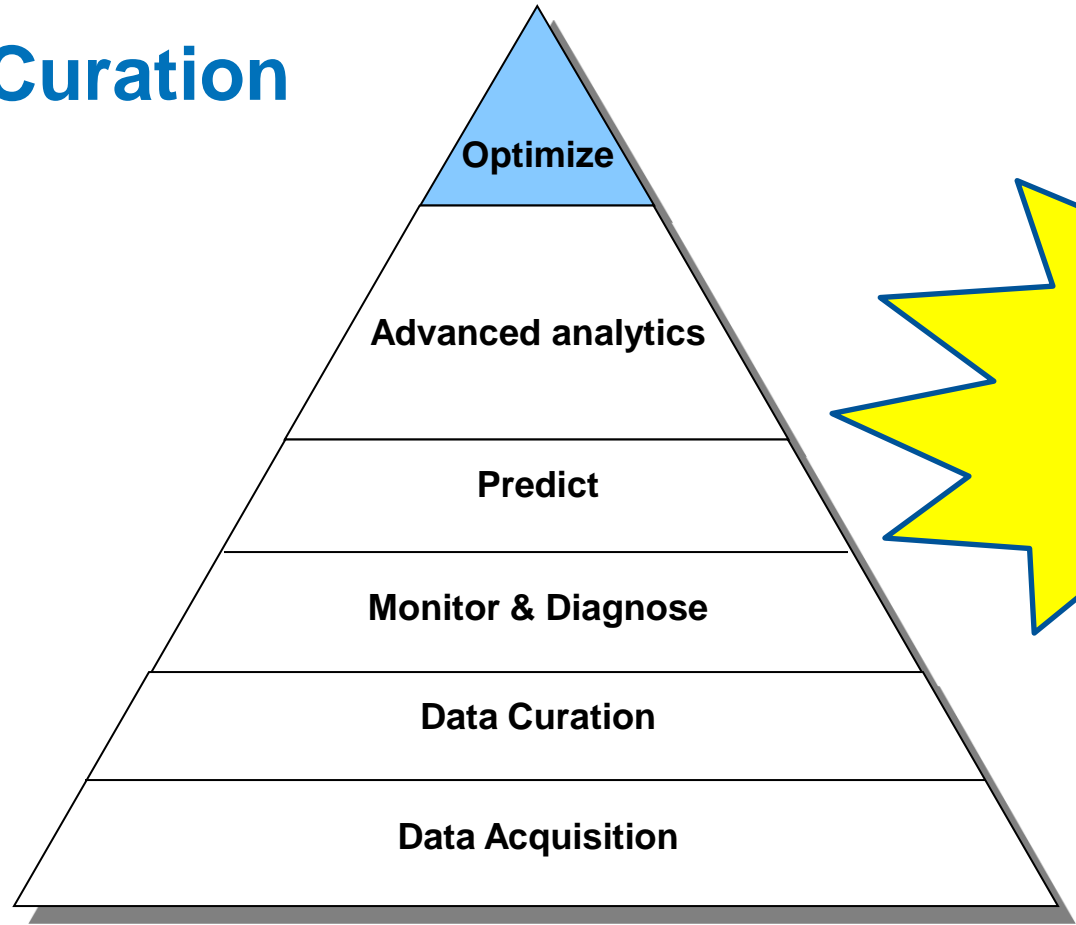


Data Curation

Data curation is the management of **data** throughout its lifecycle, from creation and initial storage to the time when it is archived for posterity or becomes obsolete and is deleted. The main purpose of **data curation** is to ensure that **data** is reliably retrievable for future use



Data Curation



Data can become the problem, not the solution

If you don't get these two right, all of the advanced analytics will be essentially useless

Event Management

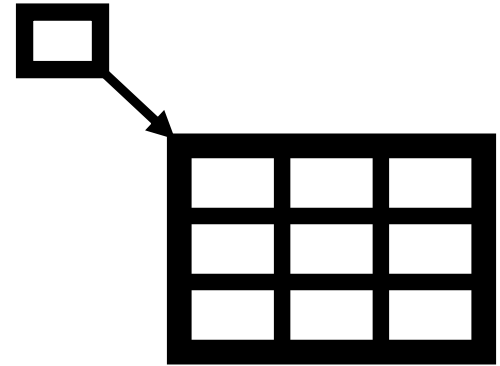
Q - What do we do with 70,000 events per day?



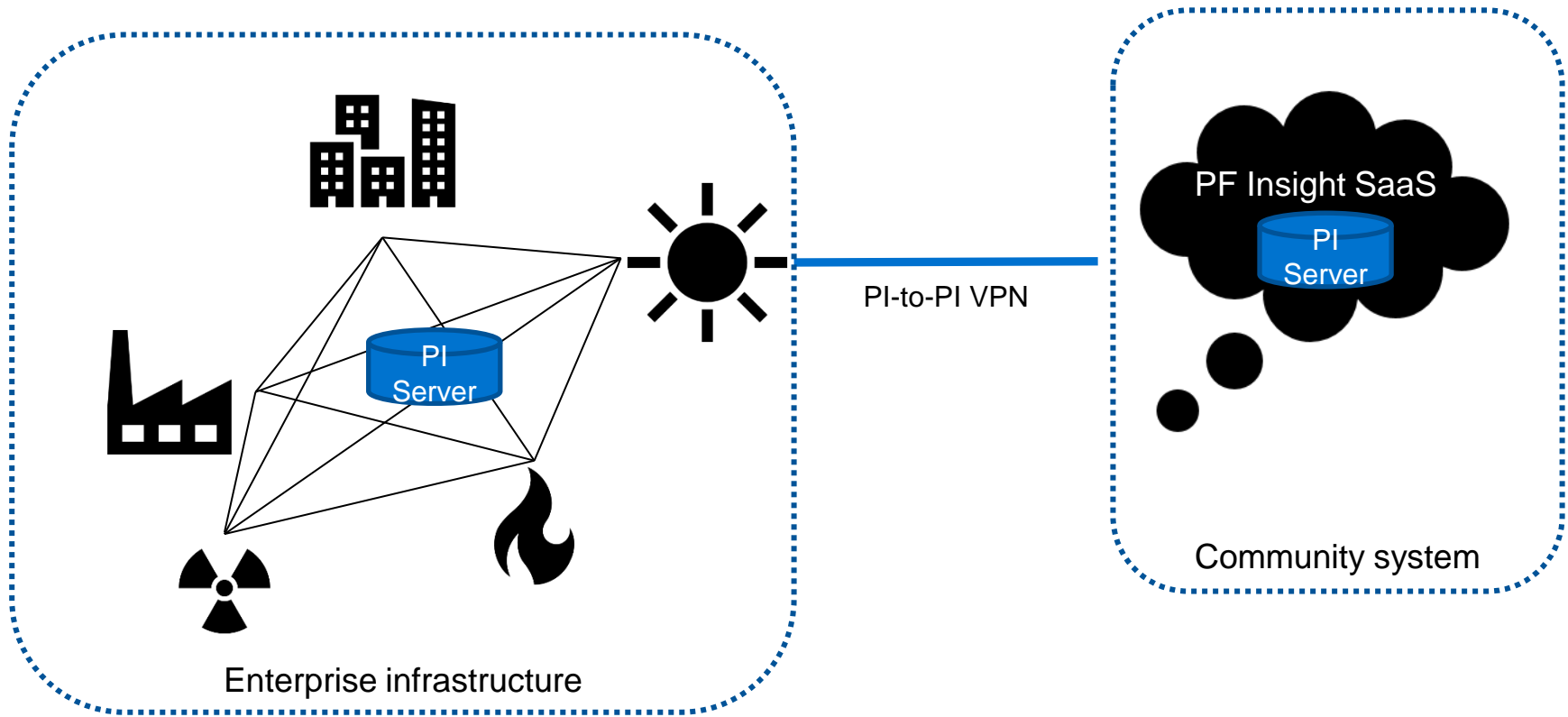
A – Ignore 69,988 of them

Scalability

- How can we make this scale?
 - Role-based
 - User-configurable
 - Onboarding utilities
 - Auto asset structure creation (Elements/attributes)
 - Templatized
 - Elements
 - Analytics
 - Element relative
 - Offboarding utilities
 - Active/Inactive
 - Auto renew



Extending Value Creation Beyond the Enterprise Knowledge Base



OSIsoft Product and Services Used

- AF Builder
- AF SDK
- Center of Excellence (CoE)
- Connected Services
- Enterprise Program Manager (EPM)
- Field Service Engineers
- PI Cloud Connect™
- PI Connectors
- PI Coresight™
- PI DataLink®
- PI OLEDB Enterprise
- PI Web Services™
- PI Interfaces
- PI ProcessBook®
- PI Server™
- Asset Framework (AF)
- Event Frames
- High Availability (HA)
- Notifications
- Performance Equations (PE)
- System Management Tools (SMT)
- Totalizers
- PI Smart Connectors™
- PI System®
- PI System Connections
- PI System Explorer™
- PI System Field Service
- PI System Tools
- PI Tag™
- PI to PI Interface™
- PI Web API
- PI WebParts™
- Software Reliance Program (SRP)
- Technical Support

Summary

COMPANY and GOAL

- 1) SaaS Portfolio Performance Management Solution
- 2) Cost-effective toolset for renewable power owners & operators for managing their portfolio of assets

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FACTORS**
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CHALLENGE

Equipping solar owners/operators with a performance management tool that is scalable, robust and fits into their budget

- High volume operational data set
- High project velocity
- Low O&M budget

SOLUTION

Fully integrated cloud-based performance, reporting & asset management tool that

- Real-time PI event detection & notification
- Curated reporting
- Automated work orders
- Contract compliance

RESULTS

2-5% improvement in project cash flows
Dramatic reduction in fixed cost structure

- Higher operational efficiencies
- Lower labor cost-of-production
- Reduced levelized cost of energy

Contact Information

Steve Hanawalt

steve.hanawalt@powerfactorcorp.com

Executive Vice President

Power Factors LLC

www.pfdrive.com

POWER
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감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado