

How to Build, Maintain and Get Value from the PI AF Model

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SPP at a Glance

- Located in Little Rock
- About 600 employees
- Primary jobs — electrical engineering, operations, settlements, and IT
- 24 x 7 operation
- Full redundancy and backup site



Our Major Services

- Facilitation
- Reliability Coordination
- Transmission Service/
Tariff Administration
- Market Operation
- Standards Setting
- Compliance Enforcement
- Transmission Planning
- Training
- Balancing Authority

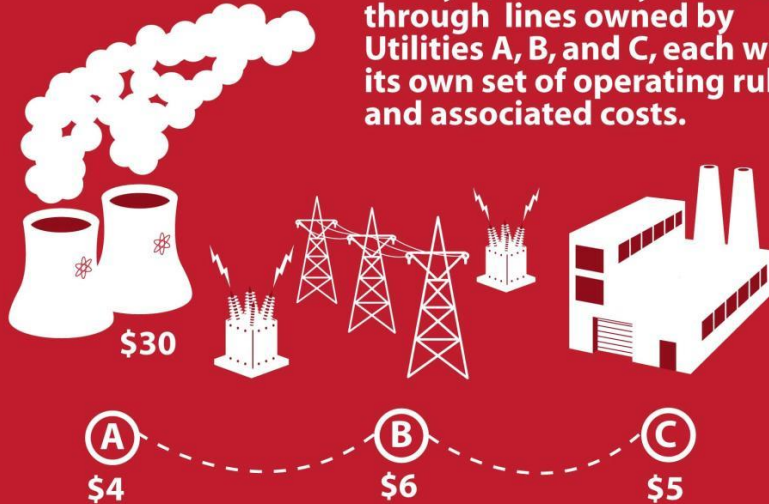
Our Approach

- Regional
- Independent
- Cost-effective
- Focus on reliability

Transmission Service

Without SPP

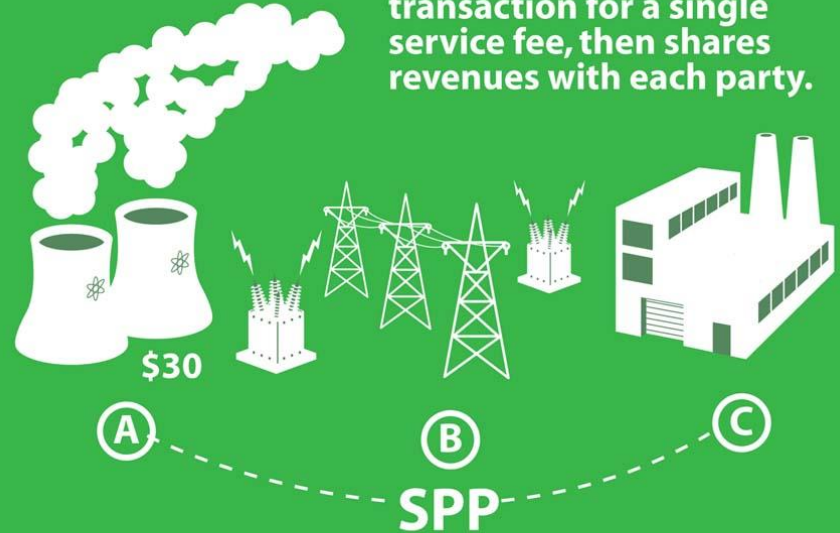
To get from a generator in Utility A to a customer in Utility C, electricity must flow through lines owned by Utilities A, B, and C, each with its own set of operating rules and associated costs.



$\$15 \text{ transmission service} + \$30 \text{ energy} = \$45$

With SPP

SPP moves electricity across Utilities A, B, and C in one transaction for a single service fee, then shares revenues with each party.

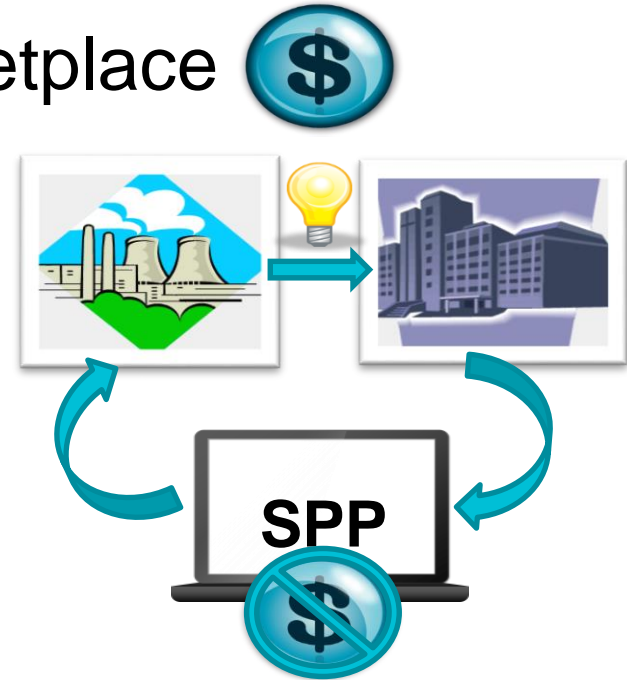


$\$5 \text{ transmission service} + \$30 \text{ energy} = \$35$

SPP's Energy Market: Integrated Marketplace

- SPP financially settles the Marketplace

- Calculates prices
- Captures wholesale energy production and consumption
- Collects from Market Participants (MPs) who owe the Market
- Pays MPs who are owed by the Market
- Remains Revenue Neutral

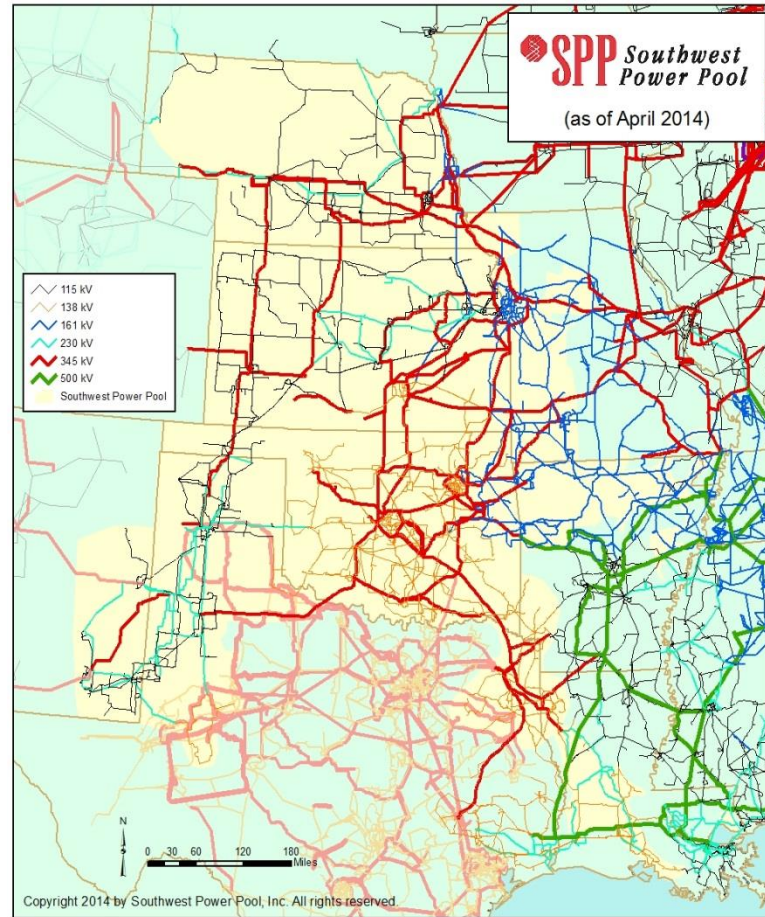


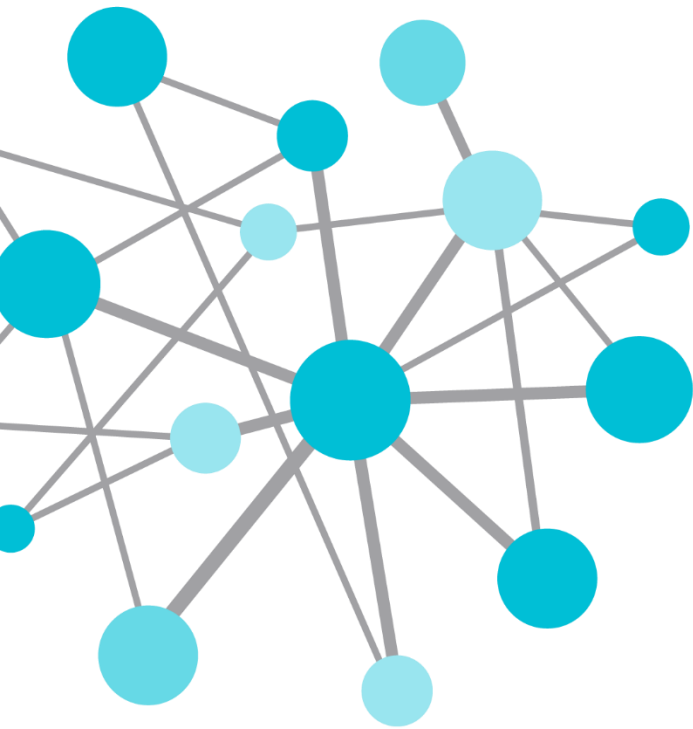
Integrated Marketplace Benefits

- Net Benefits estimated at approximately \$100 million/year
- Reduce total energy costs through centralized unit commitment while maintaining reliable operations
- Day-Ahead Market allows additional price assurance capability prior to real-time
- Operating Reserve products support implementation of the SPP Balancing Authority (BA) and facilitate reserve sharing

Operating Region

- 370,000 miles of service territory
- More than 15 million people
- 627 generating plants
- 4,103 substations
- 48,930 miles transmission:
 - 69 kV – 12,569 miles
 - 115 kV – 10,239 miles
 - 138 kV – 9,691 miles
 - 161 kV – 5,049 miles
 - 230 kV – 3,889 miles
 - 345 kV – 7,401 miles
 - 500 kV – 93 miles





Building a PI AF Model

Building a PI AF Model

SPP has the need to record over a million streaming points with reasonably fast update times, perform calculations and have users be able to locate the data they need.

PI AF is able to provide the structure needed to group and locate data. However, with such a large model, over 150,000 AF Elements, the challenge was in creating robust templates, hierarchy and automated processes to generate the model.

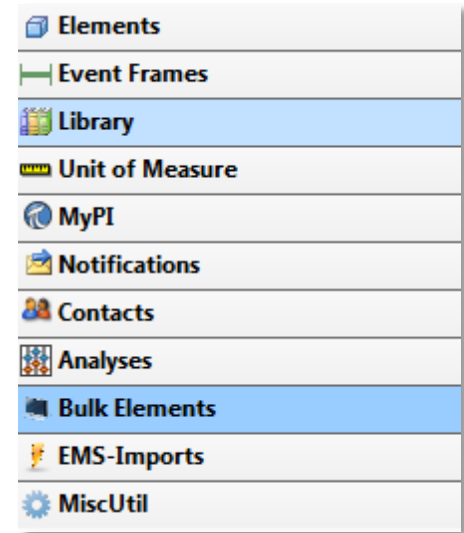


Business Challenge

- Recorded over 1 million data points with 4 second updates
- Real time calculations

Solution

- PI AF
- Custom PI System Explorer Plugins
- PI AF SDK
- PI Analytics

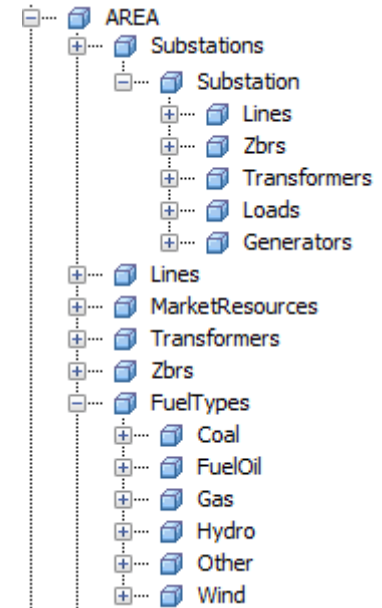


Results and Benefits

- Automated PI AF Elements and PI Tag creation
- Complex PI AF calculations recorded as PI Tags

Designing and Maintaining PI AF Model

- Large Network Model
 - 12k Substations
 - 16k Lines
 - 3.5k Transformers
 - 2.7k Generators
 - 3k Capacitors and Reactors
 - 15k Loads
 - 70k Circuit Breakers
 - 130k SCADA Measurements
- Based on EMS hierarchy
- Keep nodes small as possible
- Make use of references (links) whenever possible



PI AF Modeling Process

PI Asset Framework is used to consolidate information from multiple systems: Energy Management System (EMS), Markets, Outage Data, Forecast Data. The models are combined in SQL Views and PI AF Elements are built using the PI AF SDK.

PI AF Templates

- Create AFElementTemplates for Equipment Types
- Create AFAttributeTemplates to build PI Tags

Import Other System Models

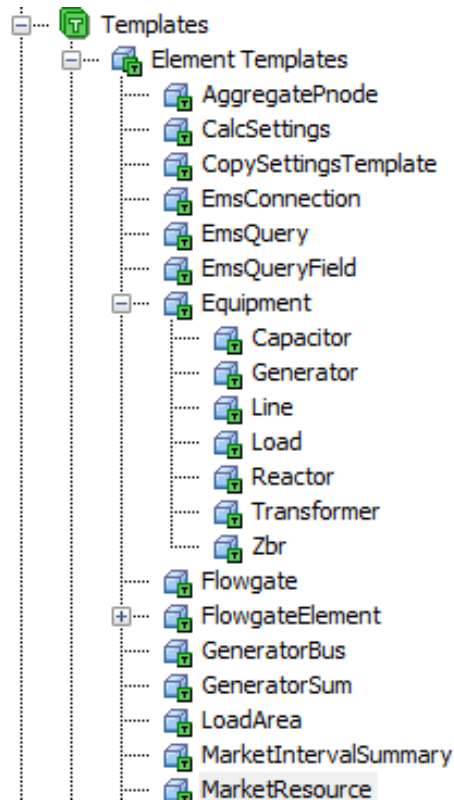
- Import EMS and Market Models into Staging Database
- Create SQL Views for each AFElementTemplate

Build PI AF Elements

- Build AFElements from AFElementTemplates and SQL Views
- Build PI Tags for each AFElement

PI AF Templates

- Build Templates for each equipment type
- Use PI Tag Creation feature to automatically generate PI Tags



	MVar
+	MW
	MWh

Name: MW

Description: SCADA\DIS_ANALOG: MW Scada

Configuration Item: ☐ Indexed: ☐

Categories: Generation

Default UOM: megawatt

Value Type: Single

Default Value: 0 MW

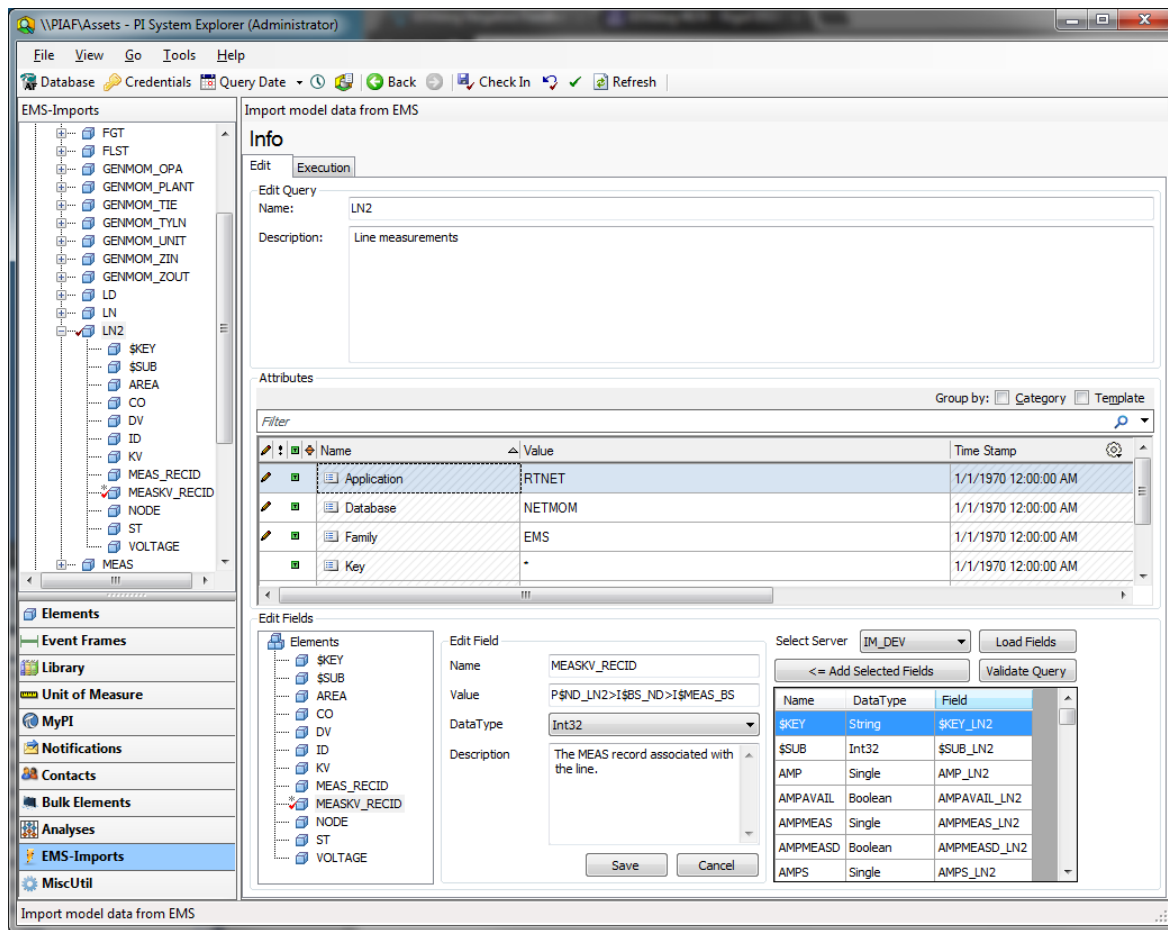
Data Reference: PI Point

Settings...

\\%Server%\%@\.[ScadaKey
%;compressing=0;descriptor="%Description
%";excdev=0;excdevpercent=0;excmax=0;exde
sc=%@\.[ScadaKey
%;instrumenttag=DIS_ANALOG;location1=1;locat
ion4=1;pointsource=HABC_SCADA;pointtype=Flo
at32;ptclassname=classic;step=1;scan=1

Customized Tools

- Import EMS and Market Models into Staging Database
- Develop PI System Explorer plugins to import data
- Store all plugin configuration as AF Elements



Customized Tools

- SQL Views showing all equipment attributes for an AF Element Template

The screenshot displays the Microsoft SQL Server Management Studio (Administrator) interface. The left pane shows the Object Explorer with a tree view of database objects, including various views like `dbo.vw_aggrPNodes`, `dbo.vw_areas`, and `dbo.vw_Lines`. The right pane shows a SQL query window with the following script:

```
1 /***** Script for SelectTopNRows command from SSMS *****/
2 SELECT TOP 1000
3     [EquipmentType]
4     , [Name]
5     , [Substation]
6     , [Node]
7     , [Voltage]
8     , [NormalLimit]
9     , [EmerLimit]
10    , [LoadshedLimit]
11    , [isTie]
12    , [EmsNetomKey]
13    , [EmsNetomKey|Division]
14    , [EmsNetomKey|EmsId]
15    , [EmsNetomKey|Node]
16    , [EmsNetomKey|Owner]
17    , [EmsNetomKey|Substation]
18    , [EmsNetomKey|Voltage]
19    , [segment]
20    , [oldID]
21    , [KEY_TO_MATCH_CNT]
```

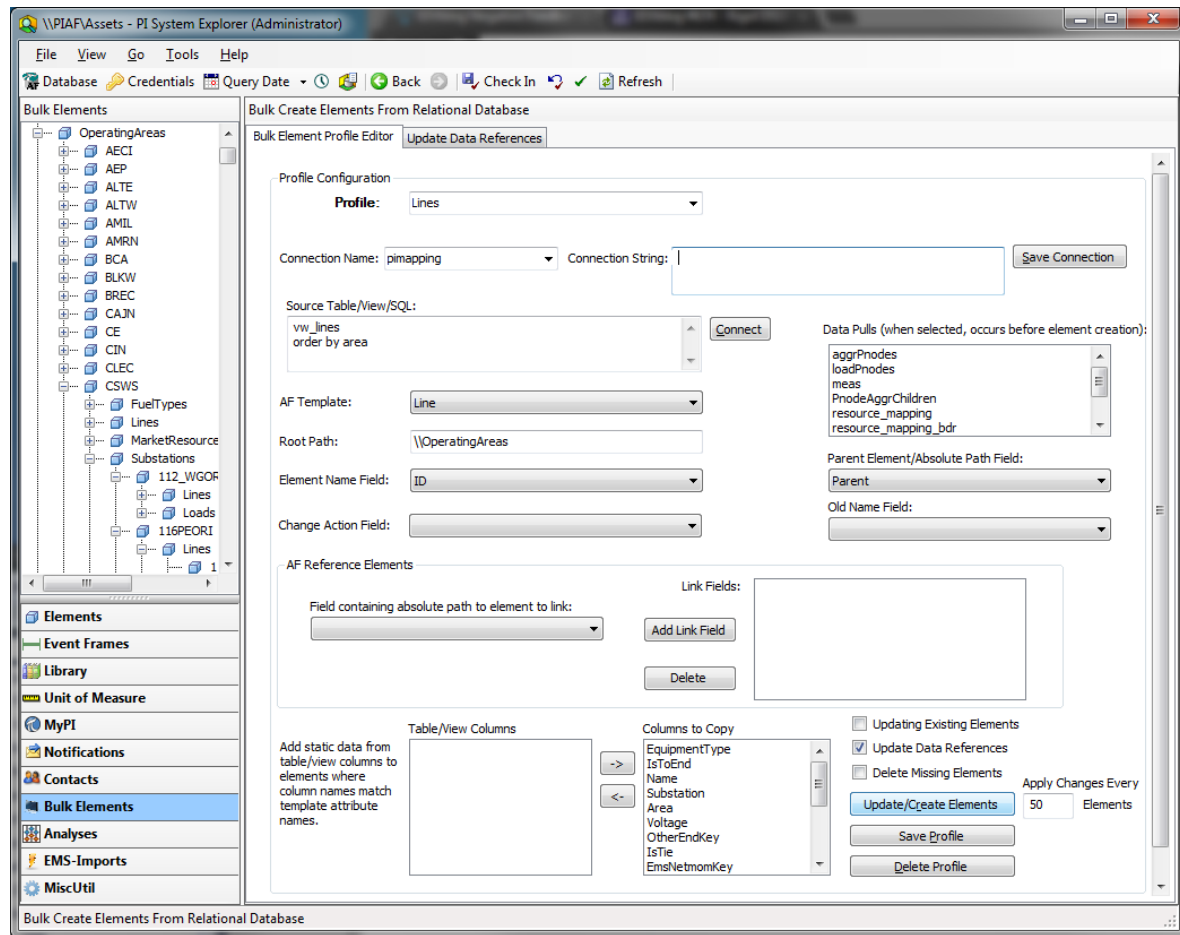
The bottom pane shows the Results tab with a table of data. The table has columns: EquipmentType, Name, Substation, Node, Voltage, and NormalLimit. The data is as follows:

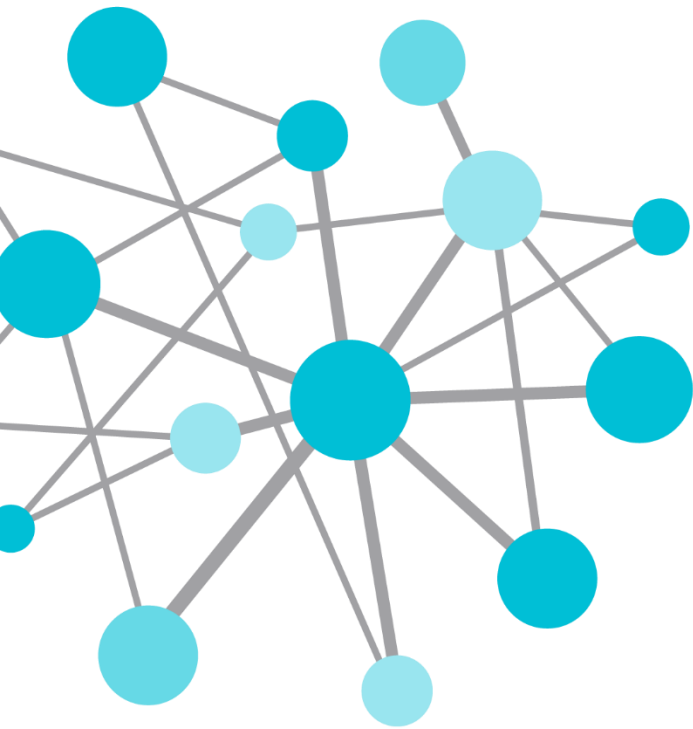
	EquipmentType	Name	Substation	Node	Voltage	NormalLimit
1	Line	5059	NICKTAP	1	69	28
2	Line	ELKS1NICKT69_1	NICKTAP	1	69	28
3	Line	5112	SPARK	2	69	60
4	Line	5115	SPARK	2	69	60
5	Line	ACADIA_RORK	ACADIA	B27	138	765
6	Line	RAMOS-BUVSTA99	BERKWKTP	1237	138	270
7	Line	5089	CENTENL	3	138	252
8	Line	5089B	CENTENL	4	138	203
9	Line	5049	BRAPID	4	138	310
10	Line	5121B	JULTAP4	4	138	270
11	Line	5121	JULTAP4	4	138	270
12	Line	5048	BRAPID	4	138	286
13	Line	BSALETECHE13_1	BSALES	3	138	270
14	Line	NORBND4_G1COLU	N_BEND1	1	138	50

The status bar at the bottom indicates "Query executed successfully." and the user "pimapping" is logged in.

Customized Tools

- Plugin to build PI AF Elements from SQL Views
- Processes Adds, Deletes and Renames
- Command line version for running as a scheduled task or batch script

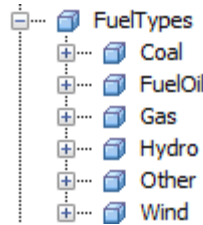




Results and Benefits

PI Analytics

- Use existing Hierarchy for calculations
- Analysis Templates for easy replication of calculations



MarketResourceSum

General | Attribute Templates | Ports | Analysis Templates

Name: TotalGeneration

Description:

Categories:

Analysis Type: ☐ Expression ☒ Rollup

Example Element: [OperatingAreas\LES\FuelTypes\Coal](#)

Rollup attributes from:
☒ Child elements of Coal
☐ This element - Coal

To select attributes set criteria below

Attribute Name: MWOut

Attribute Category:

Element Category:

Element Template:

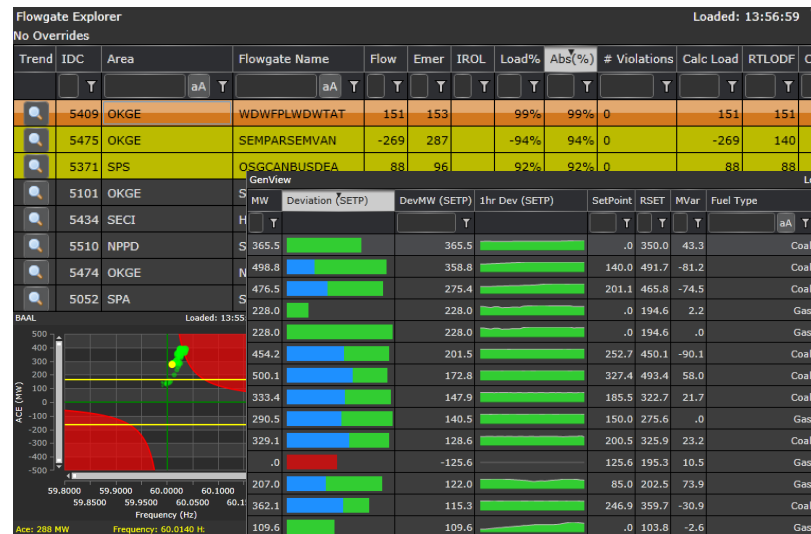
Select the function(s) to write to an attribute Evaluate

Function	Output(s)	Value
<input checked="" type="checkbox"/> Sum	TotalGeneration	

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Solution

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- PI AF SDK
- PI Analytics

Results and Benefits

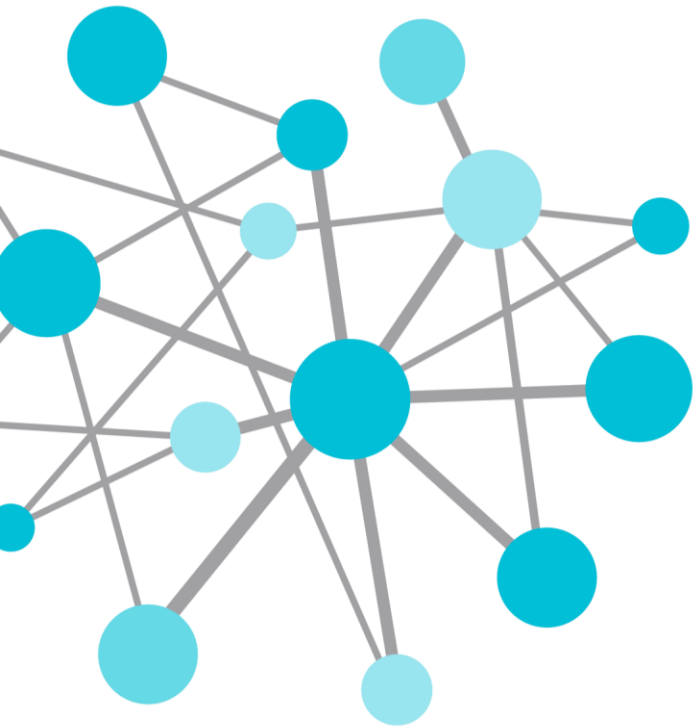
- Automated PI AF Elements and PI Tag creation
- Complex PI AF calculations recorded as PI Tags
- Customized user displays using AF Data

Next Steps

- AF Event Frames
- AF Notifications
- More Calculations
- **All based on existing AF Model**

Presenters

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THANK
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