Achieving Enterprise-Wide Operational Intelligence Using the PI Server's Asset Framework (AF)

Presented by: Stephen Reynolds

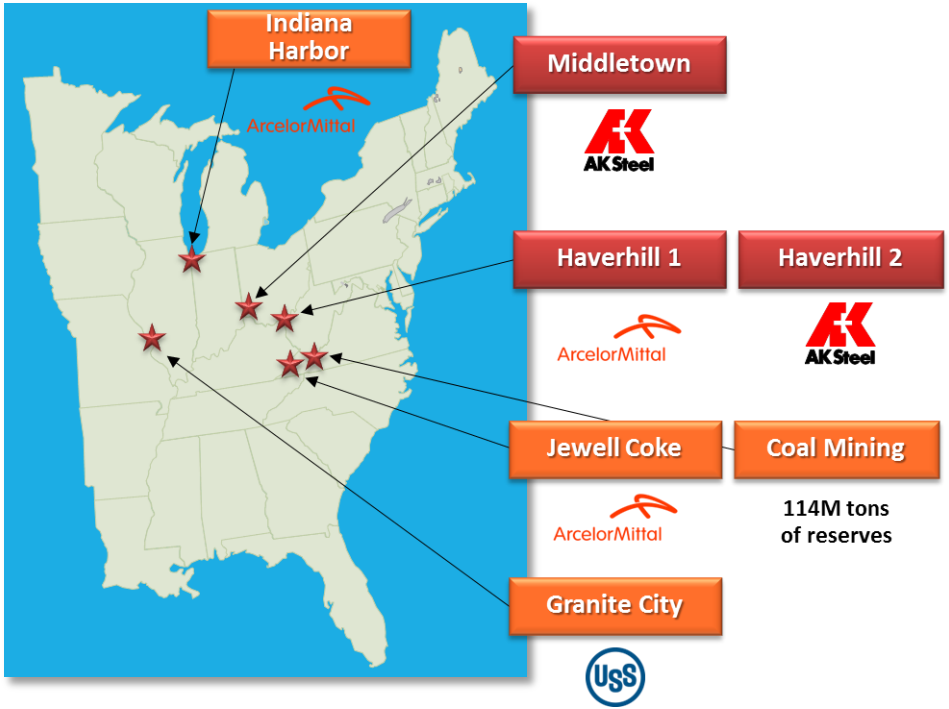
SunCoke Energy

- SunCoke Energy
- Our Vision
- Yield and Business Intelligence
- Oven Performance
- Asset Maintenance
- Next Steps

Agenda

SunCoke Energy

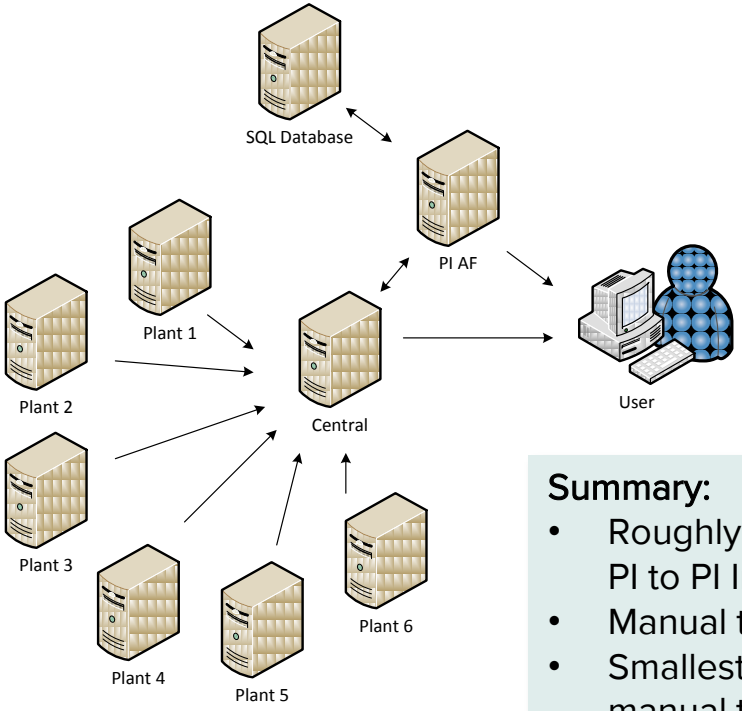
Our coke-making operations are strategically located in proximity to our customers' integrated steel-making facilities.

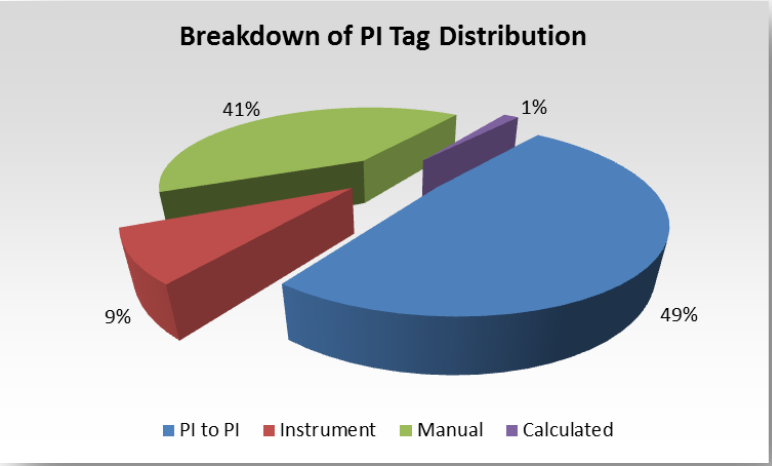


Coking and Heat Recovery

- Metallurgical coal mined and supplied to ovens
- Coal charged / coke pushed from ovens on 48 hr cycles
- Coke process operates at >2000 deg F (MACT)
- Flue gas processed in Heat Recovery Steam Generators (HRSG)
- High pressure steam supplied to customers or used to drive turbine generators
- Coke acts as a reducing agent in the smelting process while providing heat and structural support to the blast furnace reaction

PI System Overview



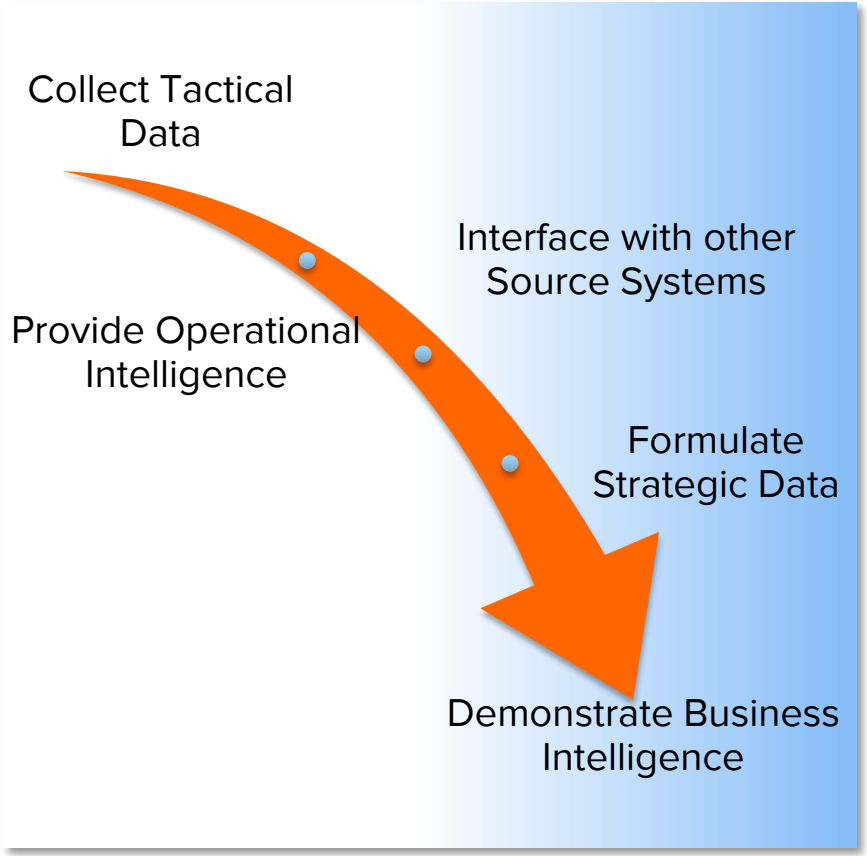


Summary:

- Roughly 400,000 total tags with nearly all site tags passing through a PI to PI Interface into the central server
- Manual tags outnumber instrument tags over 4-to-1
- Smallest plant has only 1037 instrumented tags with over 17,000 manual tags
- Oven inspections drive manual entry

Our Vision

Equipment Performance Data	•Site Instrumentation •Equipment Based Analytics
Unit Performance Data	•Unit Operations Data •Unit Specific Analytics
Site Performance Data	•Site Operational Intelligence •Site Level Analytics
Site Dashboards	•Site Specific Summaries •Site Roll-up Analytics •Internal Site Comparisons
Enterprise Dashboards	•Summary Business Intelligence •Broad Analytics •Site Comparisons



So What?

EBITDA is our primary performance measure at the corporate level

However, the plant focuses on:

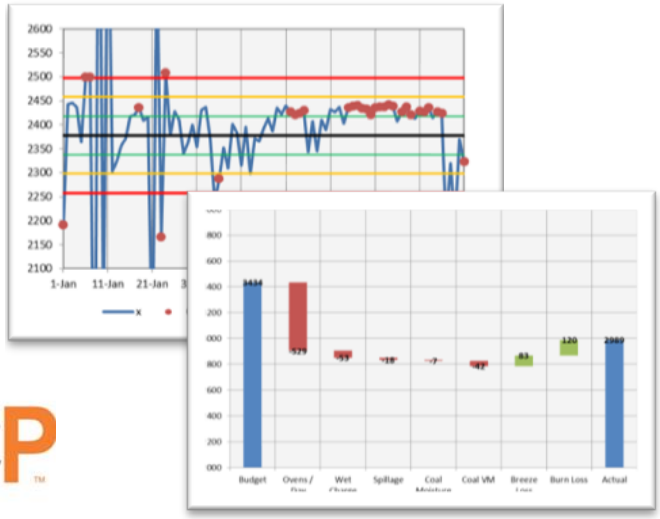
- HES Performance
- Production
- Yield
- O&M Costs

Business Intelligence goes to the sources of these metrics

- The PI System provides the operational data at the source
- Accurate and granular data improves performance troubleshooting
- Timely reporting and visual analyses enable timely course corrections
- Standardized analytics enable performance benchmarking
- Structured monitoring sustains implemented solutions

Yield and Business Intelligence

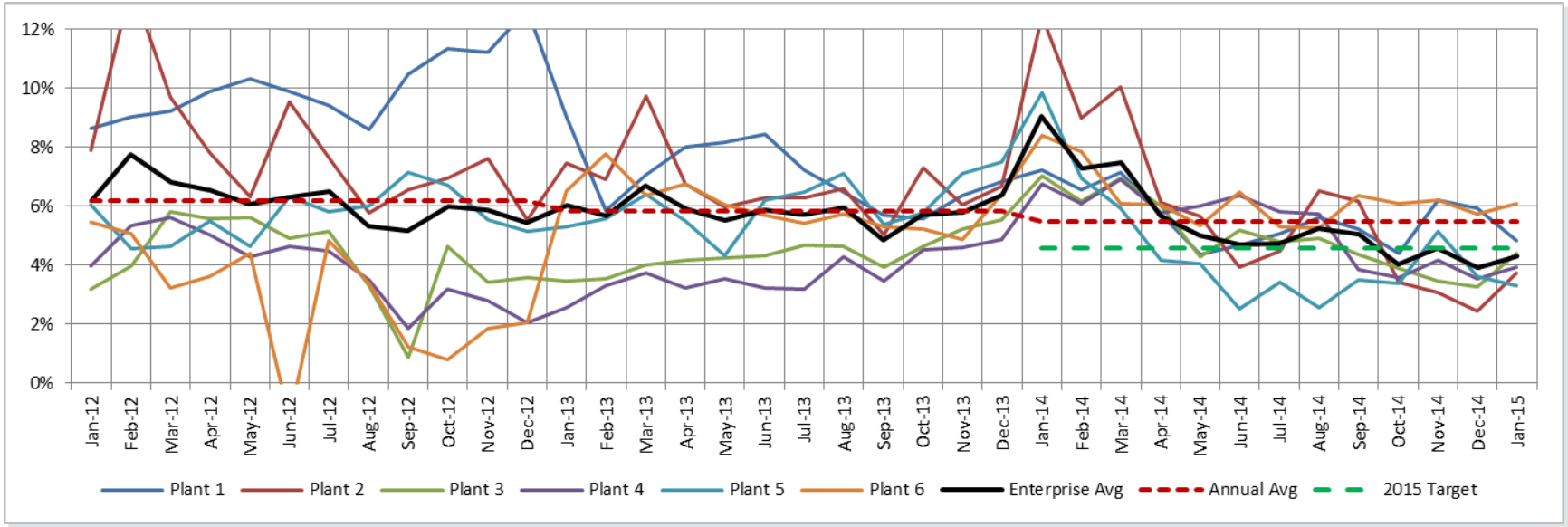
- Improving yield by just 1% across the domestic fleet adds $17 MM EBITDA annually
- And you can't spell EBITDA without "BI"…



SXCP

Challenge	Solution	Benefits
• No standard methods and measures • No clear path to analysis • Analysis paralysis	• Agree to and standardize definitions • Corral manual inputs into Asset Framework • Present in BI	• Average fleet yield loss down 1% from 2012 to 2014 • Targeting additional 1% 2015

Year-on-Year Yield Loss Improvement



- Note wide spread of reported losses in early trends of 2012
- Agreement on measures tightened consistency in 2013

- Ability to troubleshoot hastened recovery after 2014 “polar vortex”
- Enhanced PI System / BI driving continuous improvement in 2015

Designing for Business Intelligence

Problem Statement:

- Prepare Business Intelligence platform to consolidate plant metrics calculations
- Not all data is metered, routinely measured, or regularly recorded
- Manually entered data must satisfy design standards for data architecture
- Granularity of data is used for broad time analyses (weekly, monthly, yearly…)

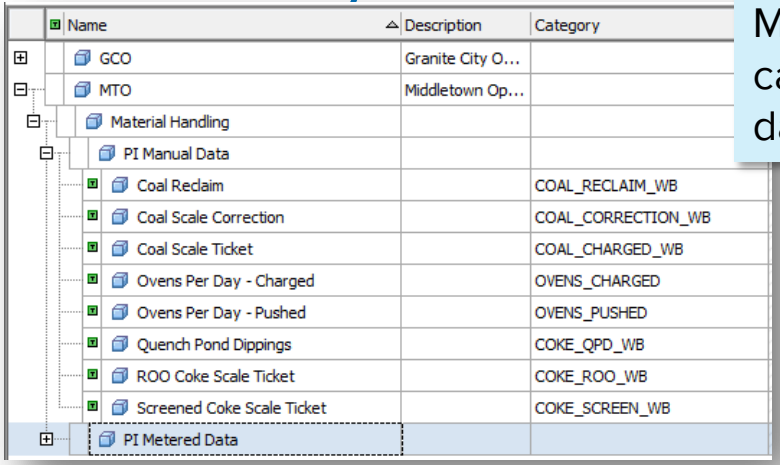
Solution:

- Utilize PI Manual Logger and Excel interface to input data
- Structure data through AF
- Prepare data for data model

Design:

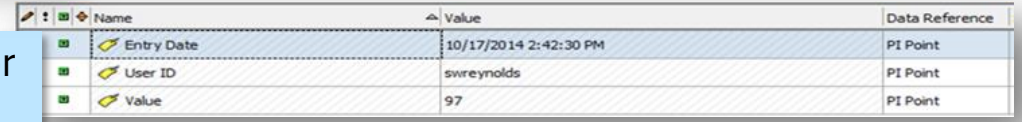
- Build separate BI Hierarchy in protected AF database
- Structure data and context to simplify E-T-L process
  - Use categorization to improve query processing
  - Prepare data using analytics
  - Use templates for scalability and standardization
- Manual entry requires three attributes sharing common timestamp
  - Actual value
  - Entry timestamp
  - User ID

BI Hierarchy



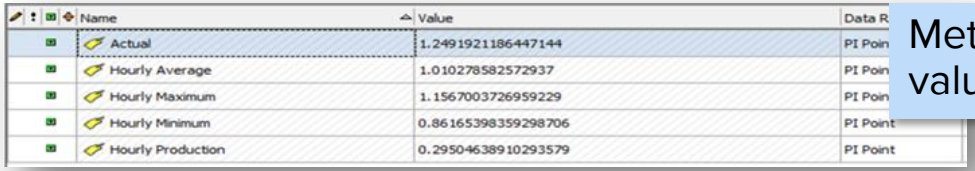
Name	Description	Category
GCO	Granite City O…	
MTO	Middletown Op…	
Material Handling		
PI Manual Data		
Coal Reclaim		COAL_RECLAIM_WB
Coal Scale Correction		COAL_CORRECTION_WB
Coal Scale Ticket		COAL_CHARGED_WB
Ovens Per Day - Charged		OVENS_CHARGED
Ovens Per Day - Pushed		OVENS_PUSHED
Quench Pond Dippings		COKE_QPD_WB
ROO Coke Scale Ticket		COKE_ROO_WB
Screened Coke Scale Ticket		COKE_SCREEN_WB
PI Metered Data		

Manual entry provides daily values, categorization provides quick reference to database key



Name	Value	Data Reference
Entry Date	10/17/2014 2:42:30 PM	PI Point
User ID	swreynolds	PI Point
Value	97	PI Point

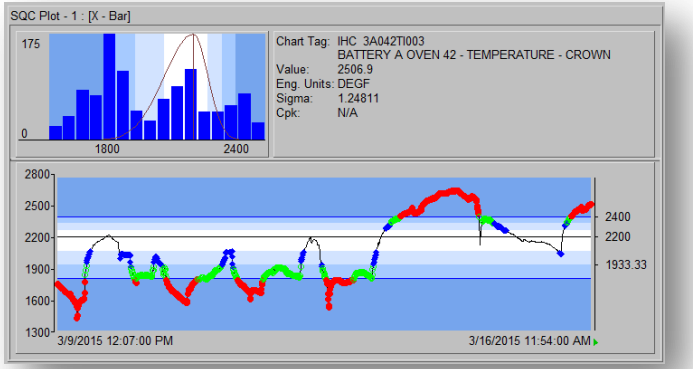
Attributes for manual entry allow for robust E-T-L process



Name	Value	Data R
Actual	1.2491921186447144	PI Poin
Hourly Average	1.010278582572937	PI Poin
Hourly Maximum	1.1567003726959229	PI Poin
Hourly Minimum	0.86165398359298706	PI Point
Hourly Production	0.29504638910293579	PI Point

Metered PI Tags provide range of values necessary for calculations

Oven Performance



To sustain high yield, the ovens must perform. Leading indicators for yield and oven performance are:

- Coking Rate
- Charge Weight
- Oven Temperatures
- Cycle Time

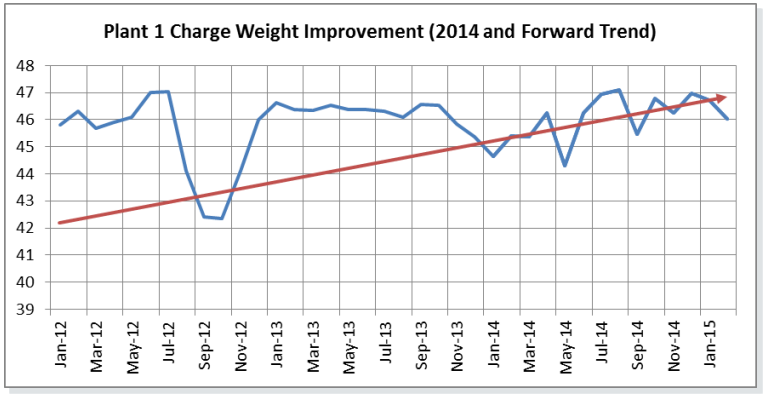
SXCP

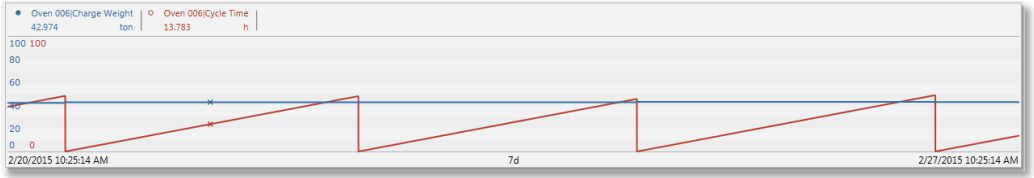
Challenge	Solution	Benefits
• Tracking metrics extremely labor intensive • Used day-to-day, but largely ignored in big picture analysis	• Identify available sources • Utilize Asset Analytics to perform calculations • Utilize SQC charts in PI ProcessBook to monitor and engage.	• Simplified engineering tasks • Standard monitoring • Early warnings • Sustained solutions

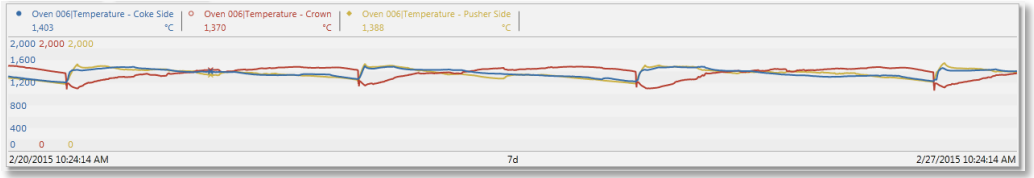
Oven Performance

Charge Weight Improvement:

Improving charge weights to permit limits at three domestic sites nets up to $9 MM in EBITDA







Cycle Time Improvement:

- Schedule is key
- Requires consistent temperatures
- An improvement in cycle time by 2 hours results in average of 7 more pushes per oven annually
- Roughly $70K in production recovery per oven

True Operational Intelligence

Define the Analytics:

- Coking Rate is f(Coking Time and Charge Weight)
- Coking Time is f(Coked Out Time and Oven Charged)
- Coked Out Time is f(Temperatures and Cycle Time)
- Cycle Time is f(Oven Charged)

Uses the same PE functionality:

- FindEq (GE,GT,LE,LT,NE)
- TimeEq (GE,GT,LE,LT,NE)
- TagVal
- PrevVal
- IF-THEN-ELSE
- Etc…

Name	Expression	Value	Output Attribute
PrCharge	`PrevVal('Indicator - Oven Charged','*')`		Click to map
ElTime	`TagVal('Charge Elapsed Time','*') <1 and TagVal('Charge Elapsed Time','*')<TagVal('Charge Elapsed Tim`		Click to map
PrCheck	`TimeEq('Indicator - Oven Charged','*-8h','*-1m',1)=0`		Click to map
ChargedPt	`If PrCheck and ElTime and PrCharge<>1 then 1 else (if PrCharge=1 then 0 else NoOutput())`		Indicator - Oven Charged

Name	Expression	Value	Output Attril
PrevCharge	`FindEq('Indicator - Oven Charged','*','*-60d',1)`	3/26/2015 5:08:00 AM	Click to map
PriorCharge	`FindEq('Indicator - Oven Charged',FindEq('Indicator - Oven Charged','*','*-60d',1)-120,'*-120d',1)`	3/24/2015 3:23:00 AM	Click to map
CyTime	`Float(PrevCharge-PriorCharge)/3600`	49.75	Previous Cha

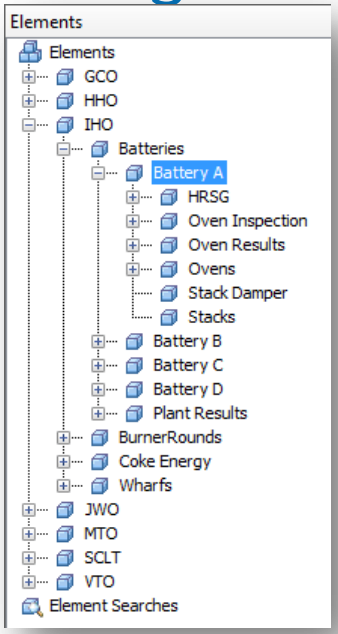
Oven Charged marks the coking cycle and the next analysis calculates the Cycle Time

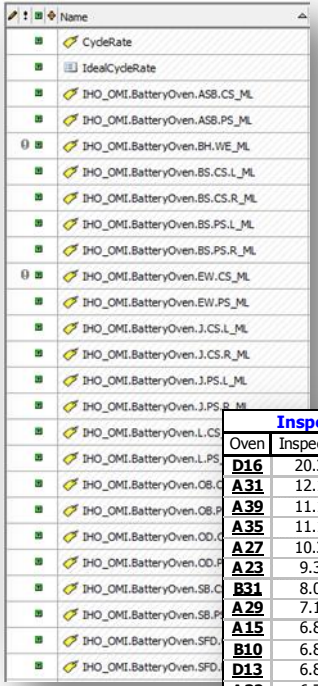
Asset Management

An oven in poor condition will not perform. Returning an oven to performance levels can cost upwards of $250k in maintenance costs alone. Not to mention the cost of lost production…

Challenge	Solution	Benefits
• >1000 ovens in fleet • >130 inspection points per oven • Paper system • Two inspectors fleet wide	• Utilize PI Manual Logger to capture inspection data • Add context through AF • Visualize through PI Coresight and PI ProcessBook.	• Easy visualization of results • Pairing with performance data to optimize repairs • Tailored repair strategy

Using Asset Framework

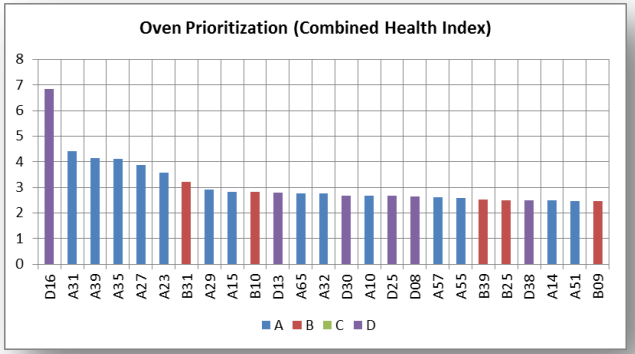




Inspection -20 Worst Scores

Oven	Inspection	Coke Rate		Final KPI	Years
D16	20.30	0.916	✓	**6.73**	6.215
A31	12.12	0.913	!	**4.27**	3.947
A39	11.10	0.869	✗	**3.94**	3.637
A35	11.10	0.902	!	**3.96**	3.658
A27	10.35	0.924	✓	**3.75**	3.464
A23	9.30	0.909	!	**3.43**	3.164
B31	8.07	0.880	✗	**3.04**	2.804
A29	7.10	0.896	!	**2.76**	2.546
A15	6.85	0.910	!	**2.69**	2.486
B10	6.85	0.918	✓	**2.70**	2.491
D13	6.80	0.937	✓	**2.70**	2.489
A32	6.70	0.929	✓	**2.66**	2.456
A65	6.65	0.910	!	**2.63**	2.430
D30	6.40	0.919	✓	**2.56**	2.367
D25	6.35	0.920	✓	**2.55**	2.353
A10	6.30	0.888	✗	**2.51**	2.319
D08	6.20	0.894	!	**2.49**	2.295
A57	6.09	0.880	✗	**2.44**	2.256
A55	6.00	0.897	!	**2.43**	2.242
D38	5.80	0.920	✓	**2.38**	2.201

- Moving inspections to Oven Templates in AF
- Utilizing roll-up functionality within Asset Analytics to prioritize sites, batteries, specific ovens.
- Combining inspection data with performance data for health index calculation and analysis



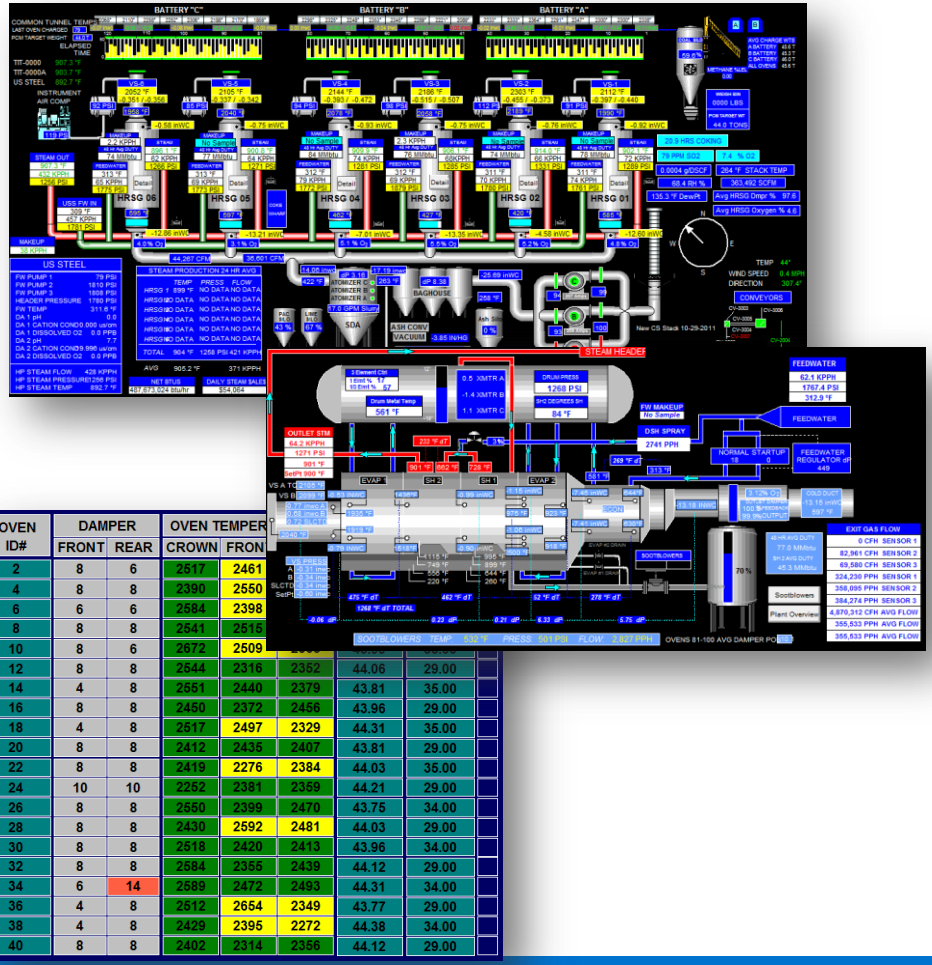
Next Steps

Move into “Energy”
- Boiler Analytics
- Power Production

Compliance
- Environmental Monitoring
- Safety Tasks

Central Monitoring
- Standard Displays
- Summary Dashboards

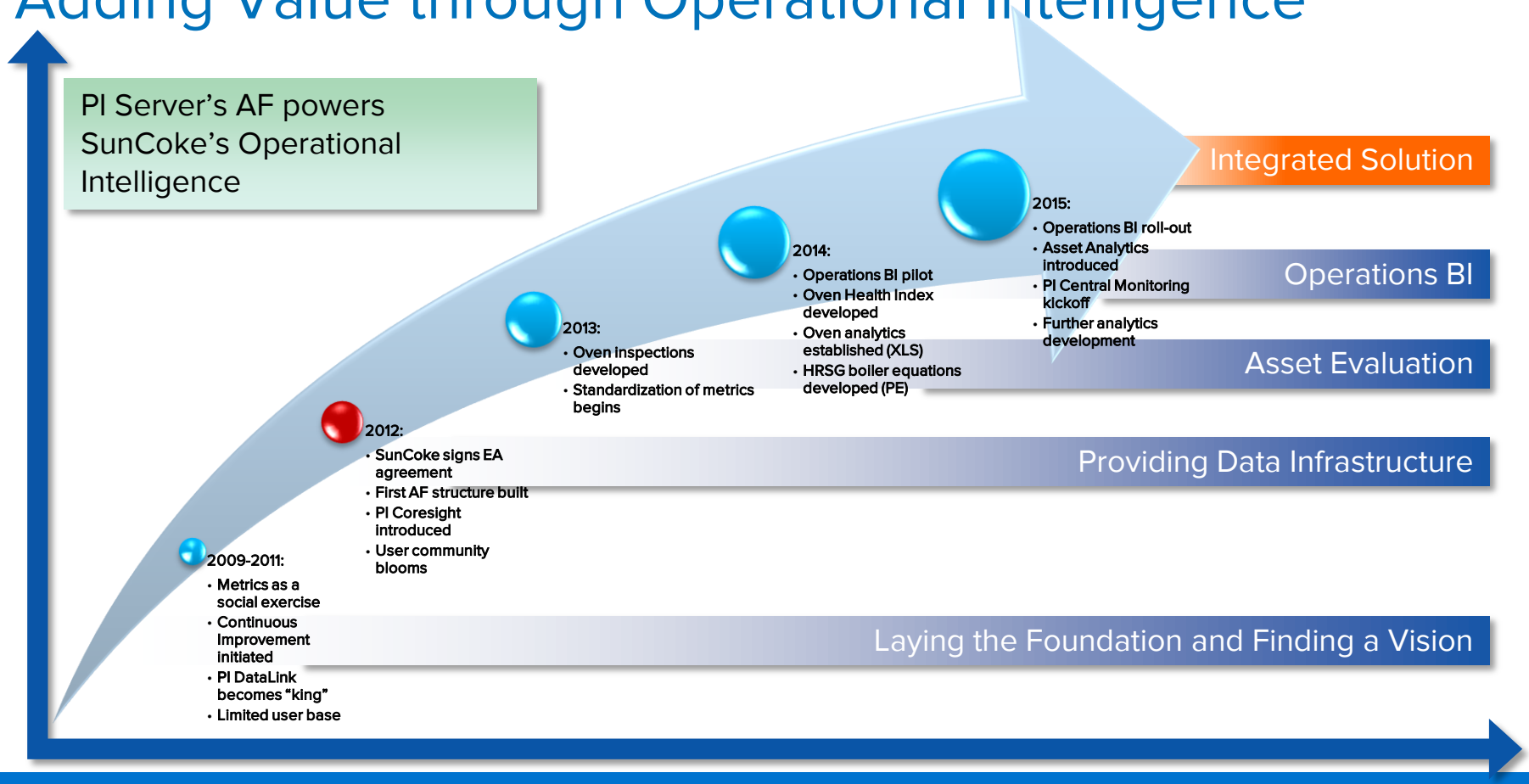
Finish What We’ve Started!



OVEN ID#	DAMPER		OVEN TEMPER				
	FRONT	REAR	CROWN	FRON			
2	8	6	2517	2461			
4	8	8	2390	2550			
6	6	6	2584	2398			
8	8	8	2541	2515			
10	8	6	2672	2509			
12	8	8	2544	2316	2352	44.06	29.00
14	4	8	2551	2440	2379	43.81	35.00
16	8	8	2450	2372	2456	43.96	29.00
18	4	8	2517	2497	2329	44.31	35.00
20	8	8	2412	2435	2407	43.81	29.00
22	8	8	2419	2276	2384	44.03	35.00
24	10	10	2252	2381	2359	44.21	29.00
26	8	8	2550	2399	2470	43.75	34.00
28	8	8	2430	2592	2481	44.03	29.00
30	8	8	2518	2420	2413	43.96	34.00
32	8	8	2584	2355	2439	44.12	29.00
34	6	14	2589	2472	2493	44.31	34.00
36	4	8	2512	2654	2349	43.77	29.00
38	4	8	2429	2395	2272	44.38	34.00
40	8	8	2402	2314	2356	44.12	29.00

Adding Value through Operational Intelligence

PI Server's AF powers SunCoke's Operational Intelligence



Closing Points

- Recruit a willing internal business partner
- Find common ground
- Structure the data
- Build the analytics
- Get help
- Deploy
- Enjoy!

Stephen Reynolds

swreynolds@suncoke.com

Solution Architect

Manager – Continuous Improvement

SunCoke Energy

Please wait for the microphone before asking your questions

State your name & company

Questions?

감사합니다

谢谢

Danke

Merci

Gracias

Thank You

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Спасибо

Obrigado