SLAC NATIONAL ACCELERATOR LABORATORY

IEEE

Complex Metering Systems Simplified Through Virtual Metering

IEEE Meeting – Wednesday, September 18th, 2013

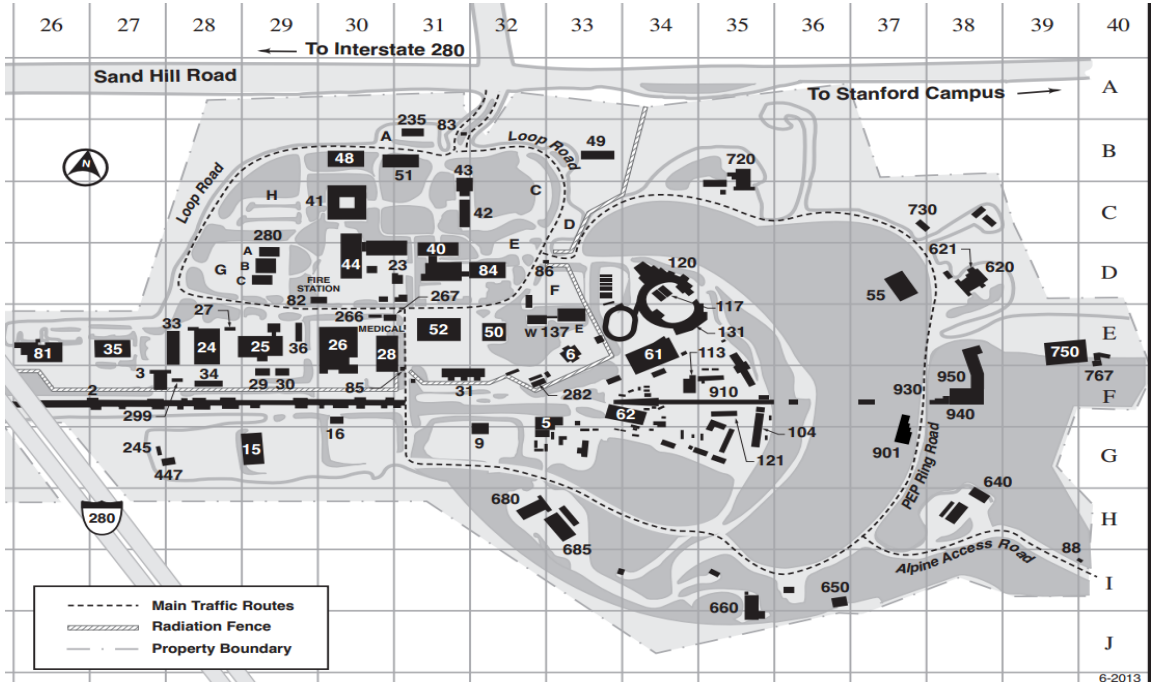
Pieter Noordam,
Founder, RFIsoft
Co-Founder, Alchemy Unlimited

Overview

- SLAC System Overview
- SLAC Business Needs
- Site Energy Distribution System
- RECIPE Concepts
- Demo
- Reports & Data Quality
- RECIPE Technologies Family

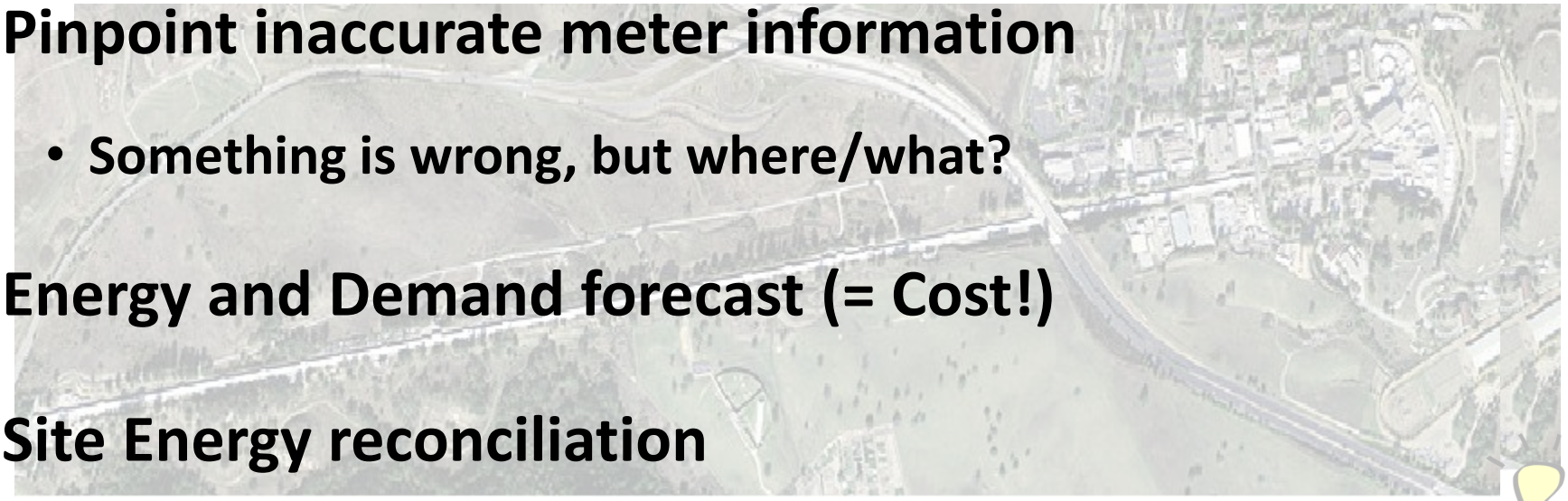
SLAC System Overview

- Located in Menlo Park
- Several building/research clusters
  - ACCEL, CAMPUS, FACET, LCLS, PEP2, PPA, SPEAR3, SSRL, SRCF
- 2 main site source meters (230kV&60kV)
- Appr. 150 substation and building meters



SLAC Business Needs

- **Energy use per building/research cluster**
- **Energy use per month, year, fiscal year**
- **Pinpoint inaccurate meter information**
  - **Something is wrong, but where/what?**
- **Energy and Demand forecast (= Cost!)**
- **Site Energy reconciliation**

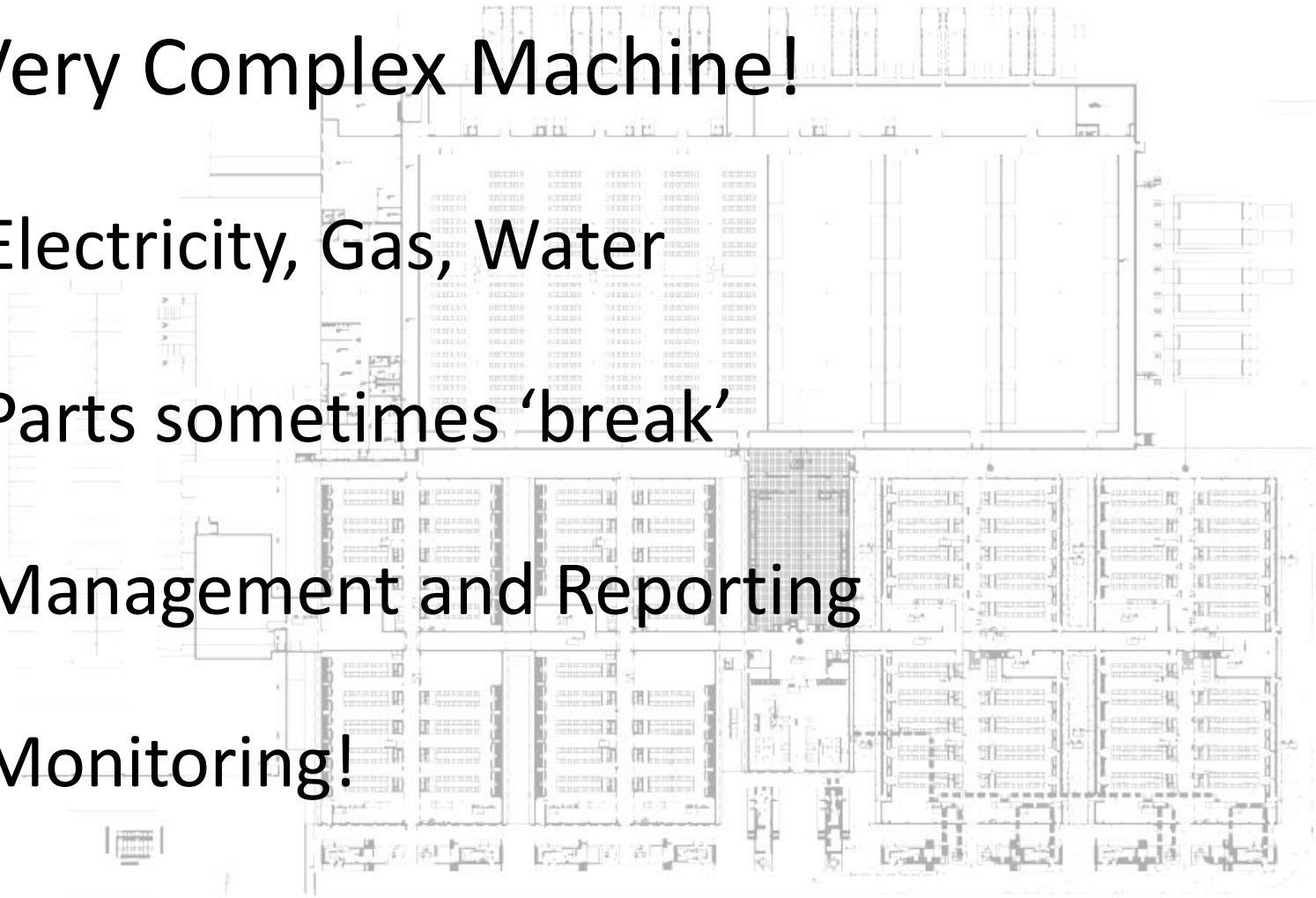


Business Solution

- RECIPE Analytics installed in 2012
  - Provide Energy use per Research cluster
  - Reporting: per month, day, year, fiscal year etc.
  - Provide monthly energy and demand forecasting
  - Instant view of non-communicating meters.
  - Easy, fast and interactive data view.

Site Energy Distribution System

- A Very Complex Machine!
  - Electricity, Gas, Water
  - Parts sometimes ‘break’
  - Management and Reporting
  - Monitoring!

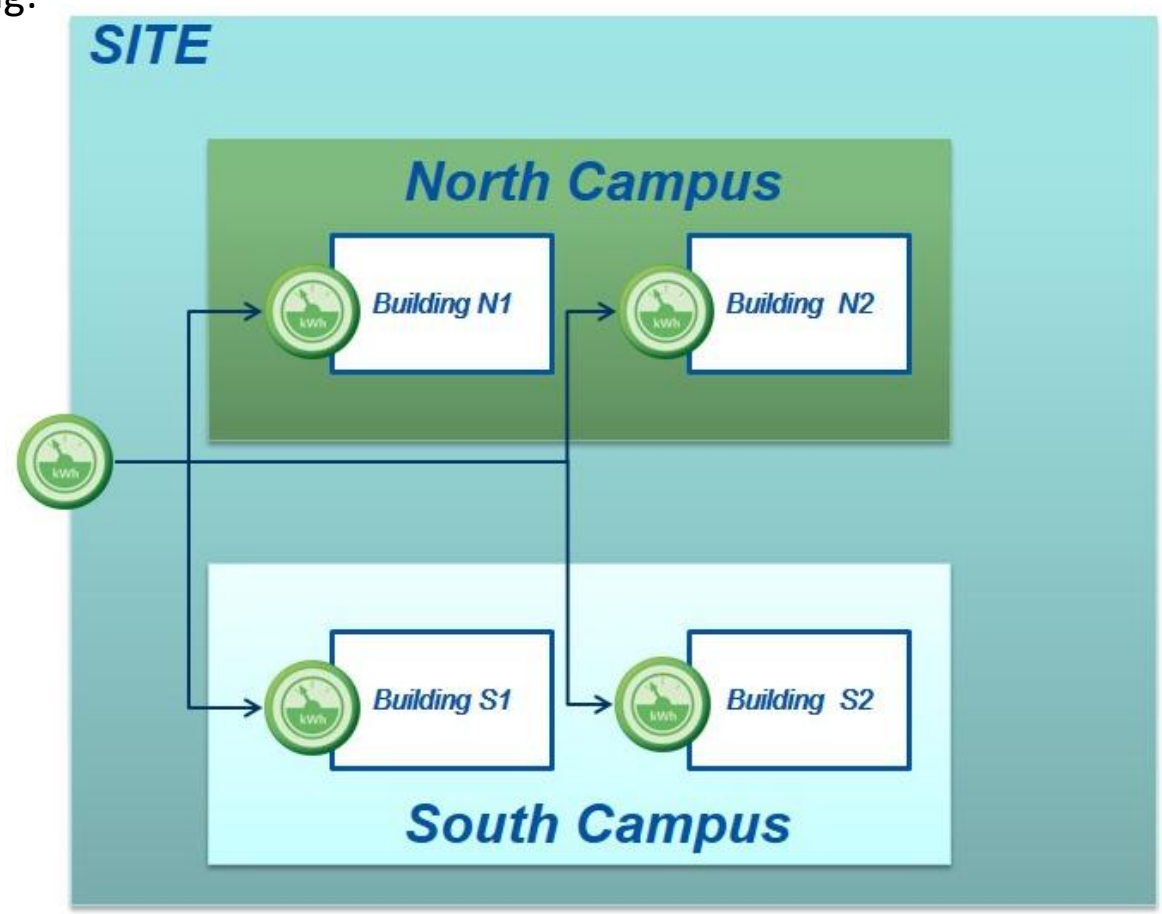


Monitoring

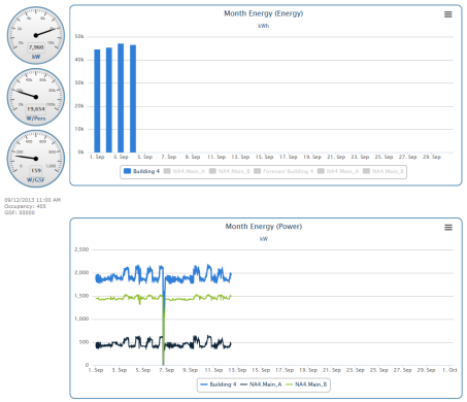
- Powerful EMS to gather all Data
- Giga bytes of Data
- Reporting? Where to find it?
- Meter focused
  - ‘Views’, reports, …, it’s all about the meter itself.

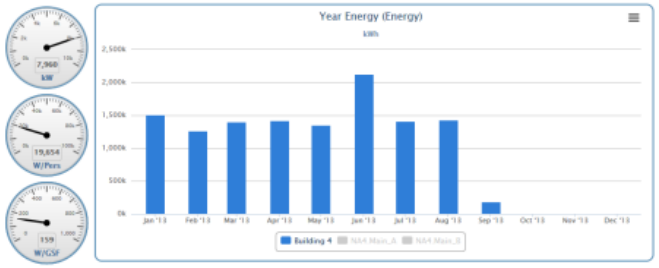
Concept

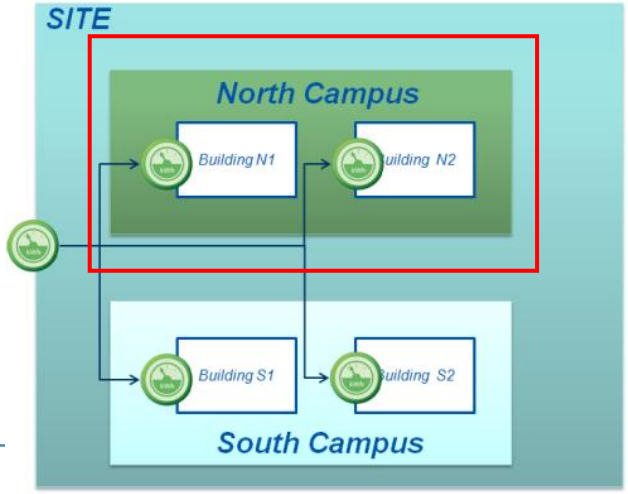
- Alchemy's view on virtual metering:
  - Reconcile Historic data
  - Fast
  - Hierarchical
  - Flexible
  - Extendable
  - Configuration Driven
  - Fit with other Alchemy products

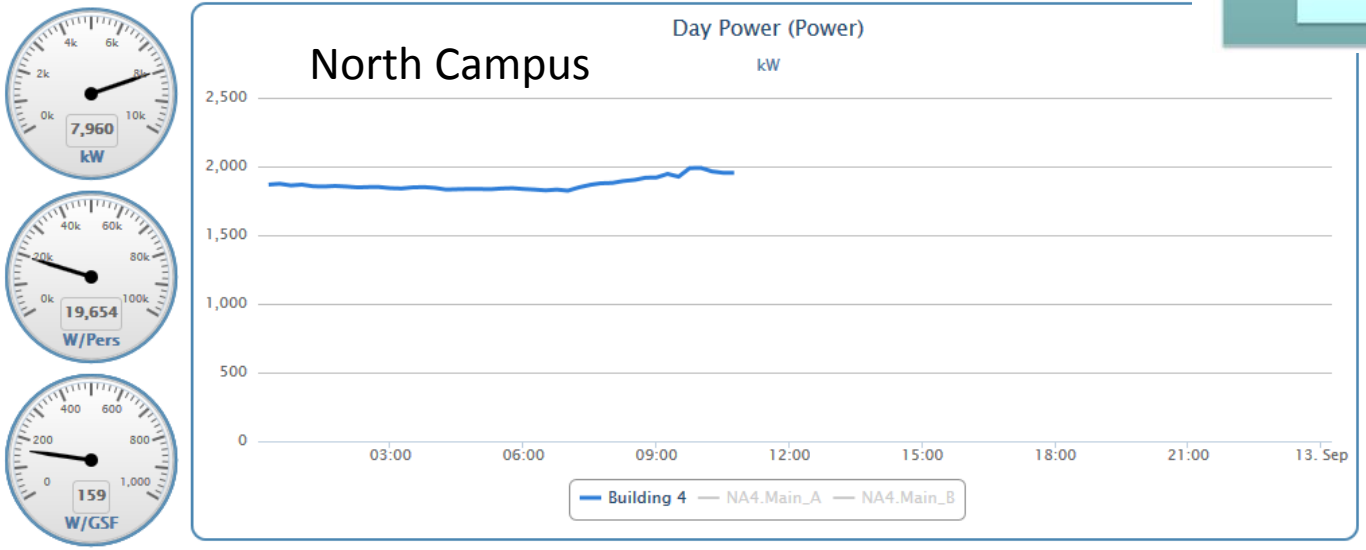


Concept: Aggregation





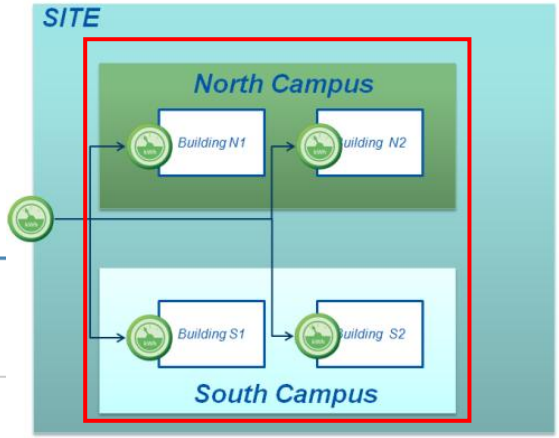


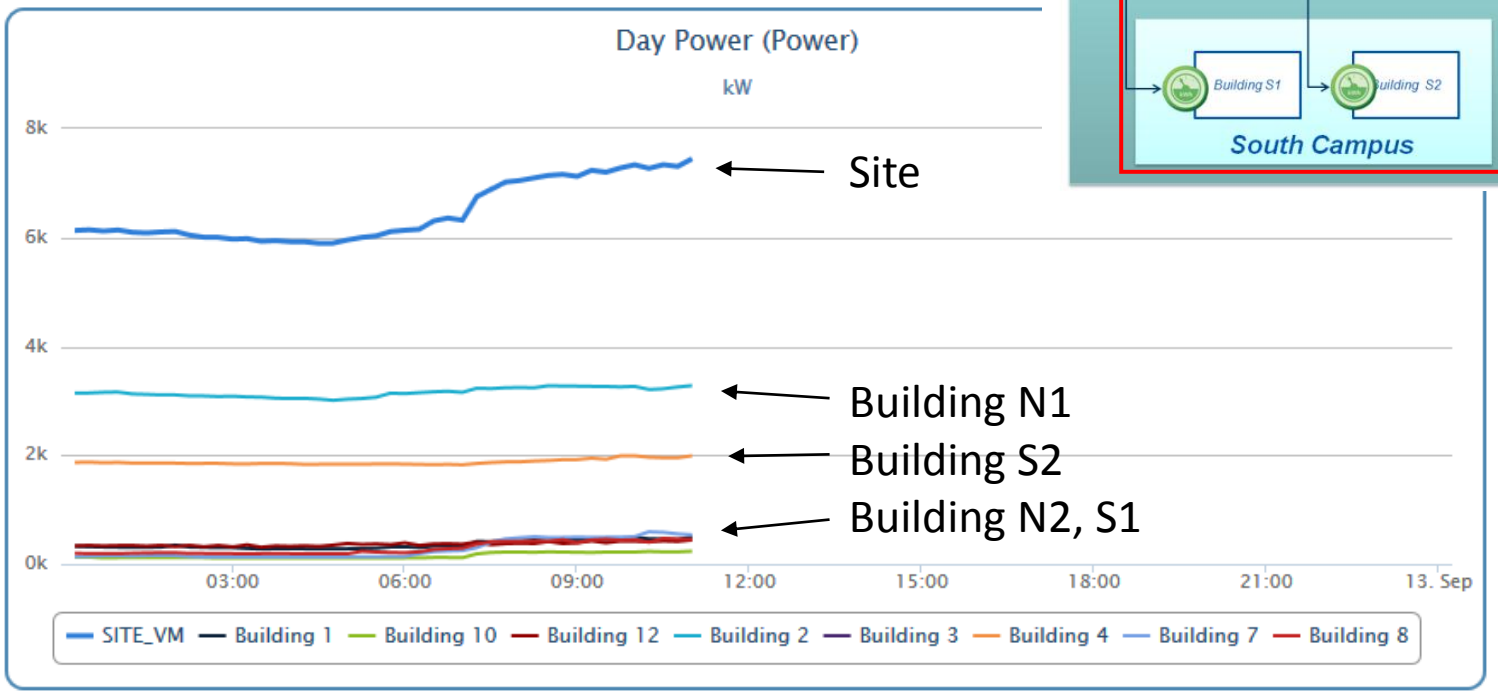


Virtual meter aggregates Building N1 and N2 into one ‘Virtual’ Meter

Concept: Aggregation cont'd

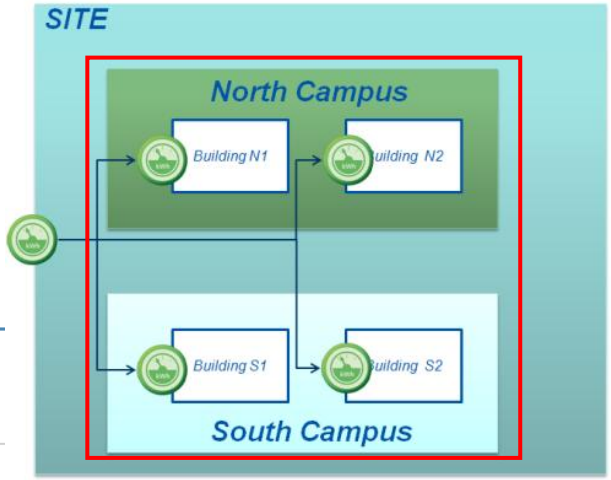
Virtual meter aggregates Building N1, N2, S1 and S2 into one 'Virtual' meter.

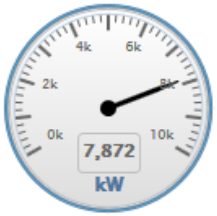


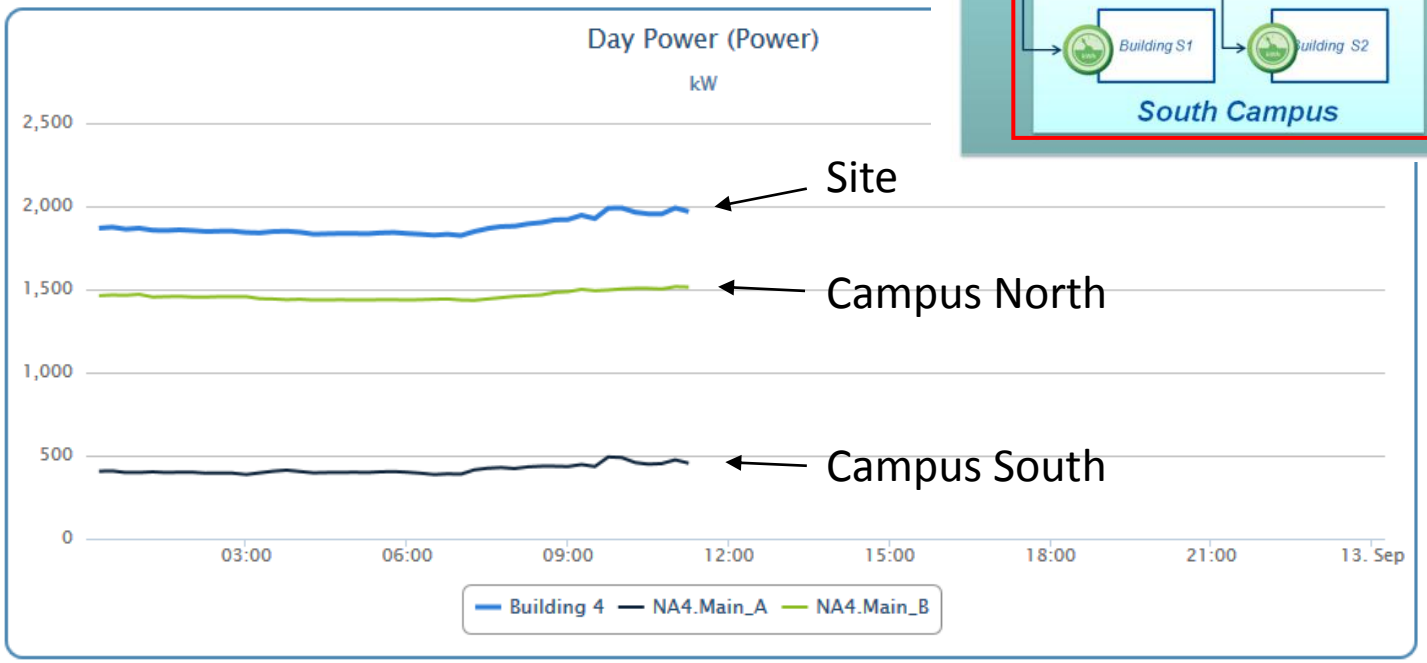


Concept: Aggregation cont'd

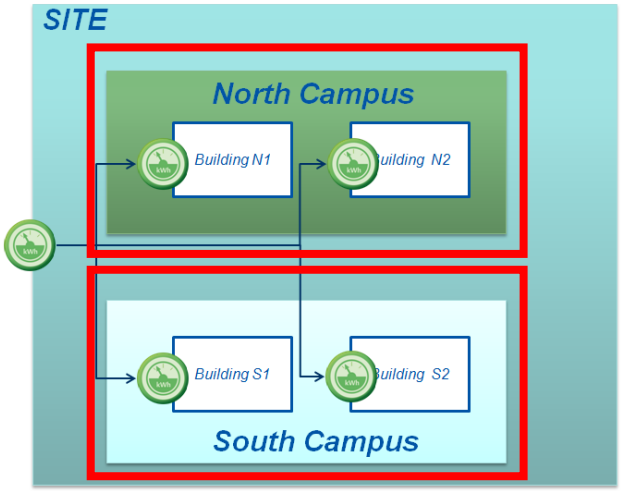
Virtual meter aggregates Virtual Meter Campus North and Campus South in one 'Virtual' meter.

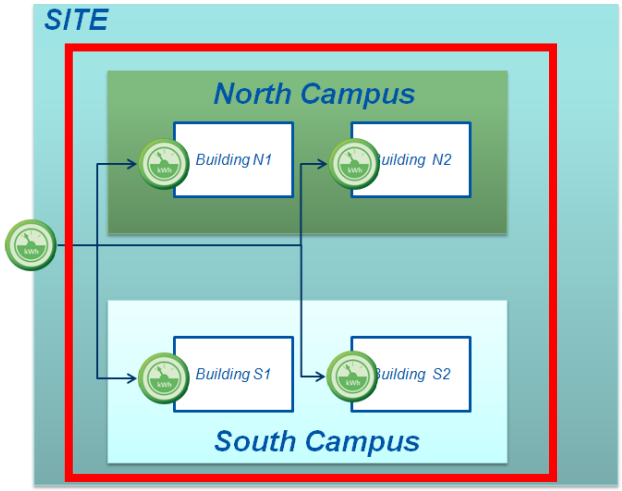


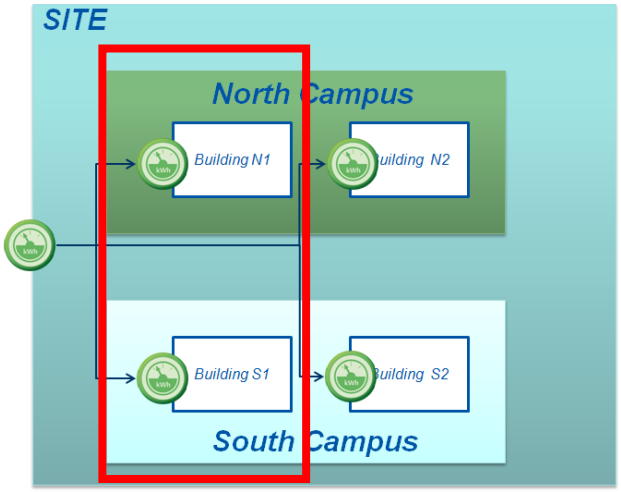


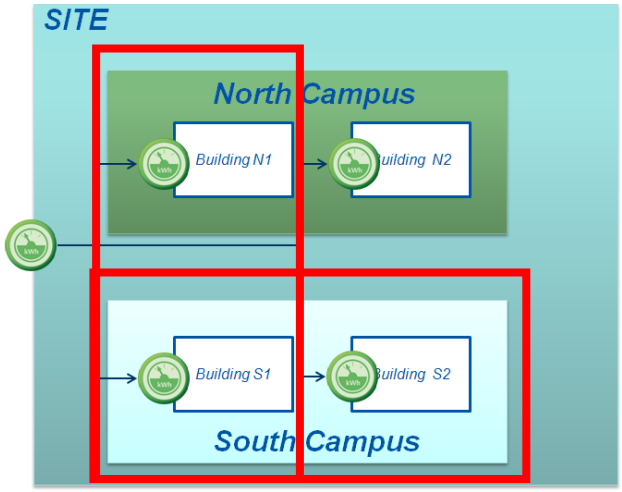


Concept: co-existing VM's









Virtual meters co-exist at the same time.

Examples:

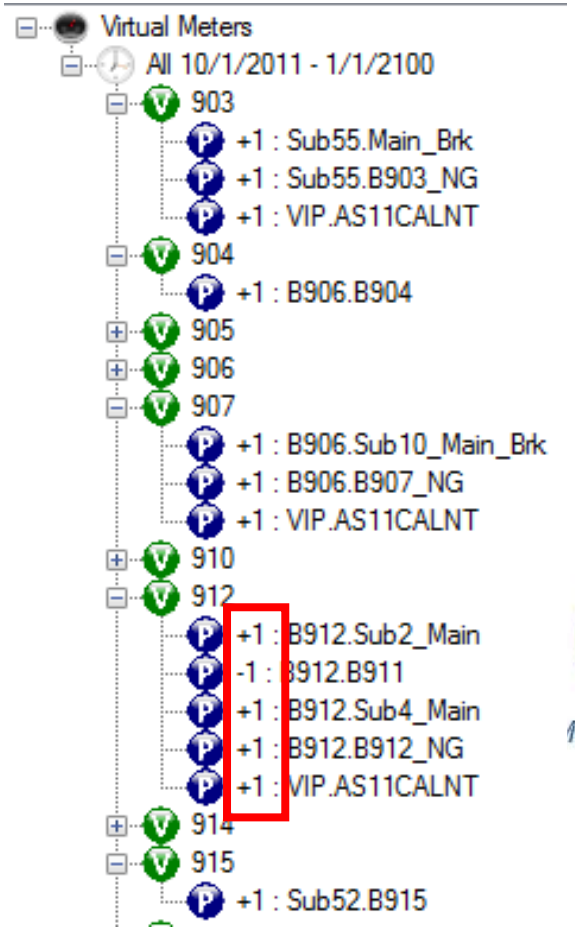
- North Campus
- South Campus
- West Campus
- East Campus
- Manufacturing
- Entire Site

Concept: Possibilities

So what did we achieve?

- Virtual meter: aggregate several Physical meters
- Virtual meter: aggregate several Virtual meters
- Virtual meters can ‘share’ the meters of other virtual meters
- Virtualized ‘Logs’: kWh, kW, Cubic Feet (Gas), Gallons (Water) can be used
- Virtual Meter: Each ‘child’ meter can apply a multiplication factor
  - →Subtracting meters

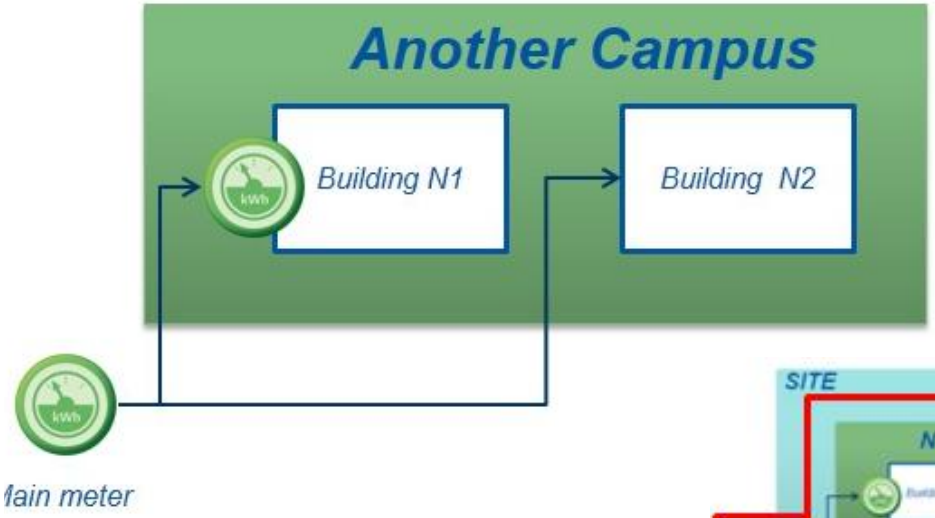
Concept: Factors

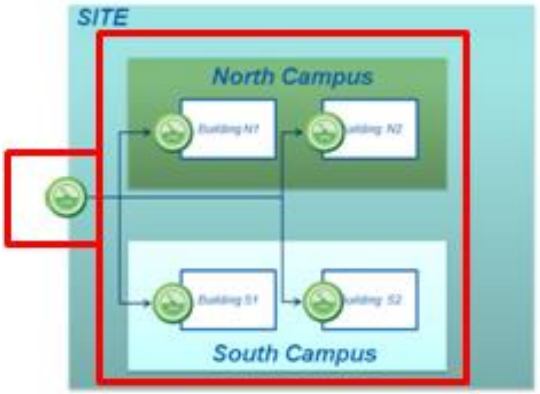


Subtracting meters

Usage of building N2:

Main Meter minus Building N1

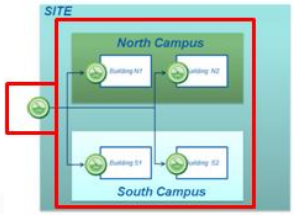




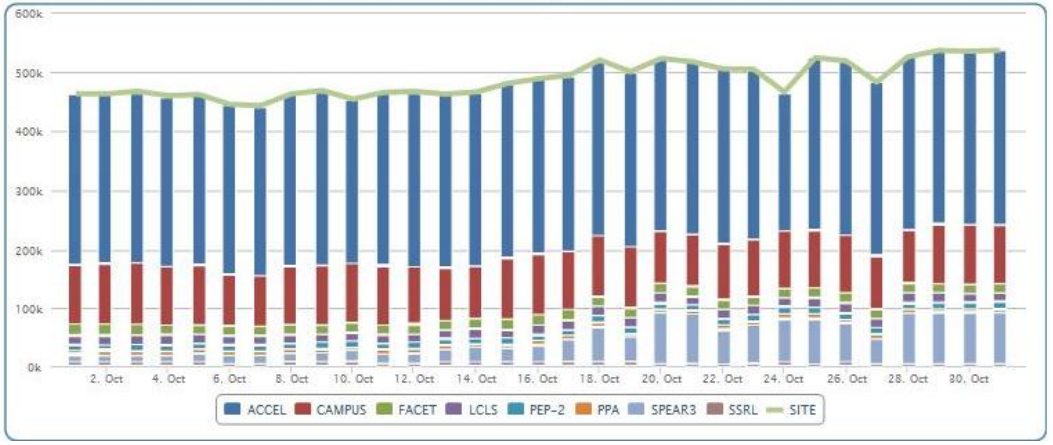
Concept: Site Audit

Now that we can subtract: Site Reconciliation (Audit)

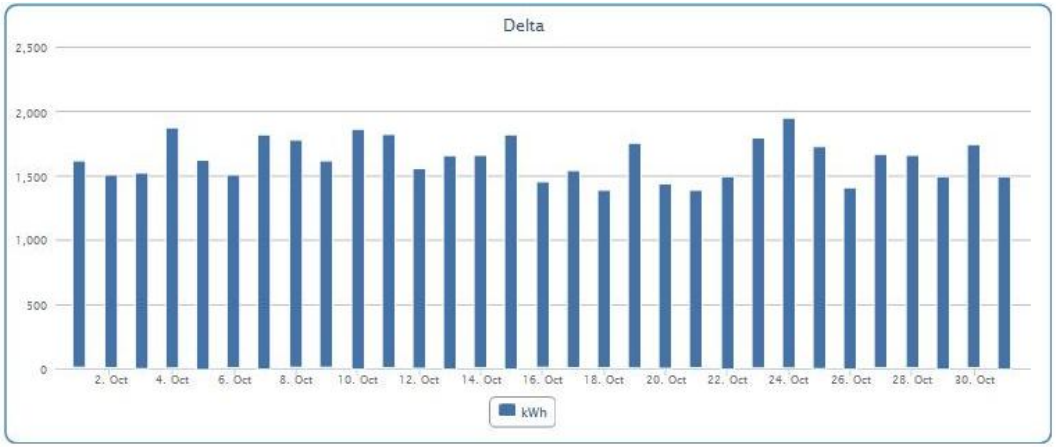
- Create a Site Virtual Meter: all meters at the site
- Create a Delta Virtual Meter
  - Subtract the Virtual Site from the main meter!



Site Energy Trend: Physical Meter<->Virtual Meter



The entire Virtual Meter, with the Site (line on top)

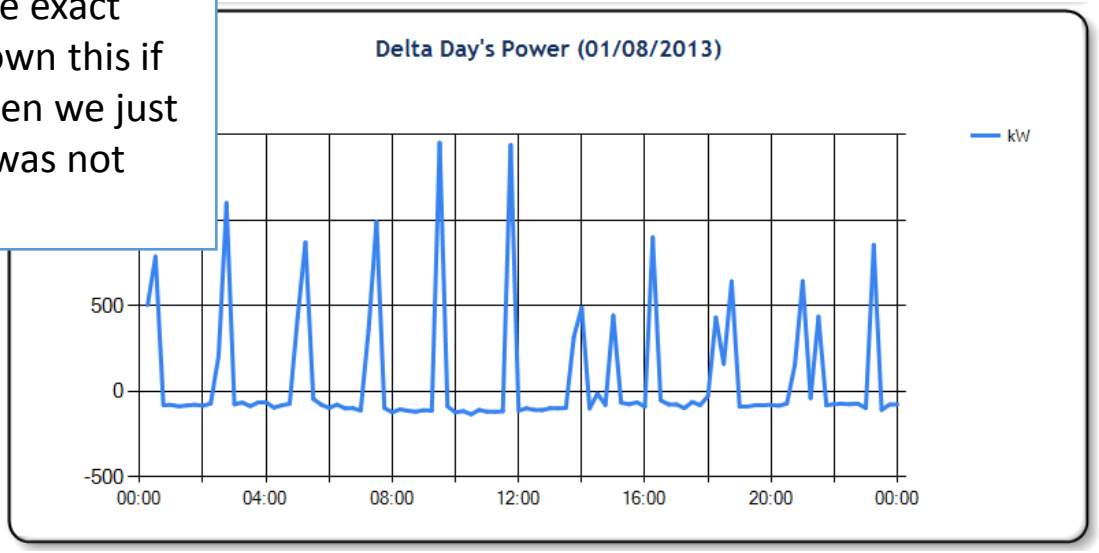


The 'Delta' Virtual Meter

Use case: Site Audit

Emma Lee, SLAC:

"We saw these spikes for delta power from Recipe Analytics early this year, and we found out all our SEL meter Modbus driver was not built correctly. They were not set to aggregate the energy at the exact 15minute interval. We would not have known this if it was not for Recipe Analytics because when we just looked at the individual meters, the spike was not noticeable."



The 'Delta' Virtual Meter in 15 minute view

Concept: One View Status

Current Situation Dashboard

Virtual Meters Details

Power (kW)

Now

09/18/2013 - 08:30 AM GO

Summary as of now (9/18/2013 8:15:00 AM)

SSRL	322	09/18/2013 08:15 AM
SUB507.M157	322	09/18/2013 08:15 AM

SPEAR3	-322	09/18/2013 08:15 AM
SUB_RA_B004.M109	0	09/18/2013 08:30 AM
SUB507.M157	322	09/18/2013 08:15 AM

SITE	13,104	09/18/2013 08:15 AM
MSS.230kV	13	09/18/2013 08:15 AM
MSS.M_T3	0	09/18/2013 08:15 AM

SRCF	112	09/18/2013 08:15 AM
MSS.M37	75	09/18/2013 08:15 AM
MSS.M67	37	09/18/2013 08:15 AM

LCLS	881	08/29/2013 02:00 PM
SUB_522.M380	856	09/18/2013 08:15 AM
SUB_522.M382	0	08/29/2013 02:00 PM
SUB_IR4_B646.CB323	25	09/18/2013 08:15 AM

PPA	197	09/18/2013 08:15 AM
SUB_455.M203	0	09/18/2013 08:30 AM
SUB_BSY_B007.M130	0	09/18/2013 08:15 AM
SUB_RA_B004.CB112	126	09/18/2013 08:15 AM
SUB_RA_B004.M106	72	09/18/2013 08:15 AM
SUB_RA_B004.M115	0	09/18/2013 08:15 AM

SITE-VM	12,990	08/29/2013 02:00 PM
ACCEL	6,406	09/18/2013 08:15 AM
CAMPUS	4,668	08/29/2013 02:00 PM
FACET	726	09/18/2013 08:15 AM
LCLS	881	08/29/2013 02:00 PM
PPA	197	09/18/2013 08:15 AM
SPEAR3	-322	09/18/2013 08:15 AM
SRCF	112	09/18/2013 08:15 AM
SSRL	322	09/18/2013 08:15 AM

FACET	726	09/18/2013 08:15 AM
MSS.M36	0	09/18/2013 08:15 AM
MSS.M40	0	09/18/2013 08:15 AM
MSS.M61	0	09/18/2013 08:15 AM
MSS.M62	0	09/18/2013 08:15 AM
MSS.M76	0	09/18/2013 08:15 AM
SUB_519.M140	790	09/18/2013 08:15 AM
SUB_519.M141	6	09/18/2013 08:30 AM
SUB_SECT20_VVS10.M_VVS10	14	09/18/2013 08:15 AM
SUB_SECT22_VVS11.M_VVS11	12	09/18/2013 08:15 AM
SUB_SECT24_VVS12.M_VVS12	12	09/18/2013 08:15 AM

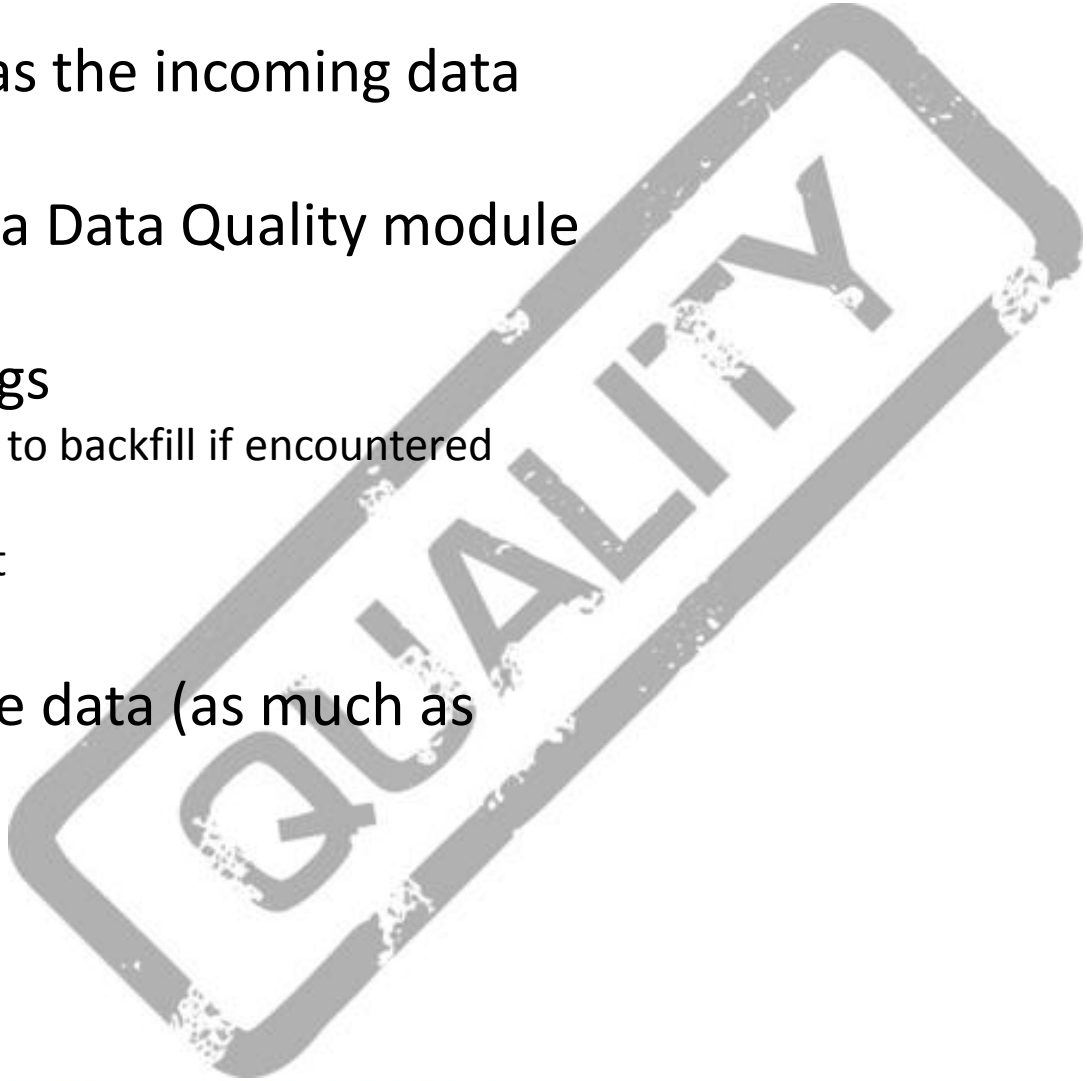
Demonstration

Reports

- Reports are created based on virtual meters
  - Day, week, month, year
- Virtual meters can be defined reflecting budgets or departments
- Virtual meters can be defined over a certain period only
  - Manufacturing vacates building 4, building 4 can be dropped from the 'Manufacturing Energy Budget' from that day onwards (and added to the new tenants)
- Multi-site
  - If connected, one 'Company' virtual meter can be defined

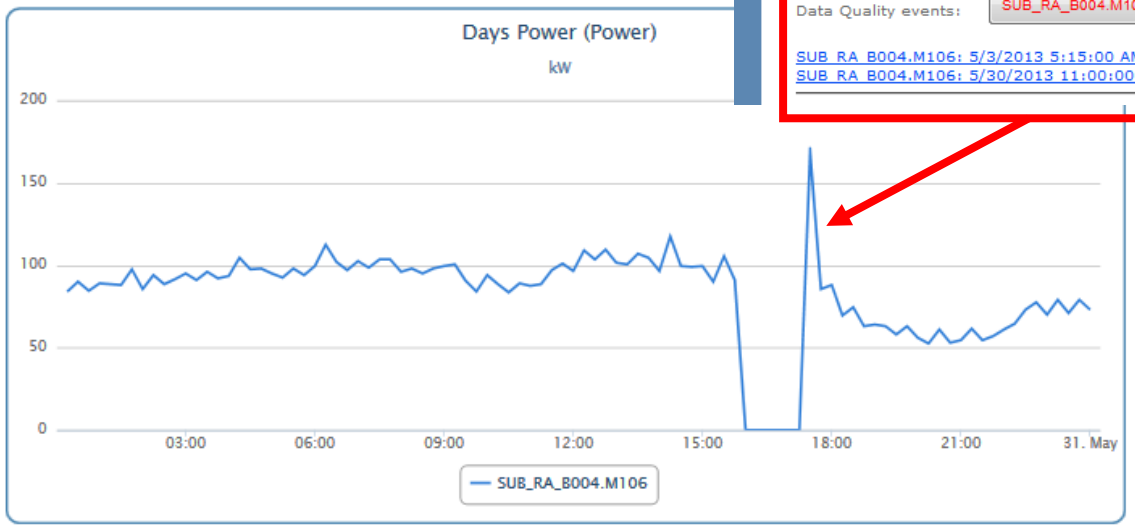
Data Quality

- Results are only as good as the incoming data
- RECIPE Analytics deploys a Data Quality module
- Analyzes all meter readings
  - Check on data gaps and tries to backfill if encountered
  - Check on Meter roll over
  - Check on Meter replacement
- Algorithms to ‘correct’ the data (as much as possible)
- Flags any irregularities



Data Quality

Data Quality Flagging



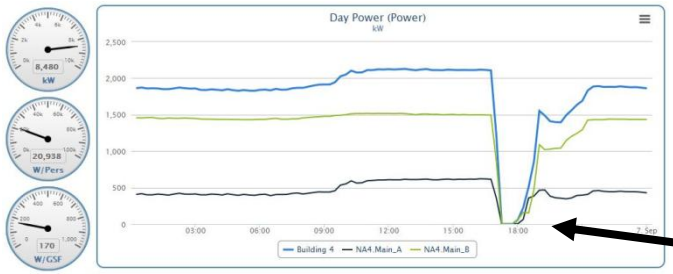
- Data Quality Events Detected
- Click Through to event

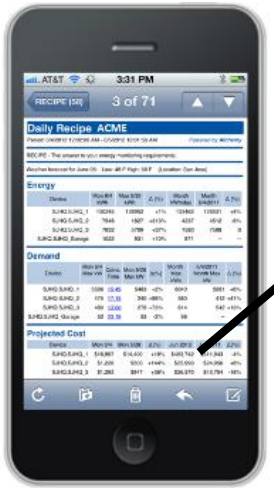
RECIPE Technologies

- Rate/Tariff Data
- Cost Calculation Modules
- Actual Bill Reconciliation
- Data Connectors
- Algorithms
  - Forecasting
  - Data Quality
- Report Generators
  - Day/Week/Month
  - Cost Forecast
  - Sustainability
- Daily Monitoring
- Virtual Metering
- Caching/ Visualization
- Cloud Hosting

The Technologies of RECIPE focus on Energy Usage, Quality and Cost Management

Discussed today





Voltage

Device	Vll ab	Min Vll bc	Vll ca	Vll ab	Max Vll bc	Vll ca
NA1.Main8600	480	481	479	496	497	494
NA10.Main8600	479	480	479	496	496	495
NA11.Main8600	482	482	481	494	494	494
NA11DC.Main	478	475	476	489	487	487
NA12.Main8600	474	475	473	489	490	488
NA16.Main8600	473	473	472	488	489	488
NA2_Main.12KVMain8600	11908	11998	11941	12233	12299	12259
NA2_Main.Main8600	467	466	464	484	483	481
NA3_Main.Main8600	483	484	483	495	497	495
NA4.Main_A	0	0	0	502	501	499
NA4.Main_B	0	0	0	506	504	503
NA7.Main_8600	476	476	472	489	489	486
NA8.Main_8600	471	472	472	490	491	490

Device: NA1.Main8600 Max: 497 at 9/6/2013 7:30:00 PM
Device: NA10.Main8600 Max: 496 at 9/6/2013 7:15:00 AM
Device: NA11.Main8600 Max: 494 at 9/6/2013 7:15:00 AM
Device: NA11DC.Main Max: 489 at 9/6/2013 6:30:00 AM
Device: NA12.Main8600 Max: 490 at 9/6/2013 7:15:00 AM
Device: NA16.Main8600 Max: 489 at 9/6/2013 7:15:00 AM
Device: NA2_Main.12KVMain8600 Max: 12299 at 9/6/2013 6:30:00 AM
Device: NA3_Main.Main8600 Max: 497 at 9/6/2013 7:30:00 PM
Device: NA4.Main_A Min: 0 at 9/6/2013 5:00:00 PM
Device: NA4.Main_A Max: 502 at 9/6/2013 2:00:00 PM
Device: NA4.Main_B Min: 0 at 9/6/2013 5:00:00 PM
Device: NA4.Main_B Max: 506 at 9/6/2013 2:00:00 PM
Device: NA7.Main_8600 Max: 489 at 9/6/2013 6:30:00 AM
Device: NA8.Main_8600 Max: 491 at 9/6/2013 6:15:00 PM

RECIPE Family

RECIPE Family of Technologies

- Utility Bill Reconcile
- Forecasting Monthly Energy bills

  (Financial budgeting)
- Scenario's analysis
  - Forecasting costs of new building/rates
  - Analysis/comparison of

    Direct Access <-> local providers

R - Reliability
E - Energy
¢ - Cost
I - Impact
P - Performance
E - Efficiency

Thank You!

With over 50 years of experience, the professionals at Alchemy unlimited provide expertise in:

- Energy analysis
- Software Solutions and Tools
- System Architecture: IT ←→ Power
- Reporting

ALCHEMY