PI as a Utility-Scale PV Monitoring Platform

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POWER FACTORS, INC.

Outline

- State of the Market
- Issues and Challenges
- Potential Solutions
- Benefits
- Summary and Q&A

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State of the Market

- Turmoil, uncertainty, change…
  - Daily news of failures
  - Price compression accelerating consolidation
  - What is going on?

- 2012 – 10-15% growth driven by US, China, India and Latin America

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Issues and Challenges in PV

- Utility PV monitoring characterized by
  - Dynamic. Evolving technology/standards/needs
  - Volume. Large quantities of data
  - Remote. Local *and* remote operations with changing O&M structures
  - Uncertainty. Forecasting and power scheduling
- Needs
  - Flexibility
  - Visibility

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Potential Solutions

To meet the monitoring needs of this new and dynamic generation technology...

- *What* should we monitor, and
- *How* should we monitor it?

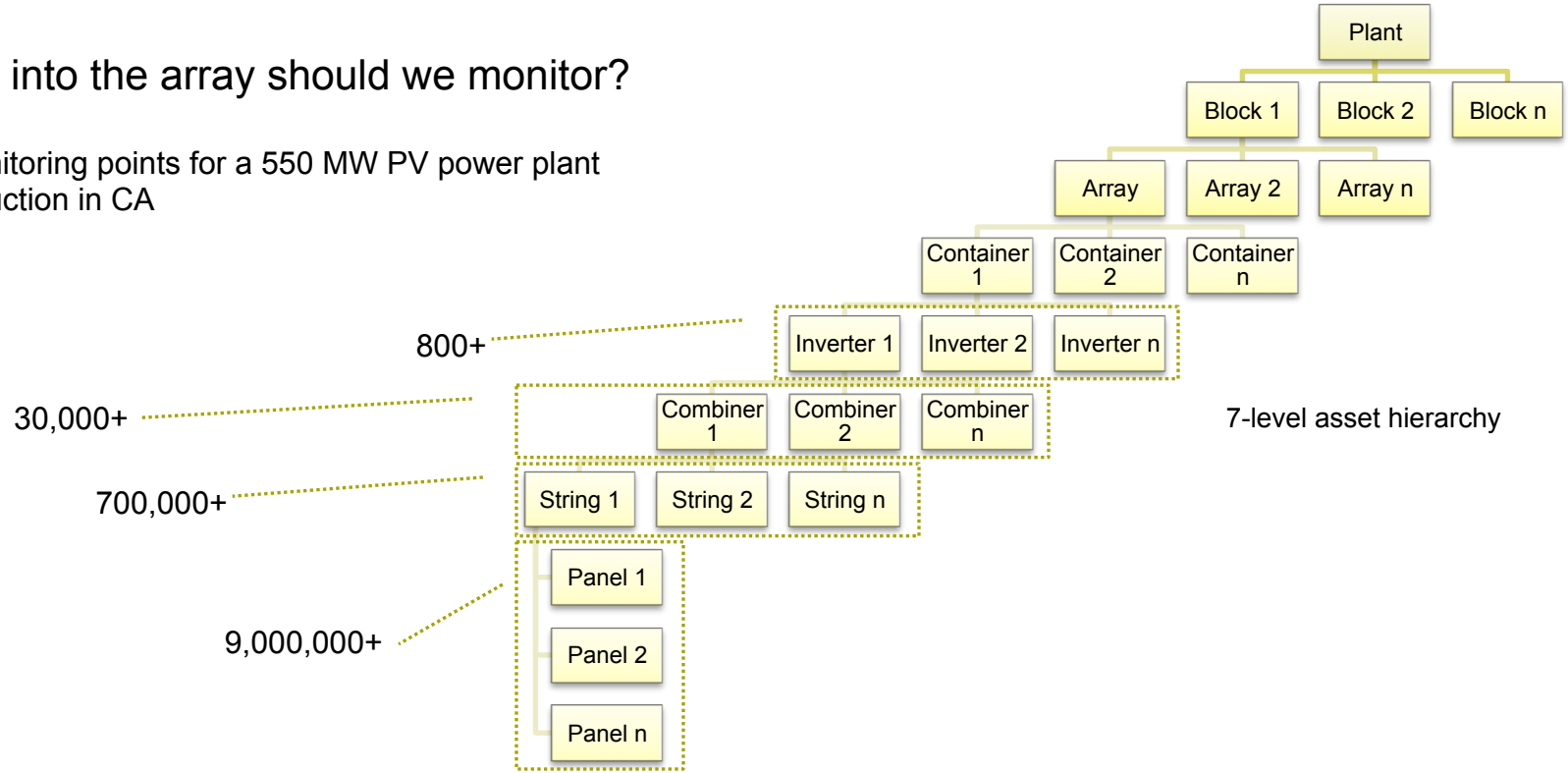
What Should we Monitor?

- Systems and components
- Solar PV KPIs
- Interfacing with external systems

What Should we Monitor? - Systems and Components

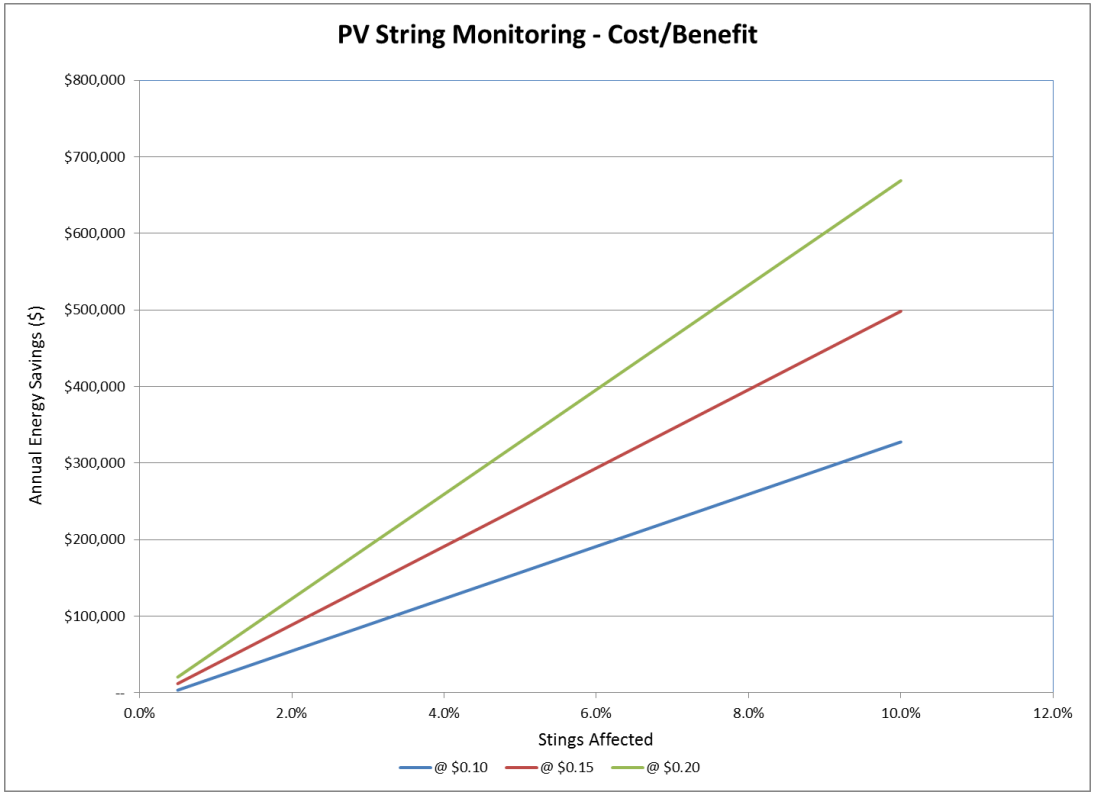
How deep into the array should we monitor?

Potential monitoring points for a 550 MW PV power plant under construction in CA



String Monitoring – Cost/Benefits

The economic benefit of string monitoring is a function of the price of energy, percentage of strings affected, and cost of labor



What Should we Monitor? - PV KPIs

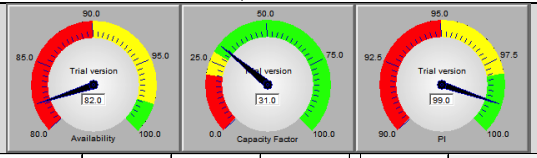
Production	• Actual • Expected • Variance
Efficiency	• PR • PI • Normalized array yield
Availability	• Equivalent availability • Capacity factor

Economics	• O&M costs
	  • Fixed
	  • Variable
	• Commercial availability

To monitor and extract value from the assets what data should you monitor?

What Should we Monitor? – PV KPIs

XYZ Renewables
Monthly Fleet Performance Report
September 2012

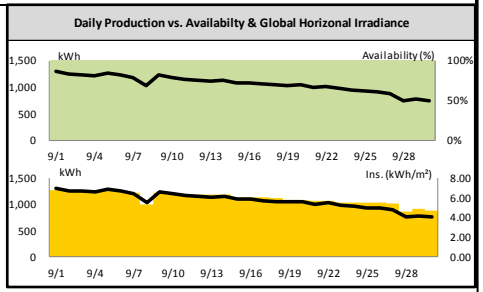


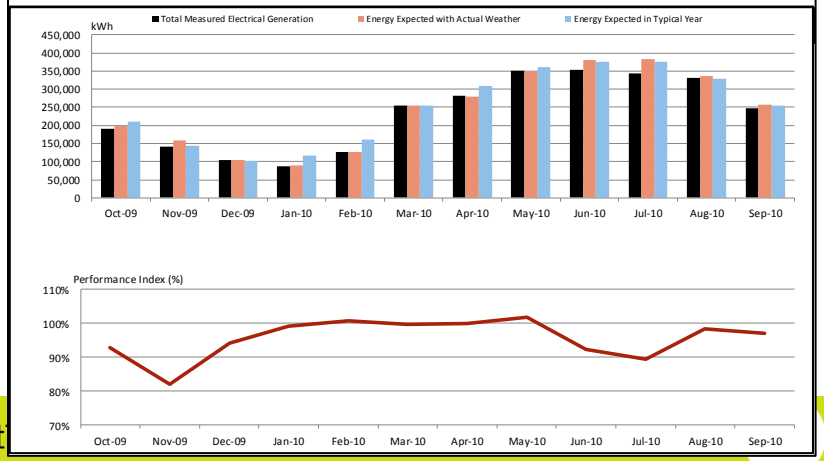
	Actual	Expected	Variance	Percent Variance	12-month avg
Financial					
Revenue	$ 1,234,567	$ 1,203,456	$ 31,111	2.6%	
Gross Margin	$ 676,543	$ 655,000	$ 21,543	3.3%	
Gross Margin %	55%	54%	0.4%	0.7%	
Production (kWh)					
Gross	2,191,482	2,147,234	44,248	2.1%	
Parasitic	43,830	51,534	-7,704	-14.9%	
Net	2,147,653	2,095,701	51,952	2.5%	
Performance					
Availability - Avg	97%	98%	-1.1%	-1.1%	
Availability - Min	89%	98%	-8.7%	-8.9%	
Availability - Max	100%	98%	2.0%	2.0%	
PI - Avg	102%	100%	2.1%	2.1%	
PI - Min	94%	95%	-1.5%	-1.6%	
PI - Max	112%	100%	12.0%	12.0%	
Capacity Factor - Avg	18.3%	18.0%	0.3%	1.7%	
Capacity Factor - Min	16.4%	17.0%	-0.6%	-3.5%	
Capacity Factor - Max	21.1%	20.0%	1.1%	5.5%	
Outages					
Total	15.0	12.0	-300.0%	-25.0%	
Avg	2.2	2.0	-20.0%	-10.0%	
Min	-	1.0	100.0%	100.0%	
Max	5.0	2.0	-300.0%	-150.0%	

Portfolio with drill-down to site

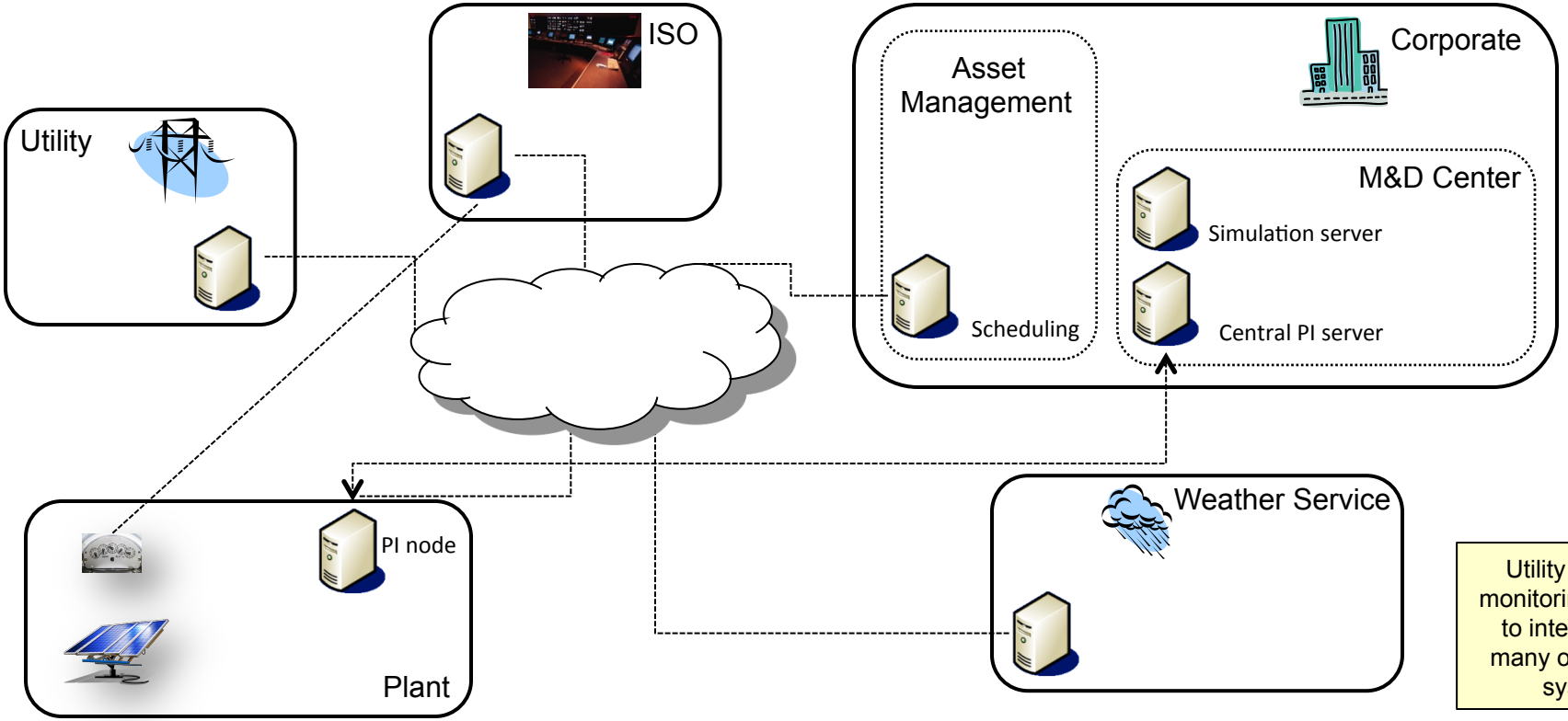
XYZ Renewables - ABC Facility
Monthly System Performance Report
September 2012

System Statistics	Current Month	Past 12 Months
kWh Produced	100	500
Availability	98.0%	99.4%
Number of Outages	0	4
Performance Indices		
Weather-Adjusted	103%	107%
Typical Year	120%	109%





What Should we Monitor? – External Systems



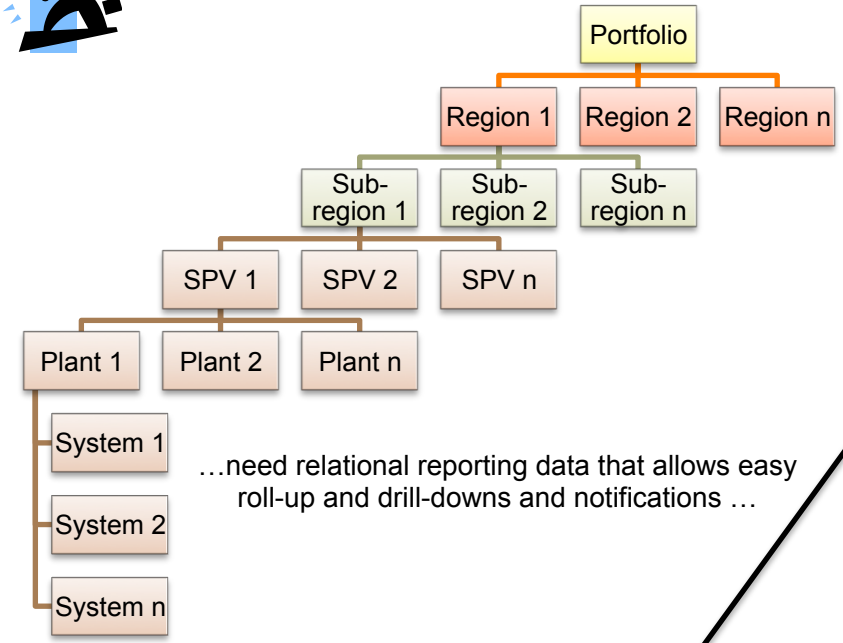
Utility scale PV monitoring will need to interface with many off-site data systems

How Should we Monitor it?

- Local and remote
- Roll-up/drill-down
- Data independence

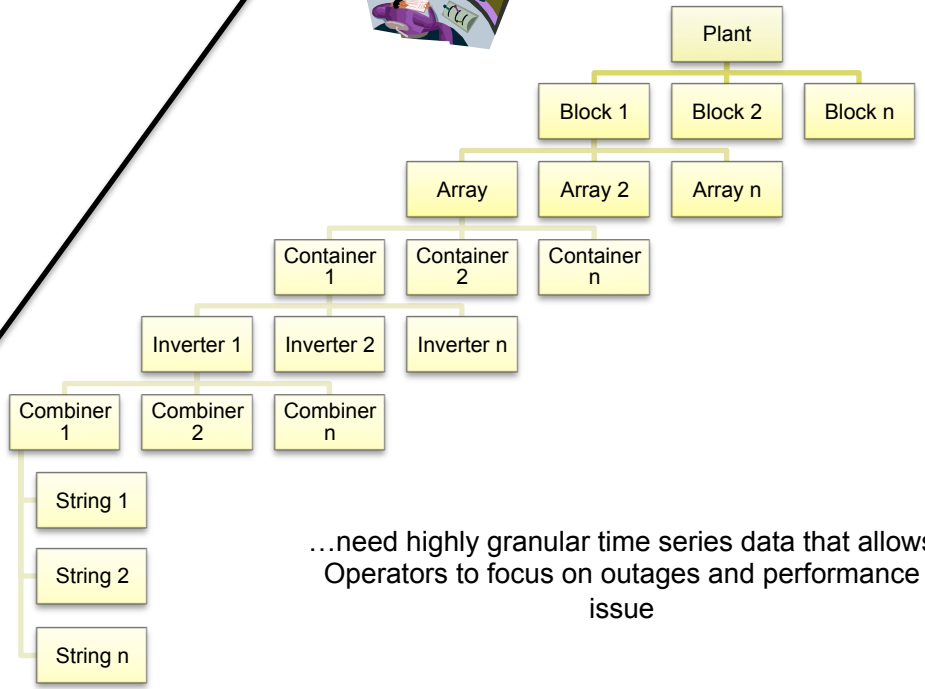
How Should we Monitor it? – Local and Remote

Asset managers and performance analysts…



…need relational reporting data that allows easy roll-up and drill-downs and notifications …

Plant operators…



…need highly granular time series data that allows Operators to focus on outages and performance issue

Utility PV Monitoring – Local or Remote?

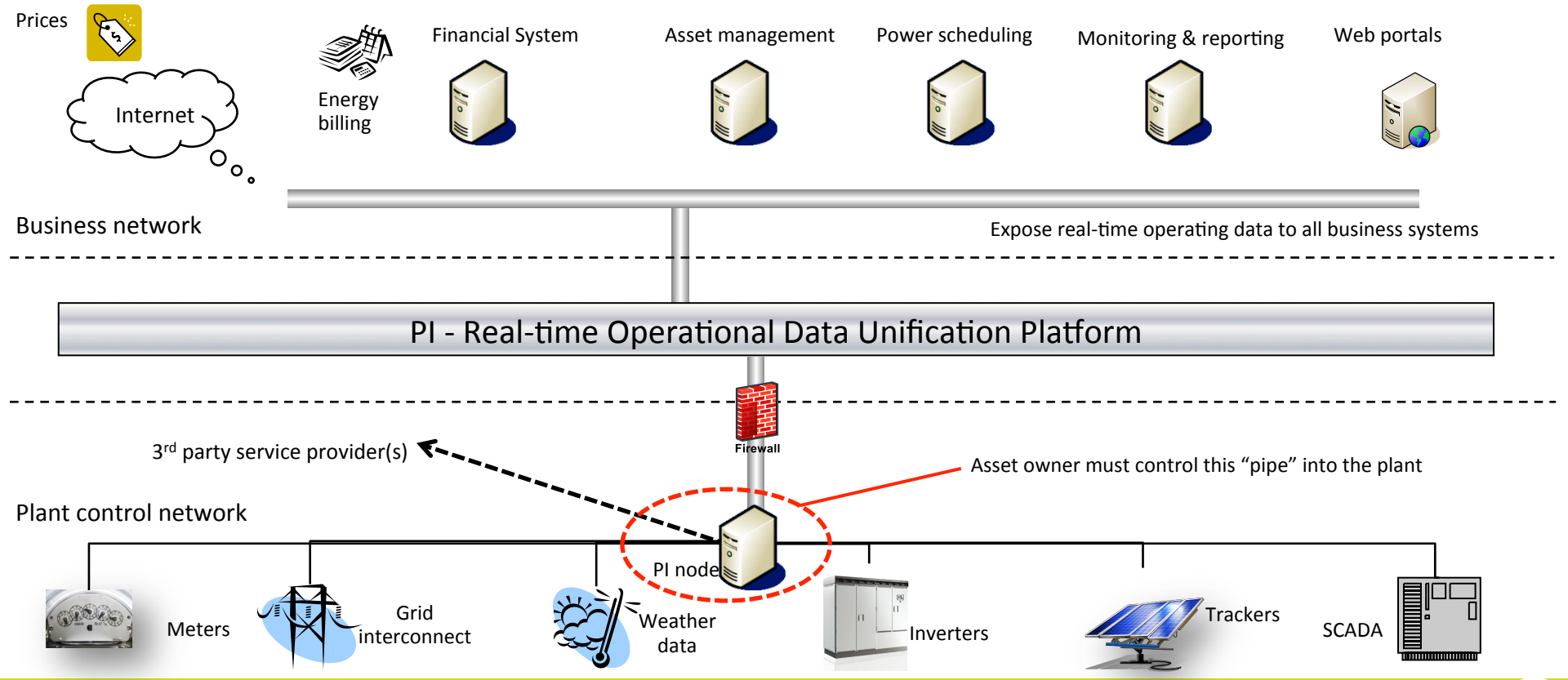
@ the Plant

- Equipment status
- Forced outages
  - Inverter trips
  - String outages
- Performance shortfalls
  - String monitoring
  - Combiner current

@ Headquarters

- Forced outages
  - Inverters
  - Feeder breakers
  - Main breaker(s)
- Performance shortfalls
  - Array yield
  - Inverter efficiency
  - Recoverable degradation
- Power scheduling
  - Available capacity
  - Weather data
  - Short-term power forecasting

PV Monitoring Platform – Maintaining Data Independence



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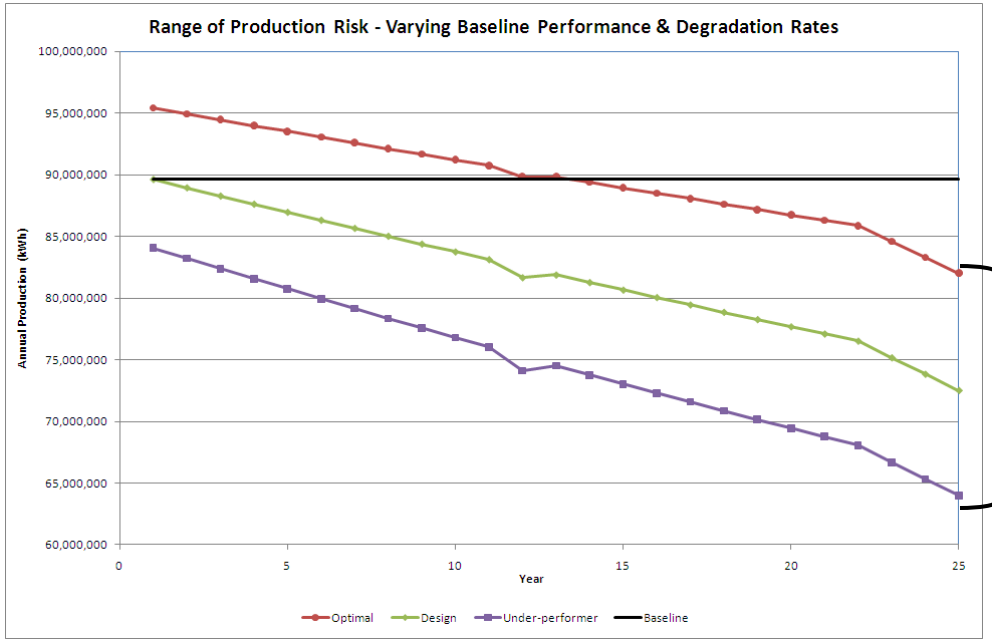
Benefits of Monitoring



17% production variance between a well-run PV plant and one that is not:

- Low availability
- High degradation
- Performance shortfalls
- O&M costs excursions

Estimated ROI for 100 MW portfolio: 366%

Other benefits:

- Minimize imbalance penalties
- Lower fleet production costs
- Seamless transition and interface with 3rd party service providers

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Summary and Q&A

- Rumors of the death of solar are greatly exaggerated…
- Owners must have real-time visibility of their asset's performance
- "Trust, but verify…"
- PI's performance, scalability, and universal presence make it a good portfolio monitoring platform

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THANK YOU

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Solar PV KPIs - Terms and Definitions

- Equivalent Availability Factor (EAF) - the proportion of hours in the period that a unit is available to generate at full capacity
- Commercial Availability Factor (CAF) - the proportion of potential revenue that the unit captures during the period
- Performance Index (PI) – the proportion of the potential energy production that the unit captures during the period
- Performance Ratio (PR) – the DC-to-AC conversion efficiency of the system
- Capacity Factor (CF) - the proportion of hours in the period that a unit generated at its nameplate rating