Enterprise Value:

How APS Creates Corporate Wide Benefits

22 March 2017

Presented by **Ravi Nair, APS**
Pat Kelly, Industrial Knowledge

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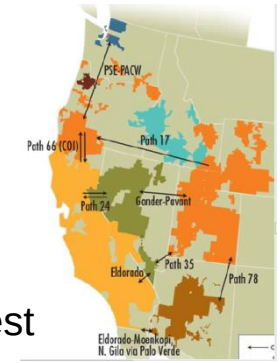
APS by the Numbers

- Arizona's largest and longest serving utility
  - Serving Arizona since 1886
- Service Territory
  - 11 out of 15 counties
  - 1.2 Million Customers (89% residential)
  - 34,646 square miles
- Peak Demand ~ 7,300 MW in August 2015
- 33,000 miles of transmission, distribution lines and cable
- The second largest generation fleet in the western US
  - Palo Verde NGS, primary source of electricity in Southwest
- Solar Capacity ~ 950 MW
  - 4th largest in the nation
  - 50% of solar portfolio is distributed
  - Pioneer in solar research since 1970s
- Recently joined the CAISO Energy Imbalance Market



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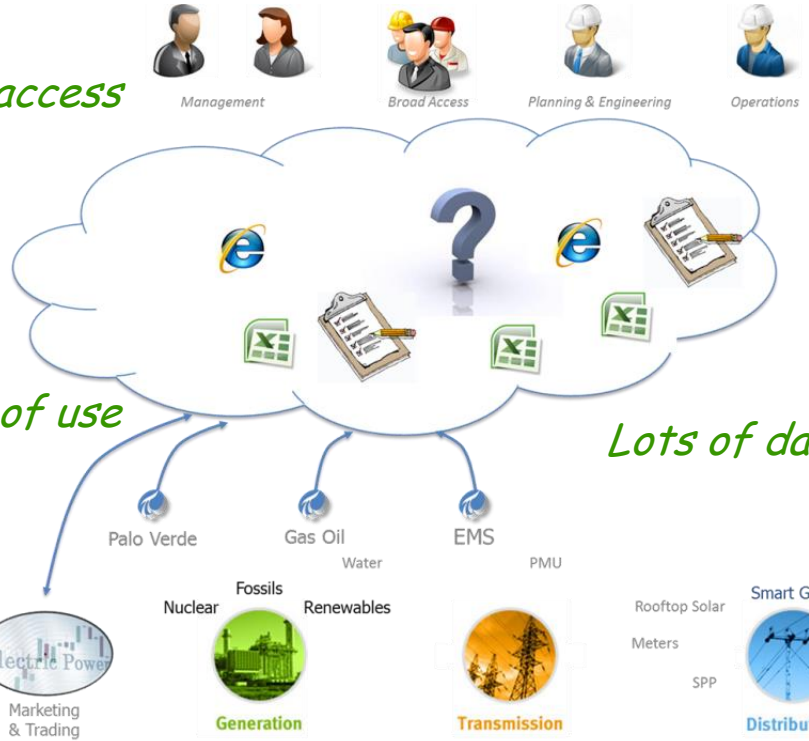
Business Challenges

Valuable data locked away

Lack of visibility and access



Inability to find data

Islands of data; pockets of use

Lots of data … and more everyday!

Additional data sources

Adding smart devices

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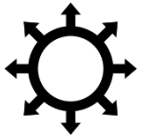
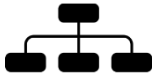
Enterprise PI Program Evolution

2017-2018



- Additional data sources (AMI, ADMS, …)
- Additional applications
- Expanding use of data; continued training
- Ongoing governance, PUG

2016



- Additional data sources (SPP, Smart Grid, EMS, AMI)
- Initial PI System applications
- Unlock data – direct access, user training
- Maturing governance processes; establish PUG

2015

- Launched Enterprise Analytics Strategy / Vision
- Connecting systems
- Entered into EA agreement; established foundation
- Recognized need for framework / governance

2013 - 2014

- Limited use of PI System (silos) for generation, EMS data
- Lack of analytics framework
- Maintained by PI System Support team and local super users

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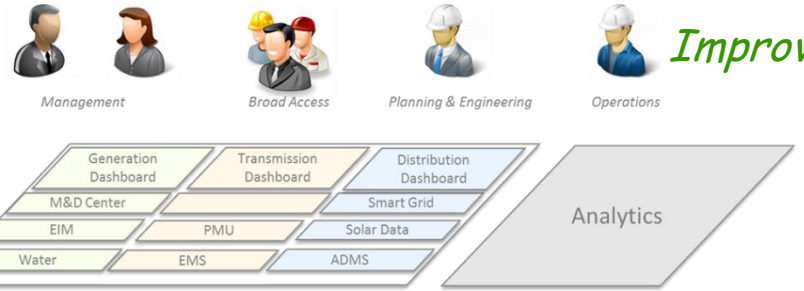
Program Vision

One version of the truth

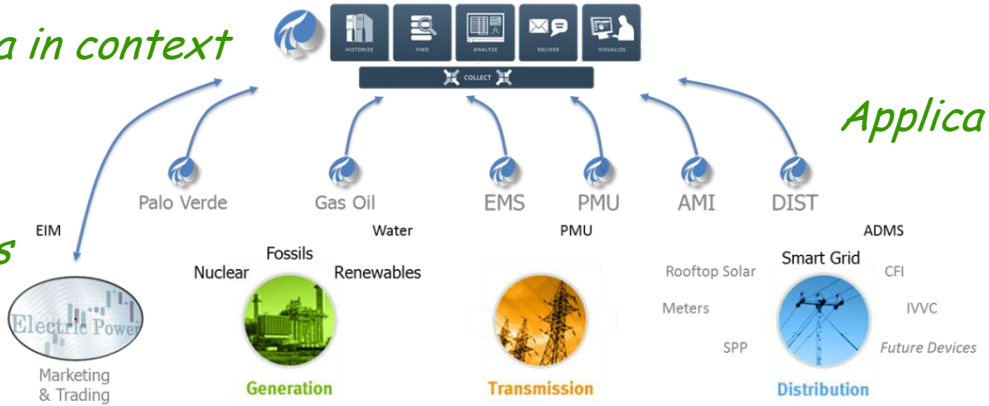
Direct access to data



Improved situational awareness

Foundation for Enterprise Analytics

Data in context



Applications monitor conditions

Additional insights

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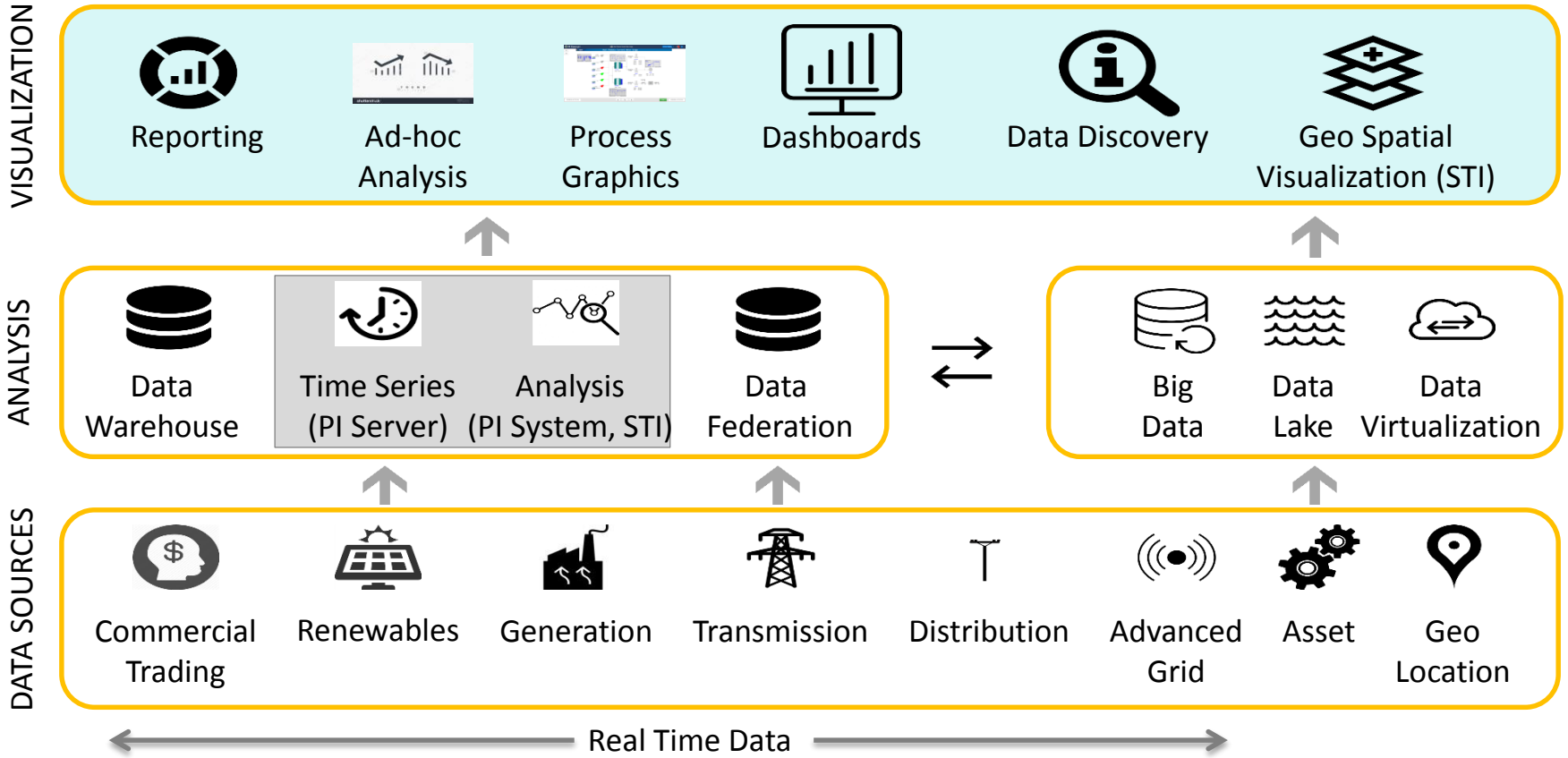
Part of Enterprise Analytics



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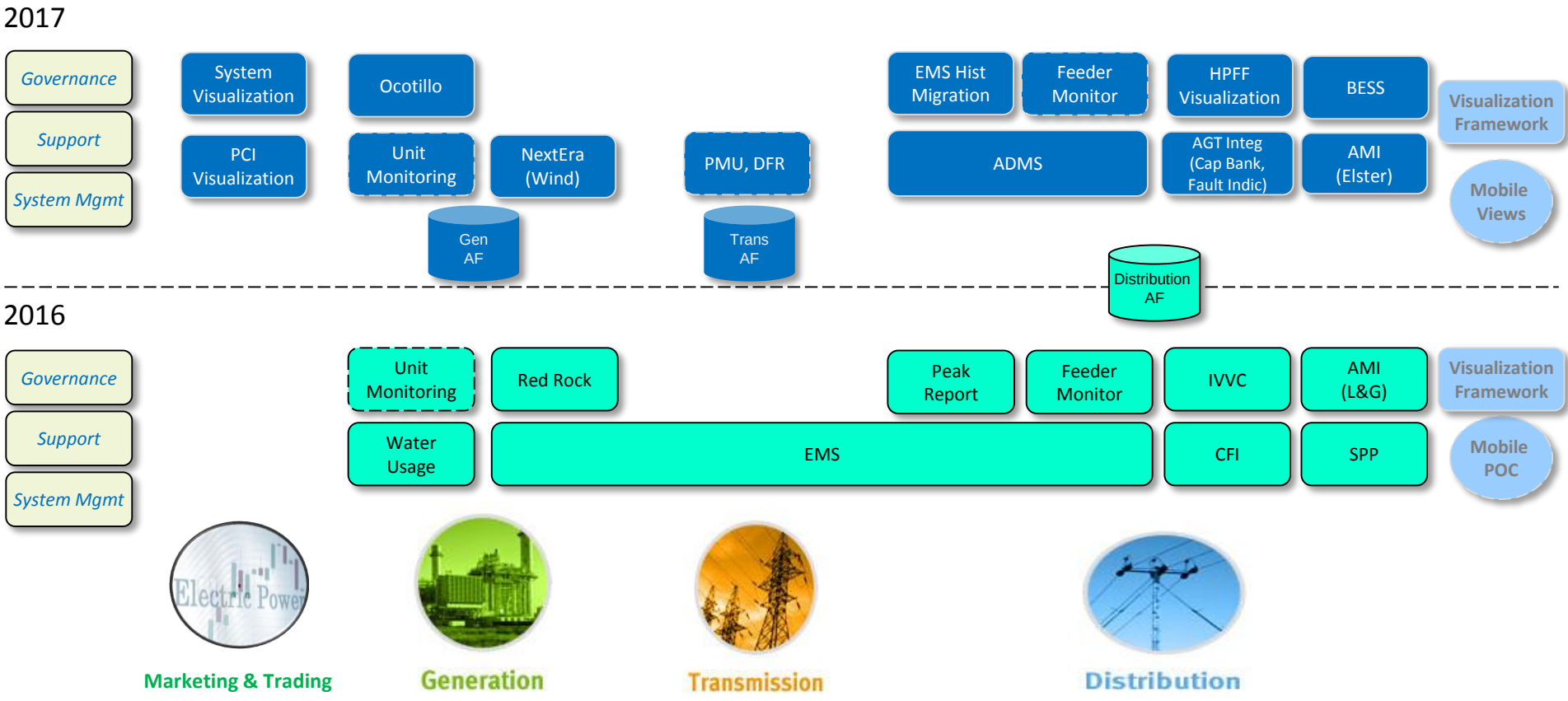
Enterprise PI Roadmap



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Exposing Data Creates Value

Direct Access
(Ad hoc)

Common Use

Applications
(Supported)

Unlock creativity and innovation

Ensure the foundation is solid
Organize the data (AF model)
Train the users – "how do I find …?"
User group to share best practices

EMS Data

Gather needs, package repeatable

User driven; users engaged
Start simple
Train the users
Address change management

Requires governance of roadmap, architecture, AF models, access to data

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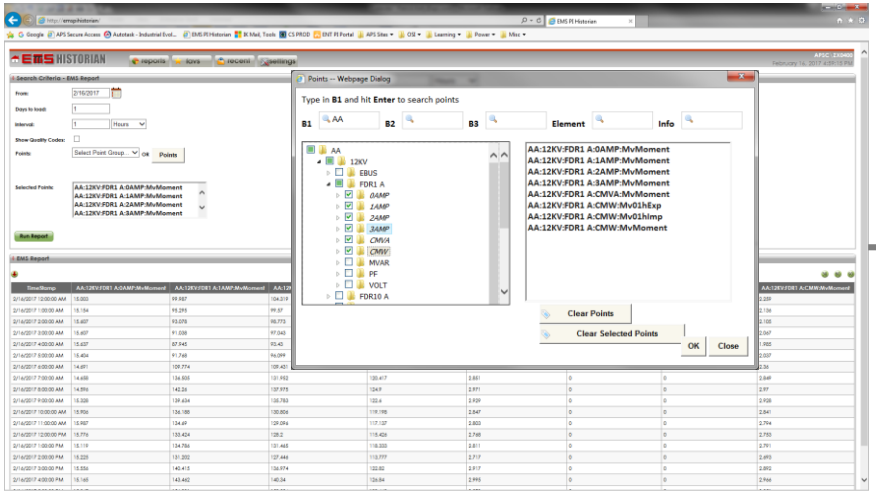
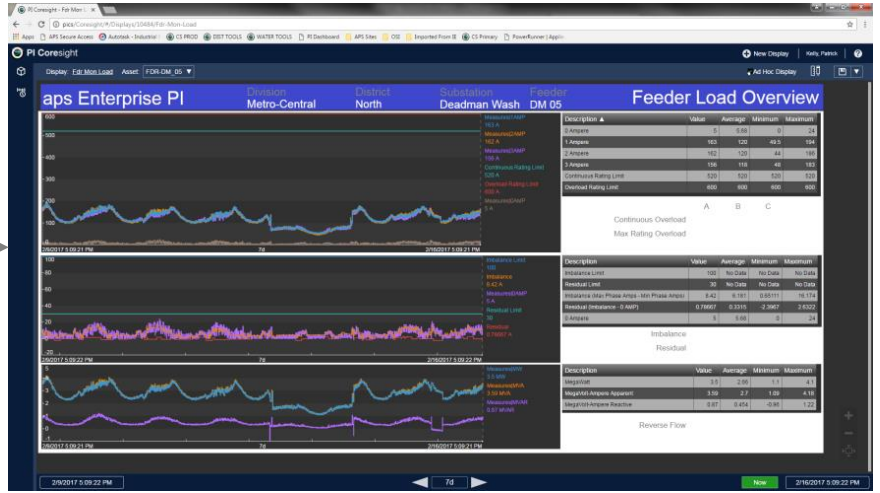
Making EMS Data Available





BEFORE

NOW

Requires culture change
Need to focus on adoption

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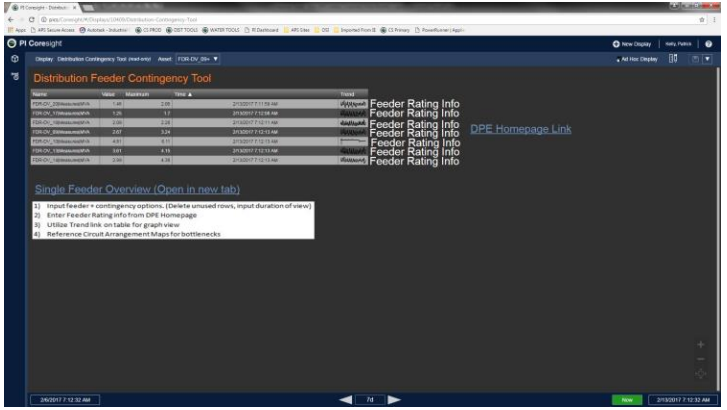
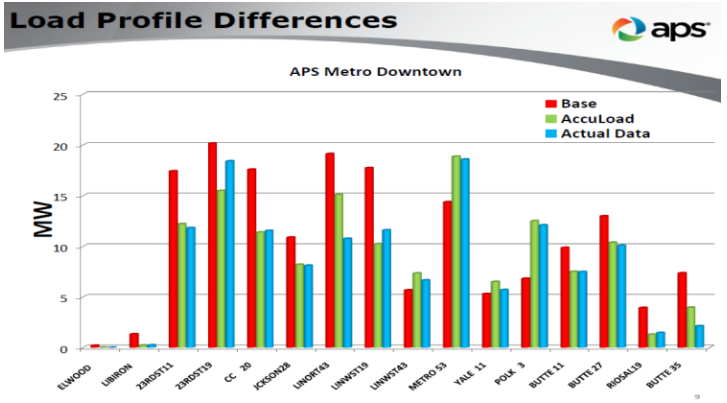
Examples of Ad Hoc Value

- Using PI Coresight to quickly solve problems
  - Displays built by the end of 2 hour training
  - Using AF model as a framework
  - Displays used everyday
- Updated Transmission Loading Tool
  - Updated tools using PI DataLink
  - Addressing key challenge for transmission





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Feeder Monitoring

Monitor feeder overloads, imbalances & power quality issues

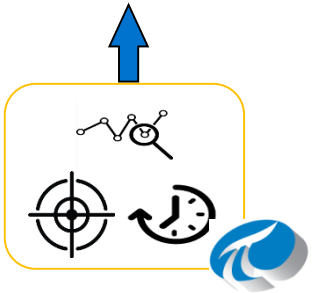
Situational Awareness

Watchlists

Foundation for additional analytics

Additional Insights
- ***Frequency***
- ***Duration***
- ***Impact***

Reporting



Diagnostic Views

Visualize In Context

Events Status Monitoring

Real Time Data

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aps Enterprise PI — Distribution PI Tools

Feeders
- Overview (basic)
- Comparison

Transformers
- Overview (basic)
- Comparison

Feeder Monitoring
- Tree View
- Select Feeders
- Problem Feeders
- Overloads
- Imbalances
- Power Quality Issues
- Reverse Flows

Fault Indicators (CFI)
- Tree View
- Watch List

IVVC
- IVVC R1 Dashboard
- IVVC R2 (prototype)

- EMS PI Historian
- Enterprise PI Portal

PI Coresight - FDR Overv

pics/Coresight/#/Displays/10491/FDR-Overview

Apps | APS Secure Access | Autotask - Industrial E | CS PROD | DIST TOOLS | WATER TOOLS | CS QA | PI Dashboard | APS Sites | OSI | Imported From IE | CS Primary | PowerRunner | Applie

PI Coresight

New Display | Kelly, Patrick

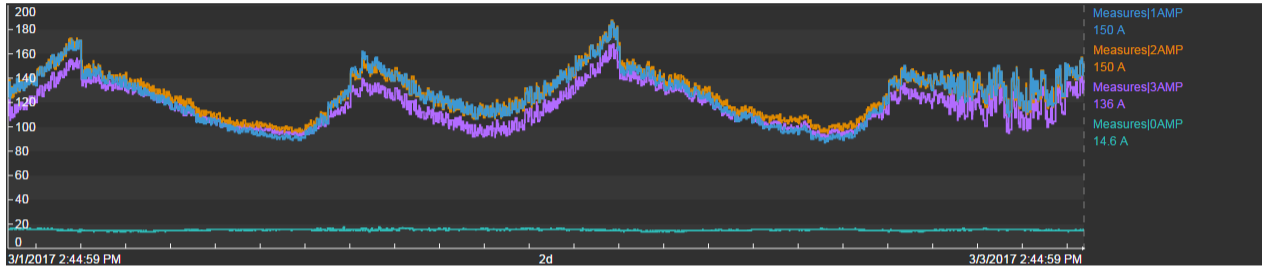
Display: FDR Overview *(read-only)* Asset: FDR-AA_01

Ad Hoc Display

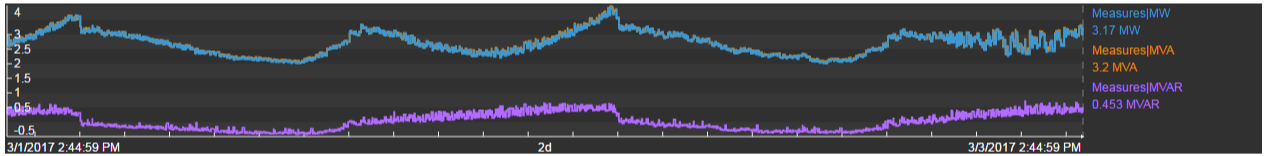
aps Enterprise PI

Division	District	Substation	Feeder
Division	District	Substation	Feeder

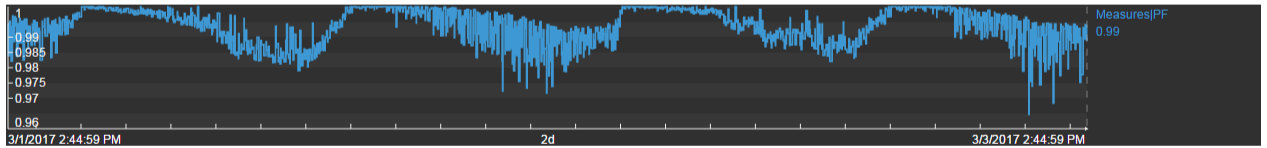
Feeder Overview



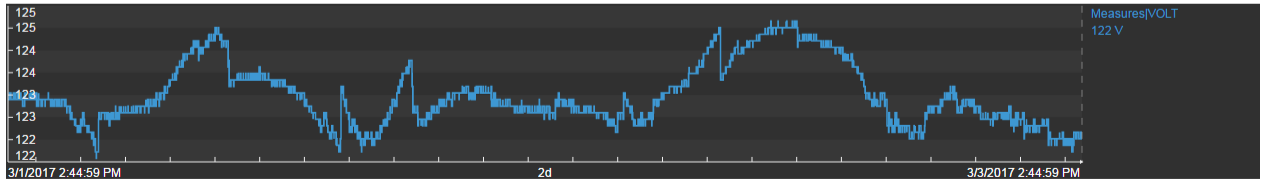
Description ▲	Value	Average	Minimum	Maximum
0 Ampere	14.6	15.2	13.7	17.6
1 Ampere	150	125	86.9	187
2 Ampere	150	127	94.7	187
3 Ampere	136	117	90.8	168



Description	Value	Average	Minimum	Maximum
MegaWatt	3.17	2.71	2	3.95
MegaVolt-Ampere Apparent	3.2	2.72	2.04	3.97
MegaVolt-Ampere Reactive	0.453	0.0103	-0.419	0.715



Description ▲	Value	Average	Minimum	Maximum
Power Factor	0.99	0.994	0.965	1



Description	Value ▲	Average	Minimum	Maximum
Voltage	122	123	122	125

3/1/2017 2:44:59 PM | 2d | Now | 3/3/2017 2:44:59 PM

PI Asset Tree | PI Coresight - Distributio

wvzzqa0007/PIDashboard/PiPortTree?PIDataServer=ENTPI&PIAFDB=APS+Pi+Portal+Test&AFElement=Business+Units%5cDistribution%5cFeeder_display

Apps | APS Secure Access | Autotask - Industrial E | CS PROD | DIST TOOLS | PI Dashboard | APS Sites | OSI | Imported From IE | CS Primary

Dashboard

Search Object Name... | Search | Reset | Coresight Only

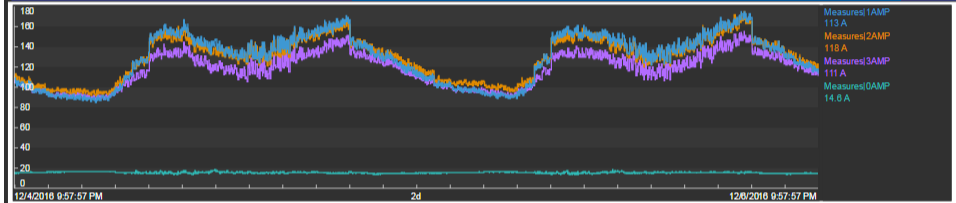
- Asset Trees
  - Metro-Central
    - North
      - Adobe
        - FDR-AD_09
        - FDR-AD_10
        - FDR-AD_12
        - FDR-AD_18
        - FDR-AD_20
        - FDR-AD_21
        - FDR-AD_22
        - XFMR-AD_11
        - XFMR-AD_19
      - Arroyo
      - Canal
      - Cheryl
      - Commerce
      - Deadman Wash
      - Deer Valley
      - Gateway
      - Gavilan Peak
      - Griswold
      - Honeywell
      - Loma Vista
      - Lone Peak
      - Lookout
      - Monte Cristo
      - Moon Valley
      - New River
      - North Valley
      - Pioneer
      - Rock Springs
      - Rose Garden

PI Coresight

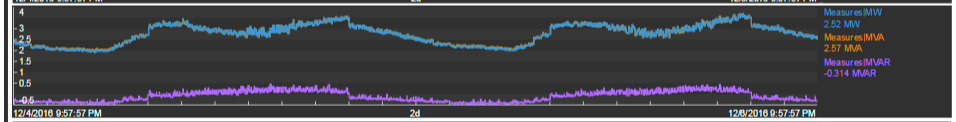
Display: FDR Overview *(read-only)*

aps Enterprise PI | Division: Division | District: District | Substation: Substation | Feeder: Feeder

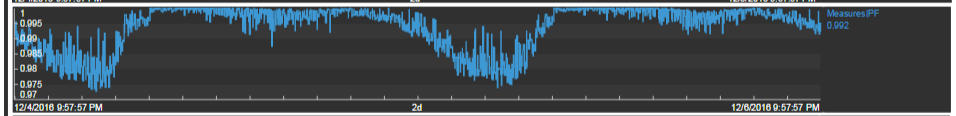
Feeder Overview



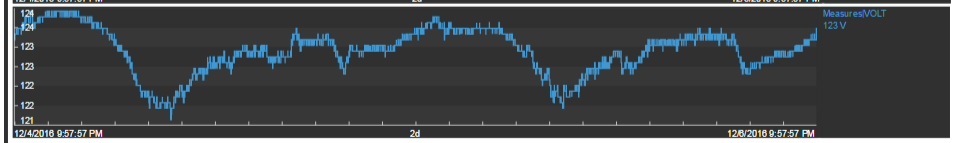
Description	Value	Average	Minimum	Maximum
0 Ampere	14.6	15.5	13.7	18.6
1 Ampere	113	129	85	175
2 Ampere	118	130	91.8	175
3 Ampere	111	118	86.9	155



Description	Value	Average	Minimum	Maximum
MegaWatt	2.52	2.76	1.9	3.7
MegaVolt-Ampere Apparent	2.57	2.78	1.96	3.71
MegaVolt-Ampere Reactive	-0.314	-0.112	-0.471	0.453



Description	Value	Average	Minimum	Maximum
Power Factor	0.992	0.994	0.973	1



Description	Value	Average	Minimum	Maximum
Voltage	123	123	121	124

12/4/2016 9:57:57 PM | 2d | Now | 12/6/2016 9:57:57 PM

aps Enterprise PI — Distribution PI Tools

Feeders
- Overview (basic)
- Comparison

Transformers
- Overview (basic)
- Comparison

Feeder Monitoring
- Tree View
- Select Feeders
- Problem Feeders
- Overloads
- Imbalances
- Power Quality Issues
- Reverse Flows

Fault Indicators (CFI)
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- Watch List

IVVC
- IVVC R1 Dashboard
- IVVC R2 (prototype)

- EMS PI Historian
- Enterprise PI Portal

Feeder Overload | PI Coresight - Distributio

wvzzqa0007/PIDashboard/Dashboard?PIDataServer=ENTPI&PIAFDB=APS+Pi+Portal+Test&AFElement=Business+Units%5cDistribution%5cFeeder+Overload

Apps | APS Secure Access | Autotask - Industrial E | CS PROD | DIST TOOLS | PI Dashboard | APS Sites | OSI | Imported From IE | CS Primary

Feeder Overload

Reset Layout | Full Display | Full Table

Watchlist Items Value

MW	>	2
1AMP		
2AMP		
3AMP		
0AMP		
Overload Status		

Search | Clear

Timestamp: 1/6/2017 10:38

refresh table

Copy | CSV

Search:

Name	Division	District	Substation	MW	0AMP	1AMP	2AMP	3AMP	MVAR
AA 01	Metro-Eastern	Eastern	Acoma	3.02	16.60	143.54	141.59	126.94	.23
AA 02	Metro-Eastern	Eastern	Acoma	5.40	13.67	250.96	256.81	249.00	1.36
AA 04	Metro-Eastern	Eastern	Acoma	3.19	67.38	152.33	146.47	138.66	-.42
AA 06	Metro-Eastern	Eastern	Acoma	3.56	25.39	167.95	166.98	152.33	-.40
AA 10	Metro-Eastern	Eastern	Acoma	4.69	14.65	225.57	226.54	211.90	1.31
AA 12	Metro-Eastern	Eastern	Acoma	2.88	17.58	136.71	131.82	135.73	-.68
AA 13	Metro-Eastern	Eastern	Acoma	3.31	13.67	150.38	152.33	150.38	-.21
AA 14	Metro-Eastern	Eastern	Acoma	4.67	46.87	204.08	221.66	229.47	1.12
AD 21	Metro-Central	North	Adobe	2.34	32.50	137.50	134.00	105.00	-1.61
AD 22	Metro-Central	North	Adobe	4.02	9.50	181.50	188.50	167.00	-.47

Showing 1 to 10 of 594 entries

Previous | 1 | 2 | 3 | 4 | 5 | … | 60 | Next

PI Coresight

Display: Fdr Mon Load *(read-only)*

PI Coresight - Fdr Mon L

pics/Coresight/#/Displays/10484/Fdr-Mon-Load

Apps | APS Secure Access | Autotask - Industrial E | CS PROD | DIST TOOLS | WATER TOOLS | CS QA | PI Dashboard | APS Sites | OSI | Imported From IE | CS Primary | PowerRunner | Applie

PI Coresight

New Display | Kelly, Patrick

Display: Fdr Mon Load Asset: FDR-AD_09

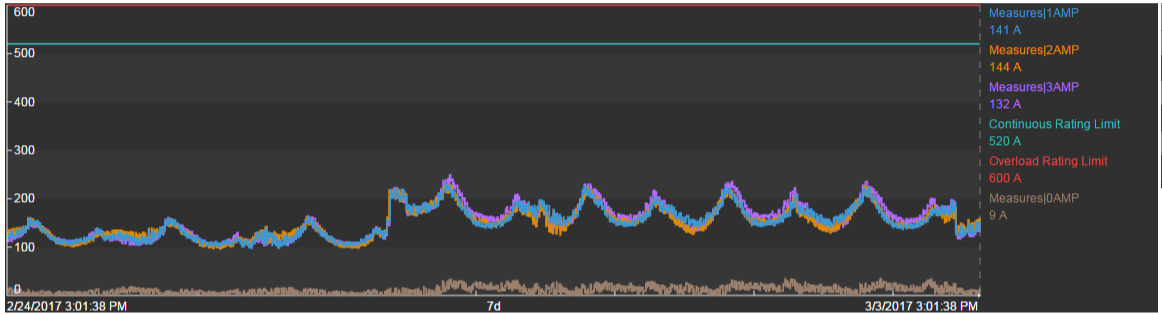
Ad Hoc Display

aps Enterprise PI

Division | District | Substation | Feeder

Division | District | Substation | Feeder

Feeder Load Overview

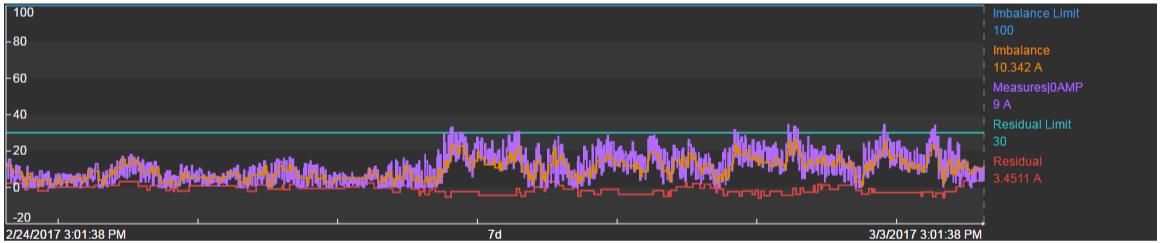


Description ▲	Value	Average	Minimum	Maximum
0 Ampere	9	10.8	0	34.5
1 Ampere	141	151	98	232
2 Ampere	144	150	96.5	230
3 Ampere	132	154	98.5	249
Continuous Rating Limit	520	520	520	520
Overload Rating Limit	600	600	600	600

A B C

Continuous Overload

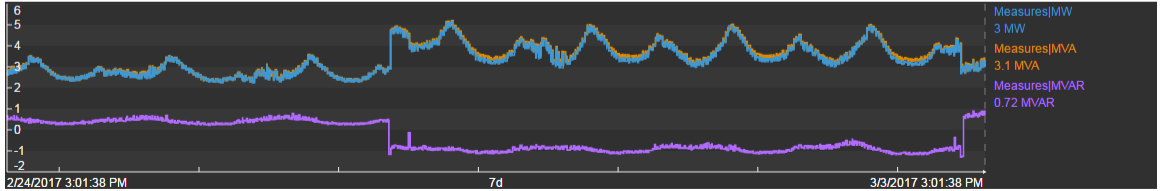
Max Rating Overload



Description	Value	Average	Minimum	Maximum
Imbalance Limit	100	No Data	No Data	No Data
Residual Limit	30	No Data	No Data	No Data
Imbalance (Max Phase Amps - Min Phase Amps)	10.342	10.026	0.60778	26.166
Residual (Imbalance - 0 AMP)	3.4511	-0.87808	-5.9744	3.6356
0 Ampere	9	10.8	0	34.5

Imbalance

Residual



Description	Value	Average	Minimum	Maximum
MegaWatt	3	3.35	2.25	5.14
MegaVolt-Ampere Apparent	3.1	3.42	2.26	5.2
MegaVolt-Ampere Reactive	0.72	-0.368	-1.29	0.885

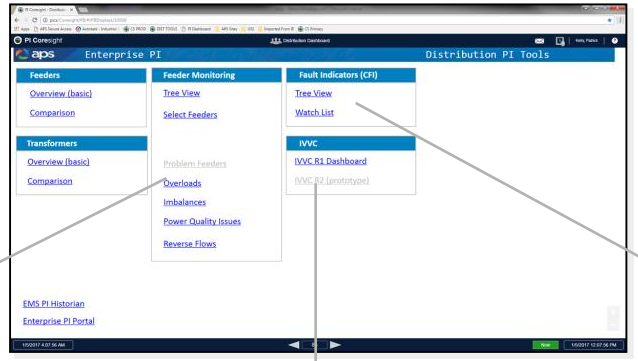
Reverse Flow

2/24/2017 3:01:38 PM 7d Now 3/3/2017 3:01:38 PM

Consistent Tools and Approach

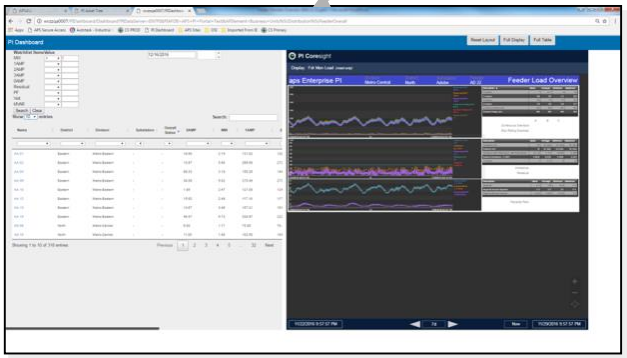
Leverage common AF model

Common framework

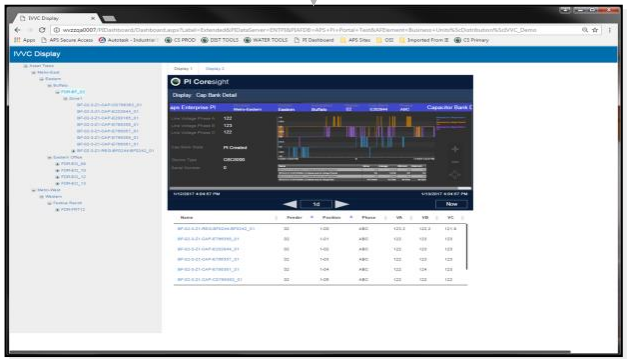


Common landing page

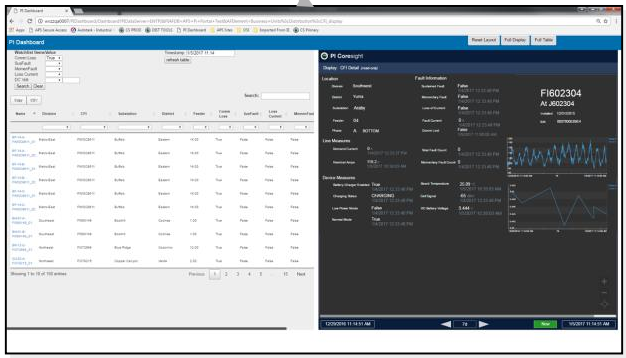
Web based visualization



Feeder Monitoring



Cap Bank Monitoring



Fault Monitoring

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Program Impact in T&D

Benefits

- ✓ End users creating tools
- ✓ Access to over 1,000 fault indicators
- ✓ Early notification of IVVC voltage exceptions
- ✓ Access to AG device info for 1,200 devices
- ✓ Less time gathering data
- ✓ Monitoring common conditions
- ✓ Improved situational awareness
- ✓ Align data from EMS, AGT, AMI (future)

Results

- ✓ Increasing adoption, solving problems
- ✓ Earlier notification; outage time reduction
- ✓ Improved tuning; improved power quality
- ✓ See and address device status, conditions
- ✓ More time for analysis, corrective action
- ✓ Frees up time for solving problems
- ✓ Address most pressing issues
- ✓ Comprehensive view of feeder conditions

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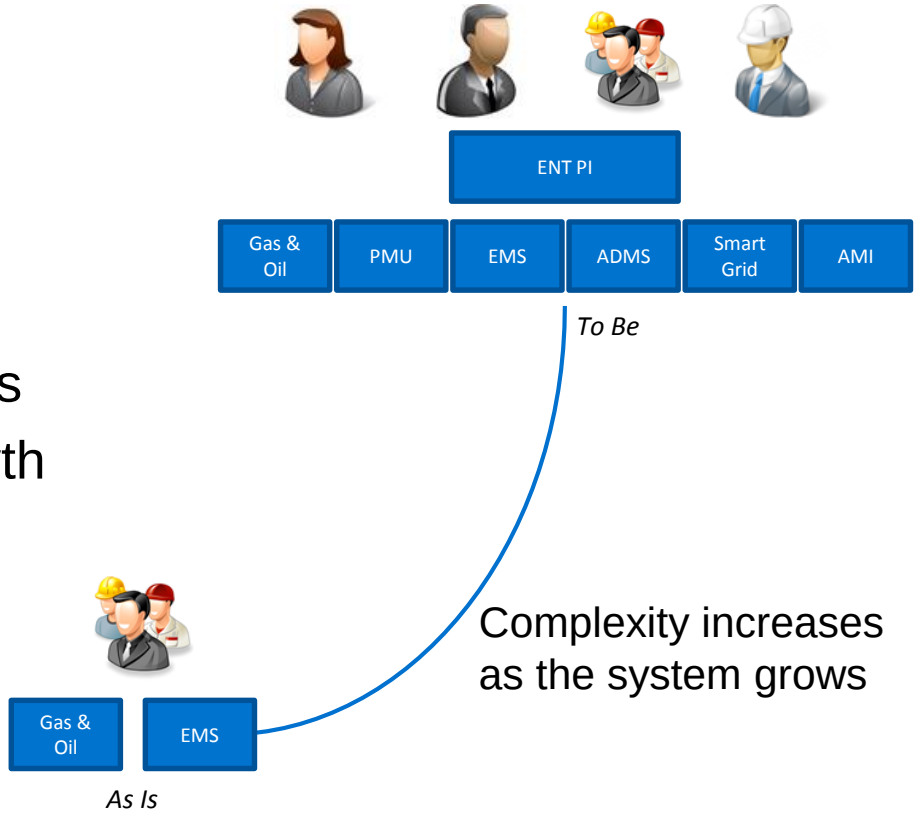
Take Aways

- Program Perspective is key
- Collaborate with Partners
- Focus on Governance
- Deliver and Manage Applications
- Unlock the Data and Engage Users
- Ensure Support and Plan for Growth



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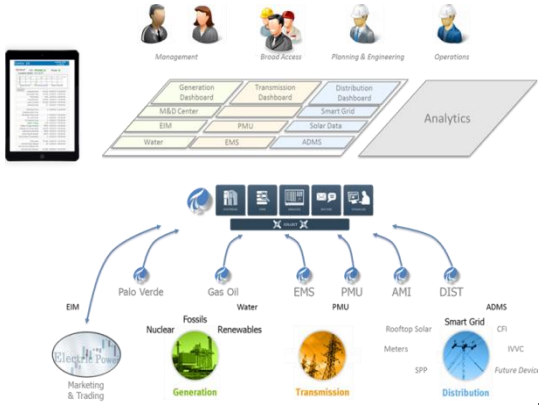
Creating Corporate Wide Benefits



COMPANY and GOAL

APS is creating a sustainable energy future for Arizona using time series data as a key pillar to improve the efficient, safe delivery of reliable energy.

CHALLENGE

Limited access to data and lack of visibility key impediment to enterprise analytics

- Systems used in silos with limited access to information
- Much more data being integrated from many more systems and devices

SOLUTION

Establish an Enterprise solution to enable ad hoc use and supported applications

- Enterprise PI established and growing
- Strong engagement with users to support adoption
- Delivering applications to solve specific business issues

RESULTS

Many more users have access to data; initial applications delivering value

- Reduced time to locate faults with fault analysis application
- Identification of cap bank issues improves system performance
- Foundation for additional analytics solutions

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Contact Information

Ravi Nair
Ravi.Nair@aps.com
Speaker's Title
APS

Pat Kelly
email@aps.com
Program Manager
Industrial-Knowledge

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Danke

Merci

Gracias

Thank You

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