



# **University of Virginia Case Study on Mining & Leveraging Big Data**

Cheryl Gomez, PE, LEED AP BD+C  
Director of Operations

Scott Martin  
Systems Integration & Development Manager



1,210 Acres  
21,238 Students

UVa's Academical Village (The "Lawn") – a World Heritage Site

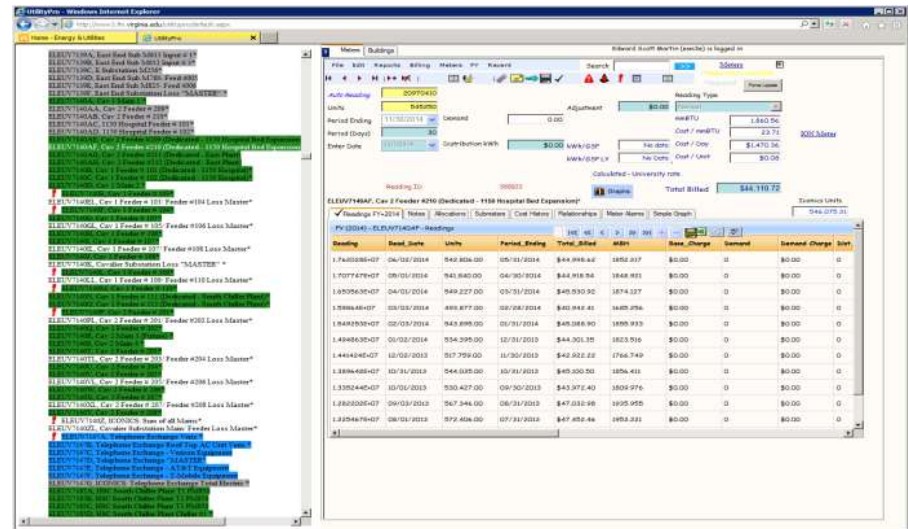
- 1 Main Heating Plant and 2 Satellite Plants
  - Steam and MTHW service
- 8 Chilled Water Loops (14 plants)
- 3 Primary Electric Substations
- Over 2,800 Meters



Jefferson' Rotunda – currently under renovation

# Genesis

- “Home-Grown” systems for trending, reporting, billing

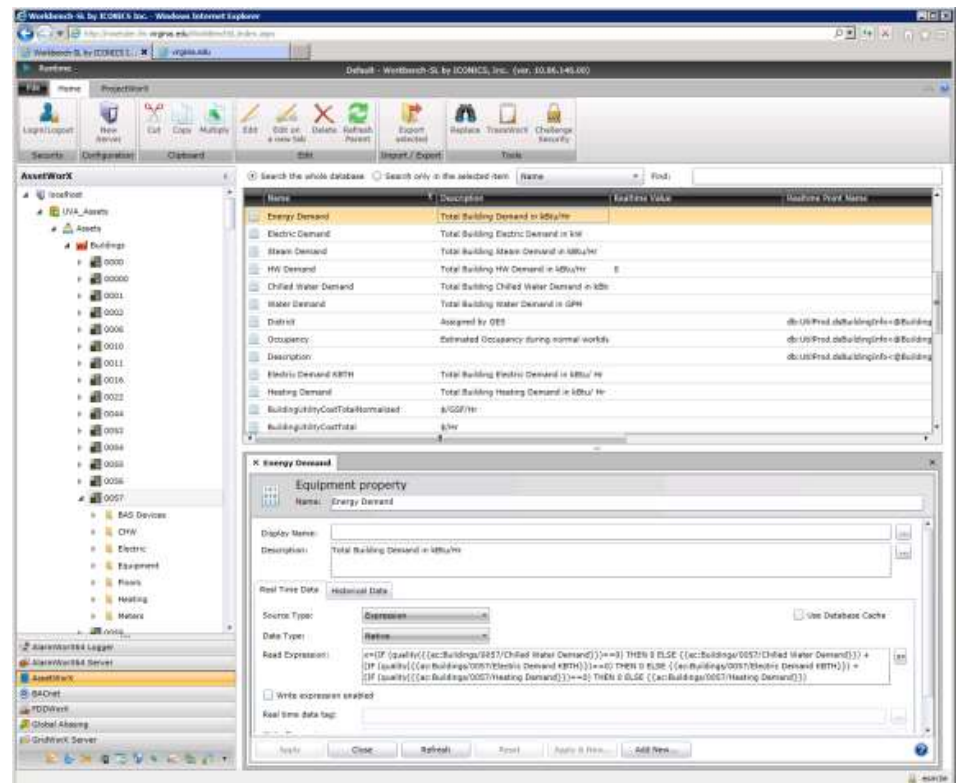


UtilityPro application – Meter Reading Form

- Interests in:
  - Modernizing
  - Visualization
- New University Financial Model (RCM)
- Central Alarm Management, Scheduling
- BAS Overlay potential

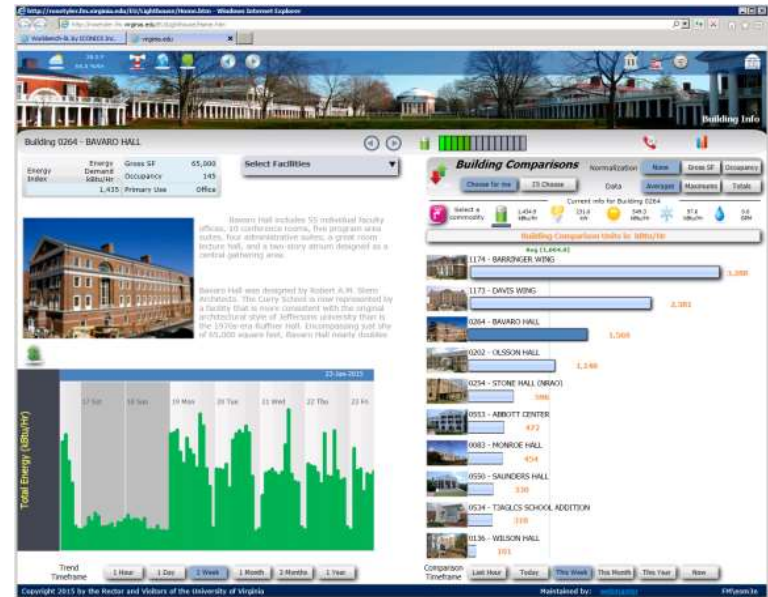
# Process

- Project budget \$300K
- Procurement - RFP
- Collaborative Internal Process
- Proposals
- Pilot project



# Decision-making

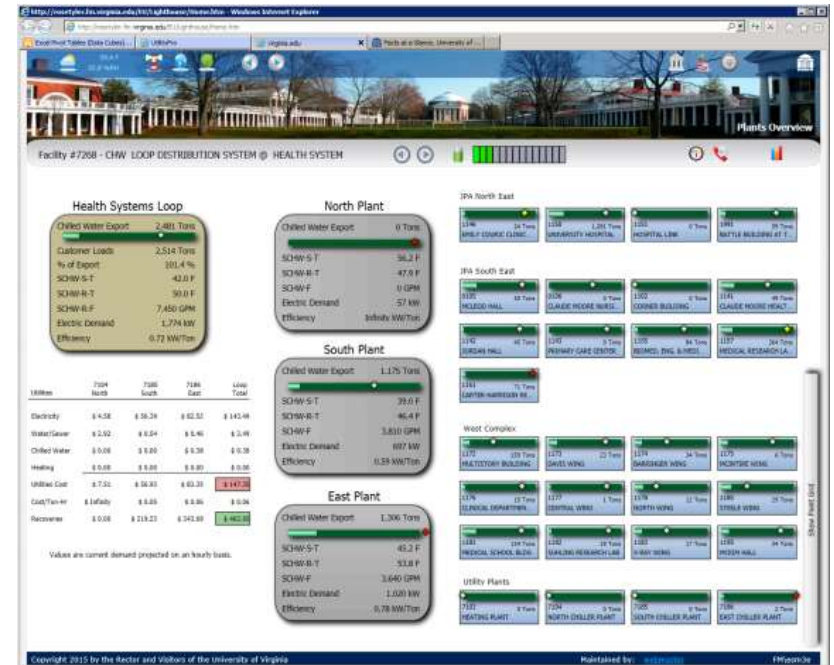
- System toolset
- Connectivity
- Microsoft platform
- Technology
- Ongoing development
- Cost and costing model



“Lighthouse” – Building info

# Decision-making

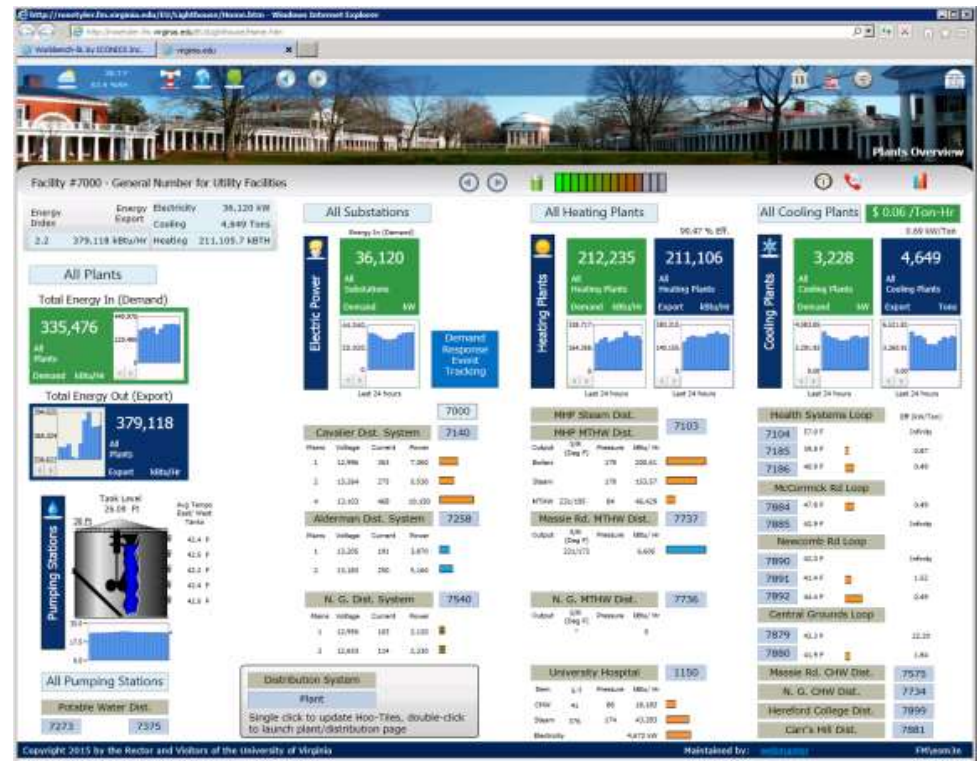
- Architecture
- Staff capabilities
- Scope of Existing Systems
- Communications
- Vendor Options
- Information Audiences
- What defines value?
- Monitor vs Control



“Lighthouse” – CHW Plant info

# Implementation

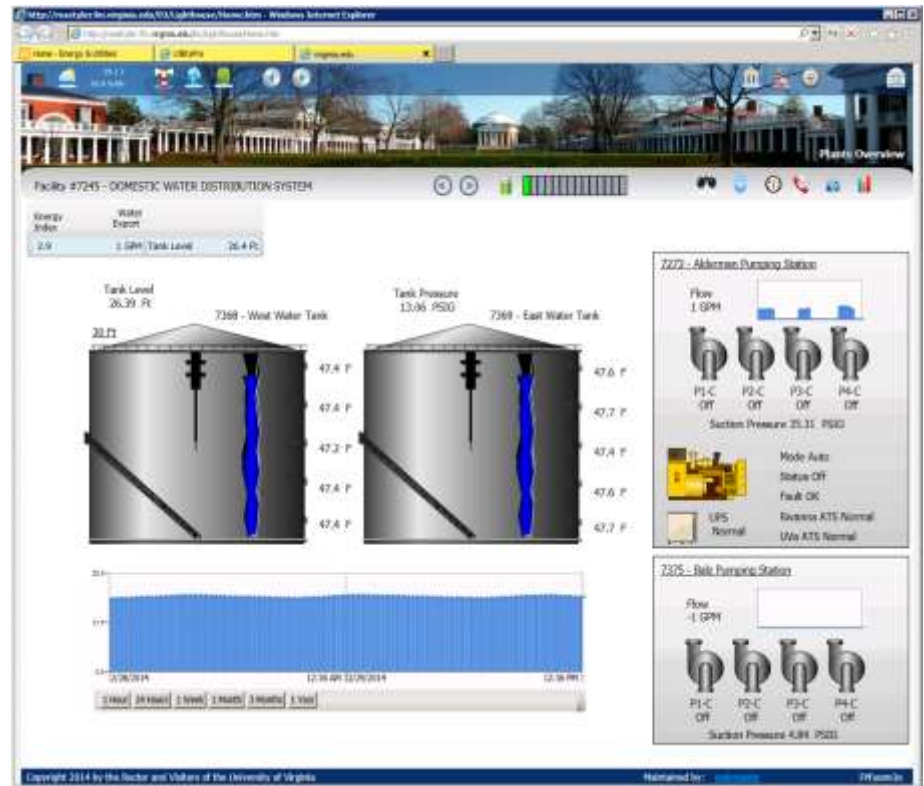
- Preliminary Work
- Pilot project
- Planning
- Development Go!



“Lighthouse” – District Energy Summary

# Issues

- BACnet Architecture
- BACnet Standards
- External accounts
- Vendor Options



"Lighthouse" – Potable water info



# Project Results

- Live Demo



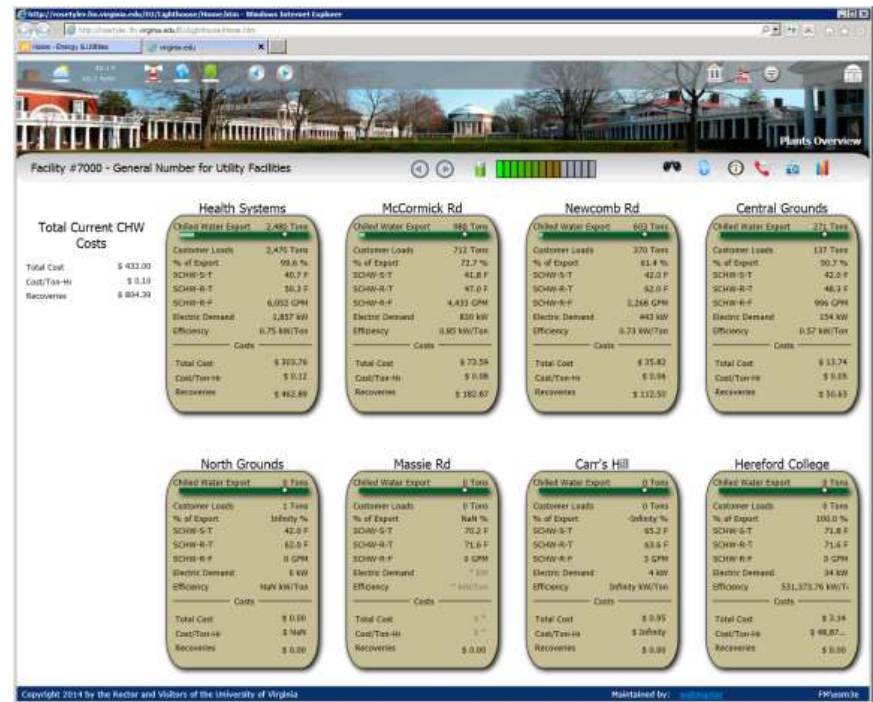
Jefferson's Rotunda



South Chiller Plant

# Project Results - Examples

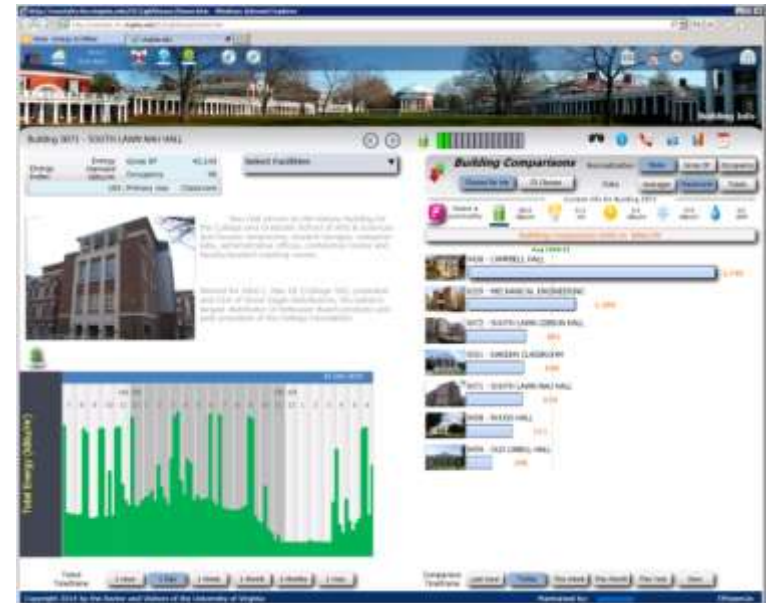
- Finding anomalies
  - Multiplier Errors
  - Sensor Issues
  - Time-base Errors for Totalization
  - Missing Data
  - BAS Programming issues
  - Billing Issues
  - Zero-value Offset Issues
  - Controls Issues



"Lighthouse" – Chilled water plant info

# Project Results

- Enterprise Data Historian
- Energy Asset Structure
- Visualization Tools
- BACnet
- Identified Issues
- Generated Interest
- Accelerated Improvements
- Improved Understanding



“Lighthouse” – Detecting anomalies

# Takeaways

- System Choices
- You need a “Champion”
- Determine what value means for you
- Plan for different audiences
- See what’s out there and make your own “Best of Breed”
- Prepare for surprises!
- “Big Data” is here – Use it!

# Next Steps

- External Account Data
- Central Scheduling
- Fault Detection and Diagnostics
- Central Alarms/ Notification
- Forecasting
- Customer Pages
- Additional Analytics



**QUESTIONS?**

# Project Results



- UVA's "Lighthouse" Application.

# Project Results

The screenshot displays the AssetWorX software interface within a web browser. The main window shows a table of energy demand metrics for various buildings. The table has four columns: Name, Description, Real-time Value, and Real-time Unit Name. The 'Energy Demand' row is highlighted in yellow.

Name	Description	Real-time Value	Real-time Unit Name
Energy Demand	Total Building Demand in kWh/hr		
Electric Demand	Total Building Electric Demand in kW		
Steam Demand	Total Building Steam Demand in kWh/hr		
HW Demand	Total Building HW Demand in kWh/hr		
Chilled Water Demand	Total Building Chilled Water Demand in kWh		
Water Demand	Total Building Water Demand in GPH		
District	Assigned by QES		@USProd.district@Building
Occupancy	Estimated Occupancy during normal work		@USProd.district@Building
Description			@USProd.district@Building
Electric Demand kWh	Total Building Electric Demand in kWh/hr		
Heating Demand	Total Building Heating Demand in kWh/hr		
BuildingUtilityCostTotalNormalized	\$/GJ/yr		
BuildingUtilityCostTotal	\$/yr		

Below the table, the 'Equipment property' dialog box is open for 'Energy Demand'. It shows the following details:

- Name: Energy Demand
- Display Name: [Empty field]
- Description: Total Building Demand in kWh/hr
- Real Time Data: [Checked]
- Source Type: Expression
- Data Type: Rate
- Real Expression: 
$$=IF (QUALITY((@ac:Buildings/0057/Chilled\ Water\ Demand))=9) THEN 0 ELSE ((@ac:Buildings/0057/Chilled\ Water\ Demand)) + IF (QUALITY((@ac:Buildings/0057/Electric\ Demand\ kWh))=4) THEN 0 ELSE ((@ac:Buildings/0057/Electric\ Demand\ kWh)) + IF (QUALITY((@ac:Buildings/0057/Heating\ Demand))=2) THEN 0 ELSE ((@ac:Buildings/0057/Heating\ Demand))$$
- Real time data tag: [Empty field]

- Energy Asset Structure

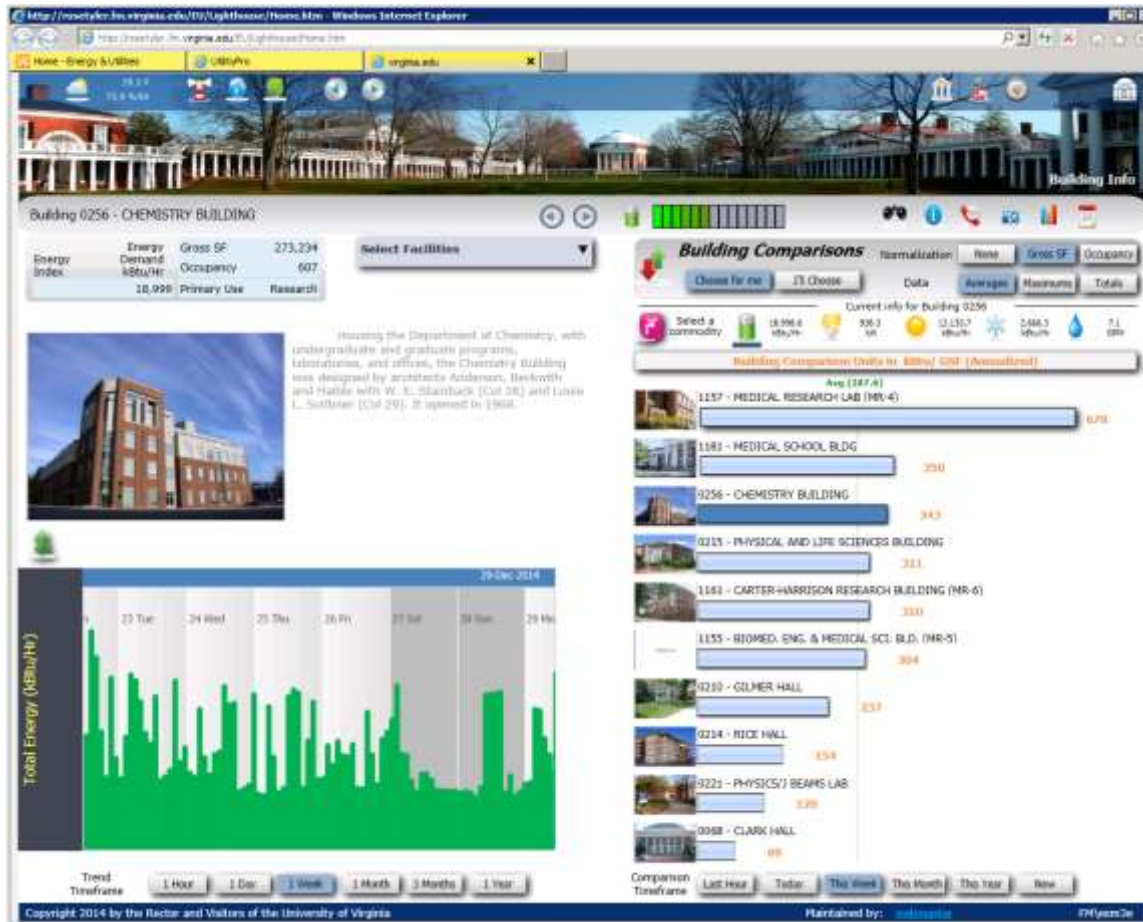


# Project Results



- Basic Building Info

# Project Results



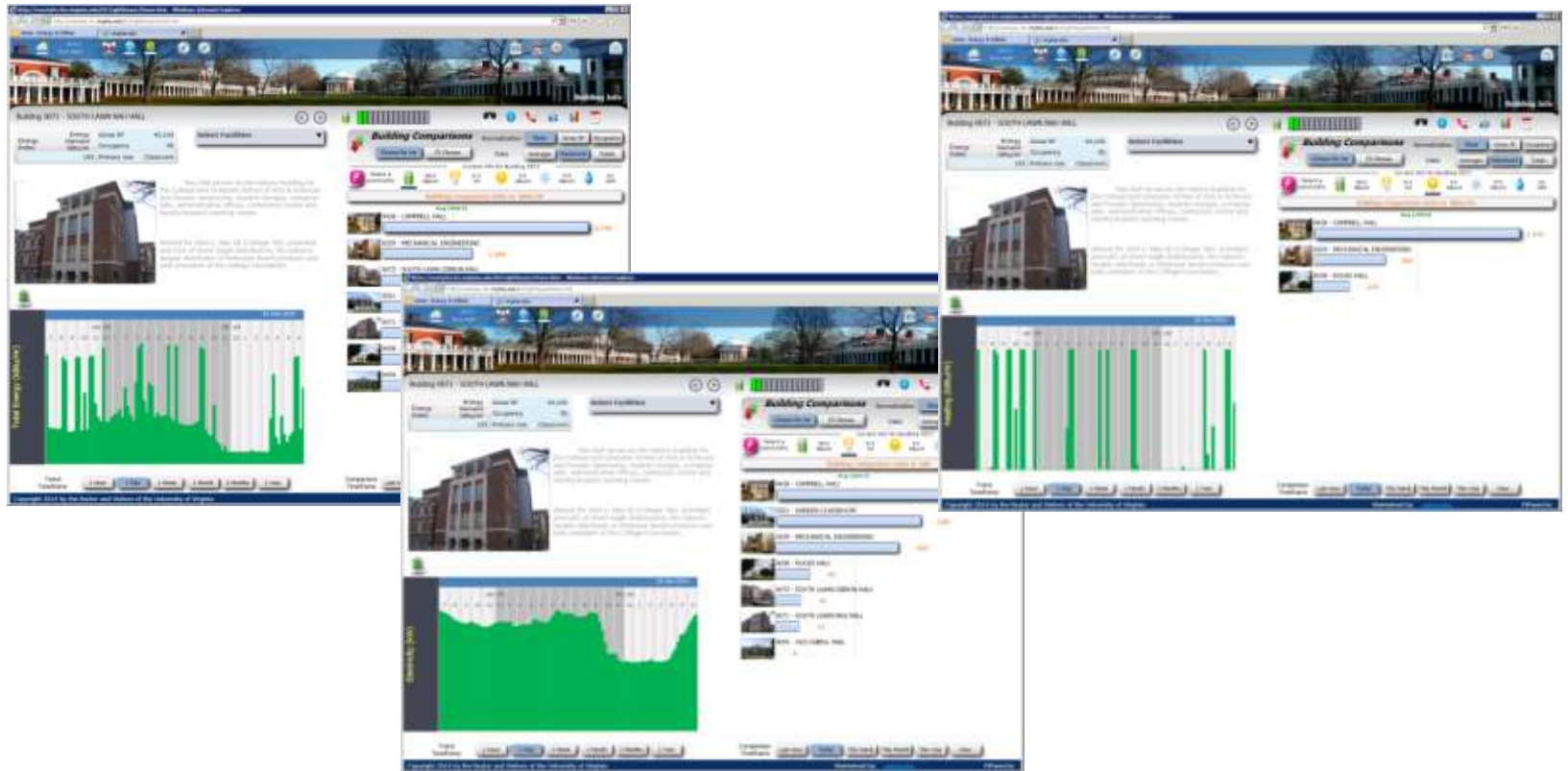
- Basic Building Info

# Project Results



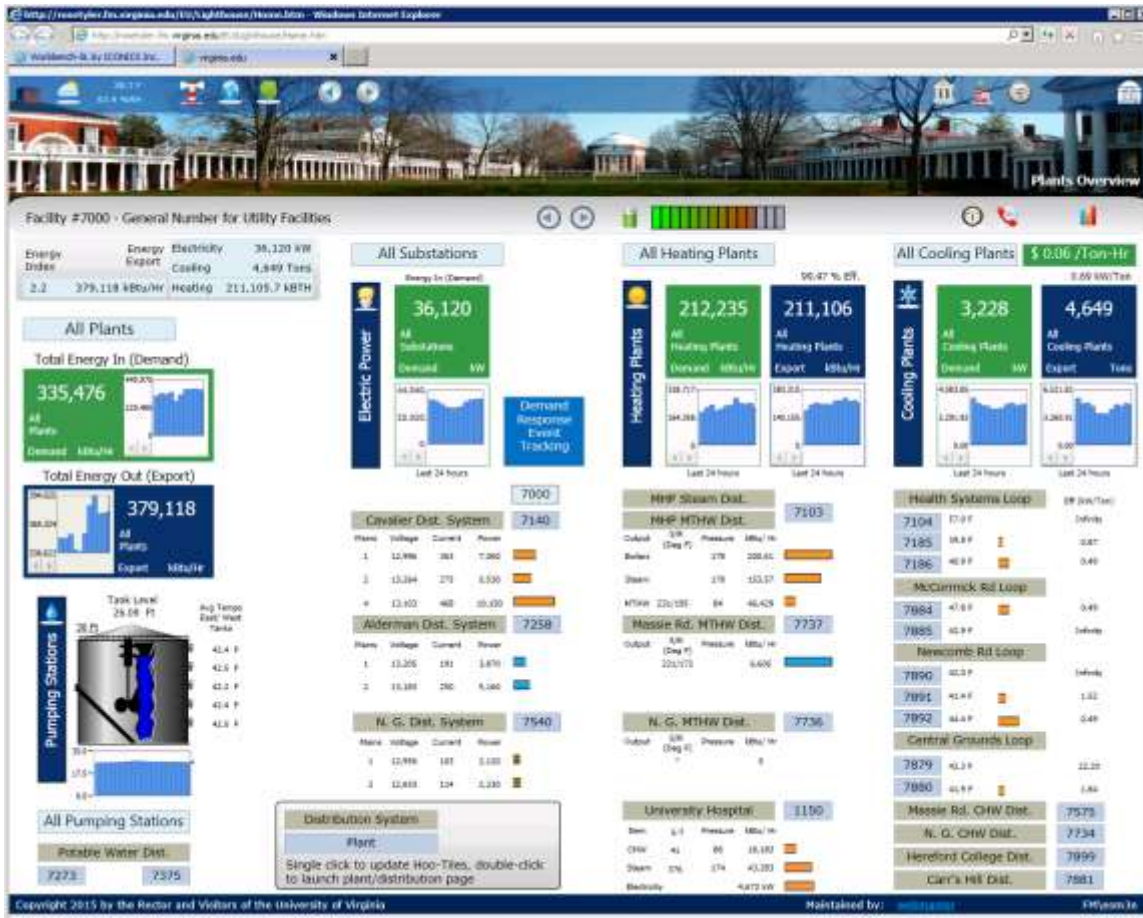
- Cost info has been added

# Project Results



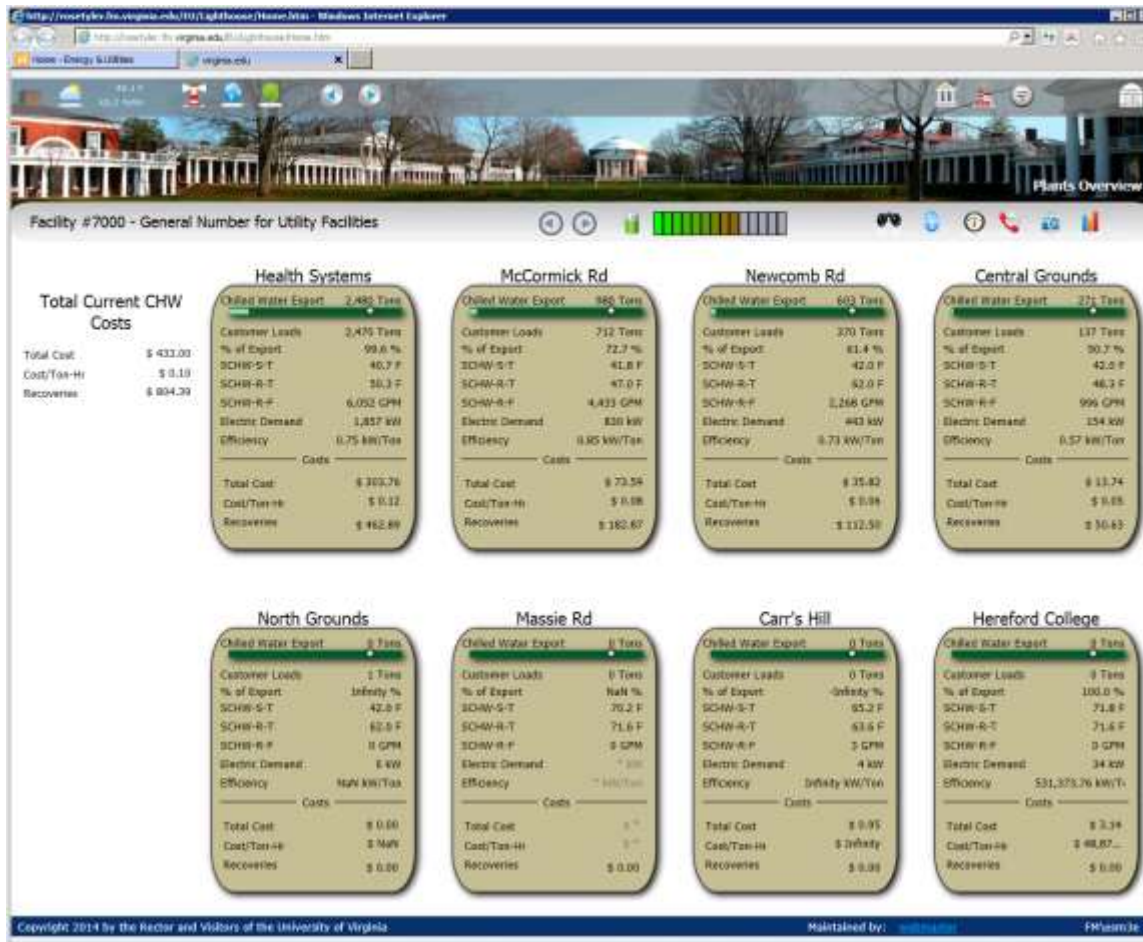
- Isolating problems

# Project Results



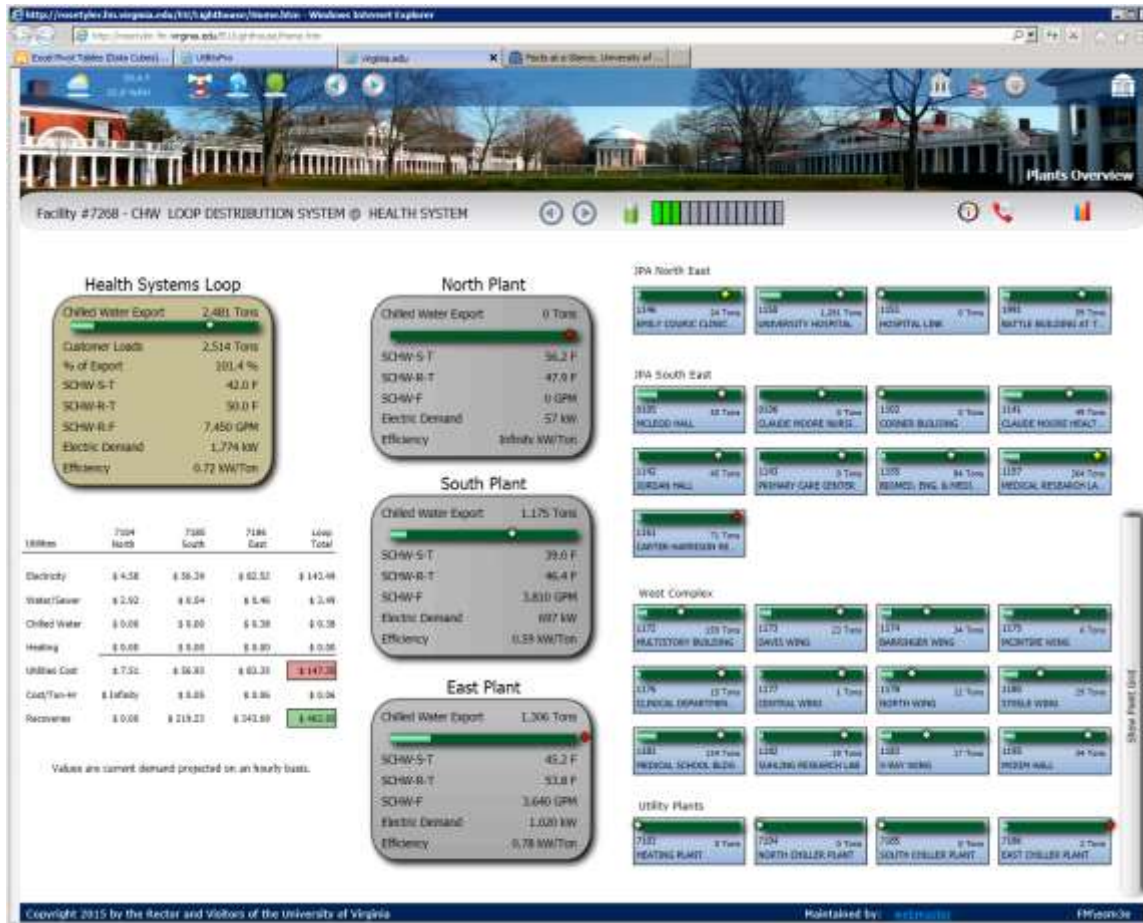
- Plant/distribution systems status

# Project Results



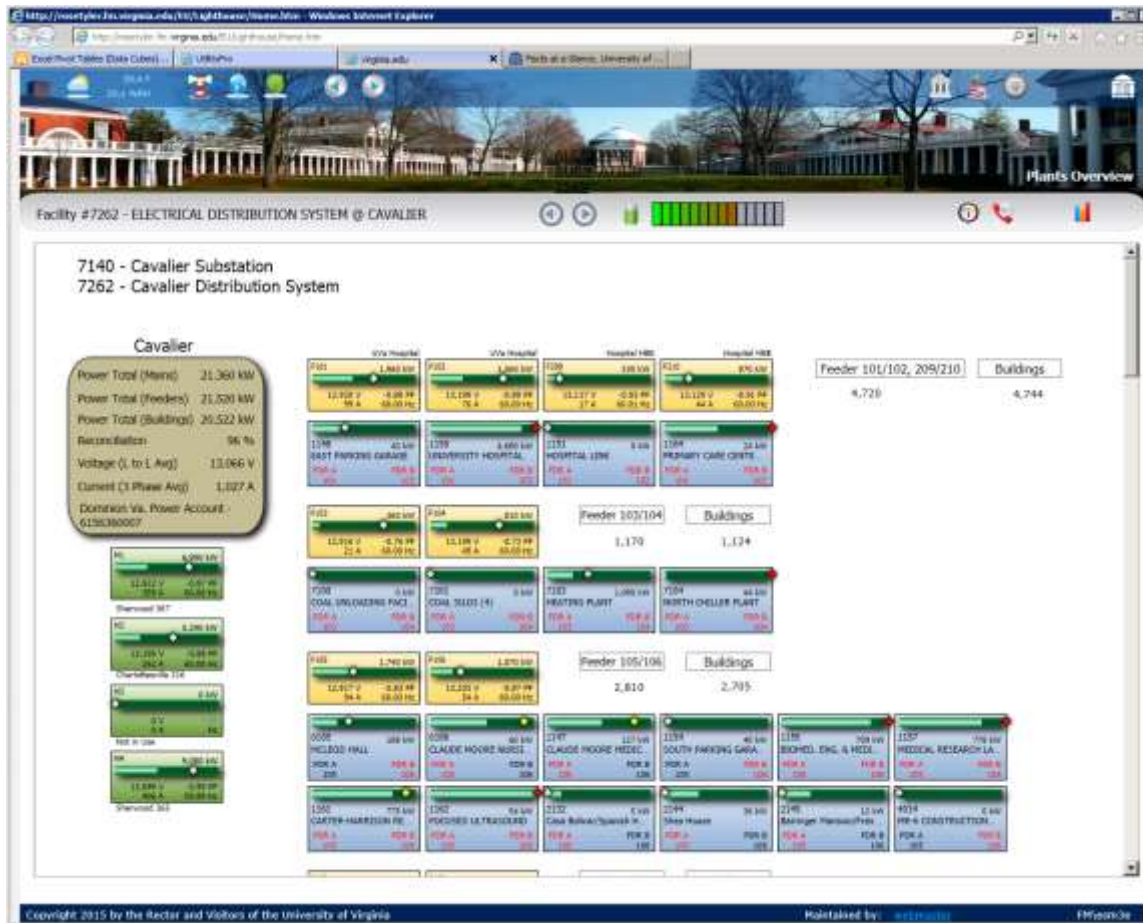
- Real-time Plant Reconciliation and Costs example

# Project Results



- Real-time reconciliation for a specific district cooling loop (system).

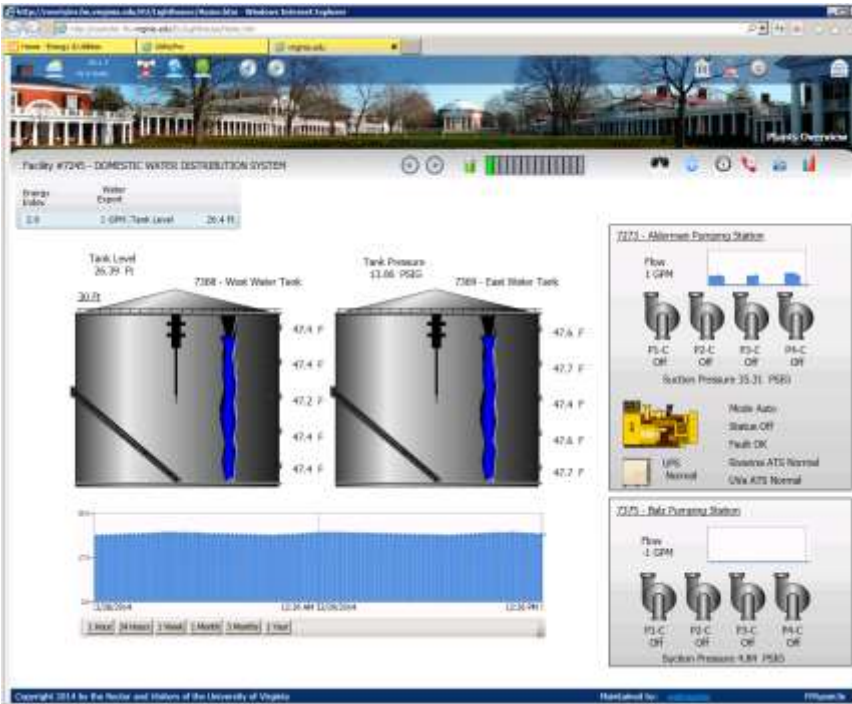
# Project Results



- Real-time reconciliation for a Substation



# Project Results



- Traditional SCADA.

# Project Results

The screenshot displays a software interface for managing utility data. On the left, a list of feeders is shown, including:

- ELEV7180A, East End Sub 5013 Ingrd # 17
- ELEV7180B, East End Sub 5013 Sgrd # 17
- ELEV7180C, E Substation M254\*
- ELEV7180D, East End Sub 5158 Feeder #001
- ELEV7180E, East End Sub 5125-Feeder #006
- ELEV7180F, East End Substation Loss "MASTER"
- ELEV7180G, Cav 1 Feeder # 209
- ELEV7180H, Cav 2 Feeder # 209
- ELEV7180I, Cav 3 Feeder # 209
- ELEV7180J, Cav 4 Feeder # 209
- ELEV7180K, Cav 5 Feeder # 209
- ELEV7180L, Cav 6 Feeder # 209
- ELEV7180M, Cav 7 Feeder # 209
- ELEV7180N, Cav 8 Feeder # 209
- ELEV7180O, Cav 9 Feeder # 209
- ELEV7180P, Cav 10 Feeder # 209
- ELEV7180Q, Cav 11 Feeder # 209
- ELEV7180R, Cav 12 Feeder # 209
- ELEV7180S, Cav 13 Feeder # 209
- ELEV7180T, Cav 14 Feeder # 209
- ELEV7180U, Cav 15 Feeder # 209
- ELEV7180V, Cav 16 Feeder # 209
- ELEV7180W, Cav 17 Feeder # 209
- ELEV7180X, Cav 18 Feeder # 209
- ELEV7180Y, Cav 19 Feeder # 209
- ELEV7180Z, Cav 20 Feeder # 209
- ELEV7180AA, Cav 21 Feeder # 209
- ELEV7180AB, Cav 22 Feeder # 209
- ELEV7180AC, Cav 23 Feeder # 209
- ELEV7180AD, Cav 24 Feeder # 209
- ELEV7180AE, Cav 25 Feeder # 209
- ELEV7180AF, Cav 26 Feeder # 209
- ELEV7180AG, Cav 27 Feeder # 209
- ELEV7180AH, Cav 28 Feeder # 209
- ELEV7180AI, Cav 29 Feeder # 209
- ELEV7180AJ, Cav 30 Feeder # 209
- ELEV7180AK, Cav 31 Feeder # 209
- ELEV7180AL, Cav 32 Feeder # 209
- ELEV7180AM, Cav 33 Feeder # 209
- ELEV7180AN, Cav 34 Feeder # 209
- ELEV7180AO, Cav 35 Feeder # 209
- ELEV7180AP, Cav 36 Feeder # 209
- ELEV7180AQ, Cav 37 Feeder # 209
- ELEV7180AR, Cav 38 Feeder # 209
- ELEV7180AS, Cav 39 Feeder # 209
- ELEV7180AT, Cav 40 Feeder # 209
- ELEV7180AU, Cav 41 Feeder # 209
- ELEV7180AV, Cav 42 Feeder # 209
- ELEV7180AW, Cav 43 Feeder # 209
- ELEV7180AX, Cav 44 Feeder # 209
- ELEV7180AY, Cav 45 Feeder # 209
- ELEV7180AZ, Cav 46 Feeder # 209
- ELEV7180BA, Cav 47 Feeder # 209
- ELEV7180BB, Cav 48 Feeder # 209
- ELEV7180BC, Cav 49 Feeder # 209
- ELEV7180BD, Cav 50 Feeder # 209
- ELEV7180BE, Cav 51 Feeder # 209
- ELEV7180BF, Cav 52 Feeder # 209
- ELEV7180BG, Cav 53 Feeder # 209
- ELEV7180BH, Cav 54 Feeder # 209
- ELEV7180BI, Cav 55 Feeder # 209
- ELEV7180BJ, Cav 56 Feeder # 209
- ELEV7180BK, Cav 57 Feeder # 209
- ELEV7180BL, Cav 58 Feeder # 209
- ELEV7180BM, Cav 59 Feeder # 209
- ELEV7180BN, Cav 60 Feeder # 209
- ELEV7180BO, Cav 61 Feeder # 209
- ELEV7180BP, Cav 62 Feeder # 209
- ELEV7180BQ, Cav 63 Feeder # 209
- ELEV7180BR, Cav 64 Feeder # 209
- ELEV7180BS, Cav 65 Feeder # 209
- ELEV7180BT, Cav 66 Feeder # 209
- ELEV7180BU, Cav 67 Feeder # 209
- ELEV7180BV, Cav 68 Feeder # 209
- ELEV7180BW, Cav 69 Feeder # 209
- ELEV7180BX, Cav 70 Feeder # 209
- ELEV7180BY, Cav 71 Feeder # 209
- ELEV7180BZ, Cav 72 Feeder # 209
- ELEV7180CA, Cav 73 Feeder # 209
- ELEV7180CB, Cav 74 Feeder # 209
- ELEV7180CC, Cav 75 Feeder # 209
- ELEV7180CD, Cav 76 Feeder # 209
- ELEV7180CE, Cav 77 Feeder # 209
- ELEV7180CF, Cav 78 Feeder # 209
- ELEV7180CG, Cav 79 Feeder # 209
- ELEV7180CH, Cav 80 Feeder # 209
- ELEV7180CI, Cav 81 Feeder # 209
- ELEV7180CJ, Cav 82 Feeder # 209
- ELEV7180CK, Cav 83 Feeder # 209
- ELEV7180CL, Cav 84 Feeder # 209
- ELEV7180CM, Cav 85 Feeder # 209
- ELEV7180CN, Cav 86 Feeder # 209
- ELEV7180CO, Cav 87 Feeder # 209
- ELEV7180CP, Cav 88 Feeder # 209
- ELEV7180CQ, Cav 89 Feeder # 209
- ELEV7180CR, Cav 90 Feeder # 209
- ELEV7180CS, Cav 91 Feeder # 209
- ELEV7180CT, Cav 92 Feeder # 209
- ELEV7180CU, Cav 93 Feeder # 209
- ELEV7180CV, Cav 94 Feeder # 209
- ELEV7180CW, Cav 95 Feeder # 209
- ELEV7180CX, Cav 96 Feeder # 209
- ELEV7180CY, Cav 97 Feeder # 209
- ELEV7180CZ, Cav 98 Feeder # 209
- ELEV7180DA, Cav 99 Feeder # 209
- ELEV7180DB, Cav 100 Feeder # 209

The right pane shows a detailed view for 'ELEV7180AF, Cav 3 Feeder #210 (Dedicated - 1100 Hospital Bed Expansion)'. It includes a 'Readings FY-2014' table with the following columns: Reading, Read Date, Units, Period Ending, Total Billed, kWh, Base Charge, Demand, Demand Charge, and Sift. A blue arrow points to the 'Total Billed' column.

Reading	Read Date	Units	Period Ending	Total Billed	kWh	Base Charge	Demand	Demand Charge	Sift
1.7480288+07	04/05/2014	942,806.00	05/31/2014	\$44,998.42	1852,217	\$0.00	0	\$0.00	0
1.7077478+07	05/01/2014	941,840.00	04/30/2014	\$44,918.34	1848,931	\$0.00	0	\$0.00	0
1.6505635+07	04/01/2014	949,227.00	03/31/2014	\$48,530.92	1874,127	\$0.00	0	\$0.00	0
1.588448+07	03/03/2014	889,877.00	02/28/2014	\$40,942.41	1685,256	\$0.00	0	\$0.00	0
1.6492859+07	02/03/2014	943,898.00	01/31/2014	\$48,386.90	1899,933	\$0.00	0	\$0.00	0
1.4948635+07	01/02/2014	934,395.00	12/31/2013	\$44,301.35	1823,516	\$0.00	0	\$0.00	0
1.4442442+07	12/03/2013	917,759.00	11/30/2013	\$42,922.22	1766,749	\$0.00	0	\$0.00	0
1.3894485+07	10/31/2013	954,035.00	10/31/2013	\$48,300.50	1856,411	\$0.00	0	\$0.00	0
1.3352445+07	10/01/2013	930,427.00	09/30/2013	\$43,972.40	1809,276	\$0.00	0	\$0.00	0
1.2820205+07	09/03/2013	967,346.00	08/31/2013	\$47,032.98	1925,955	\$0.00	0	\$0.00	0
1.2254675+07	08/01/2013	972,406.00	07/31/2013	\$47,852.46	1953,331	\$0.00	0	\$0.00	0

- Separate Monthly Totals for Comparison.