“Day-to-Day Chilled Water System Management and Operation Using Real-time Distribution System Hydraulic and Temperature Modeling”

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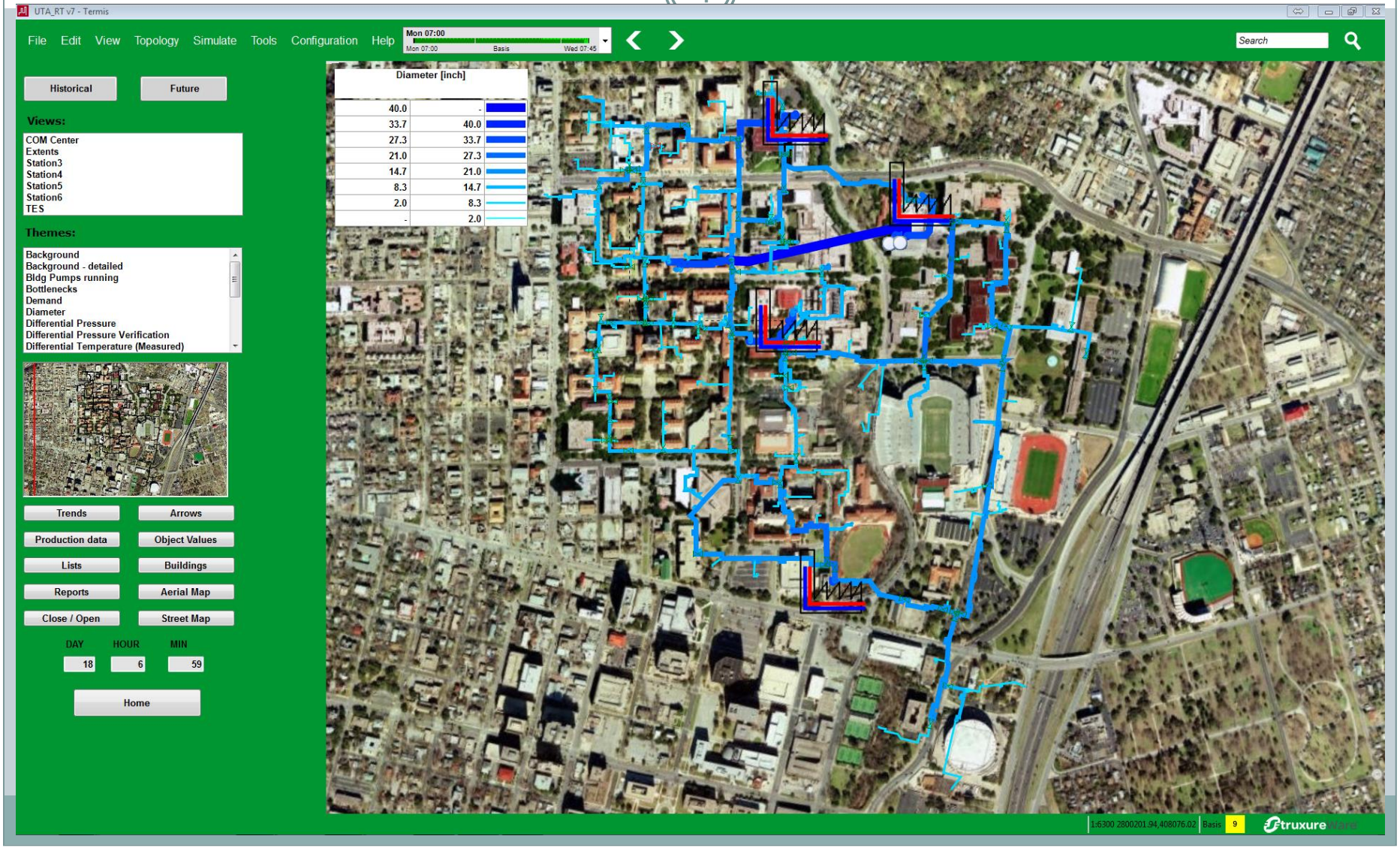
Purpose of Presentation

- HOW UT AUSTIN IS USING TERMIS REAL-TIME DISTRIBUTION SYSTEM MODELING TO ENABLE INDUSTRY LEADING EFFICIENCY
- SEEING IT IS BELIEVING IT – DEMO
- RESULTS, SAVINGS AND BENEFITS

UT Austin Energy Systems

- 100% power, heating and cooling requirements for 20 million sf and 150+ buildings – USD $50 Million Annual
- Power Plant
  - 135MW of on-site Combined Heat and Power (62 MW Peak), 1.2 million lb/hr of steam generation (300K Peak)
- Chilled Water
  - 45,000 tons (157 MW) capacity in 4 plants, 33,000 tons (116 MW) peak
  - 4 Million Gallon/36,000 ton-hrs TES Tank
  - + 15,000 tons (53 MW) to come online June 2016
  - + 5.5 Million Gallon/49,500 ton-hrs TES tank to come online June 2016

UT Austin Energy Systems



Content of Presentation

1. MANAGEMENT AND OPERATION CHALLENGES
2. REAL-TIME HYDRAULIC AND TEMPERATURE MODELING 101
3. EXAMPLES OF USE – LIVE DEMO
4. CONCLUSION AND NEXT STEPS

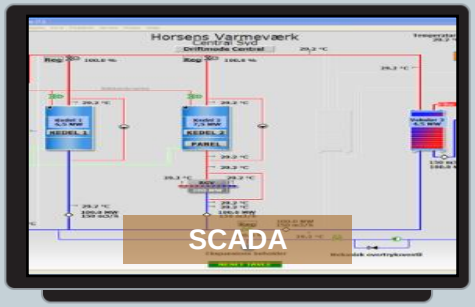
Management and Operation Challenges - 2007

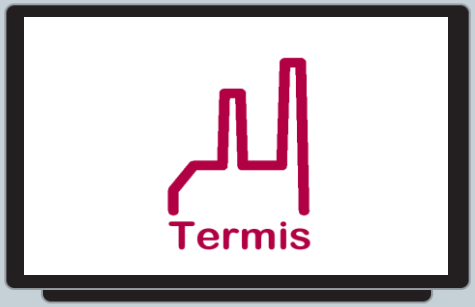
- **Management:** Do more with less – Need to build detailed in-house knowledge through availability of trustworthy forecasted, real-time and historical information; modeled and measured
- **Design:** Static modeling based typically on design day only
- **Operation:** No or very little information about the hydraulics and thermo dynamics of the distribution system – **"black hole syndrome"**
- **Control Strategy - Optimization:** One single system pressure used for determining whether chillers to be brought on line or taken off line. Avoiding ' hot or cold calls'

Management and Operation Challenges

1. PRESSURE OPTIMIZATION STRATEGY
2. DP MEASUREMENTS FOR THE PLANT CONTROL
3. MONITORING MEASUREMENT ACCURACY
4. CS#6 OPERATION AND TES DISPATCH FLOW
5. MONITORING OF DISTRIBUTION SYSTEM PRESSURES AND IDENTIFICATION OF PRESSURE ISSUES
6. MONITORING OF VALVES, BLOCKAGES IN THE DISTRIBUTION SYSTEM SUCH AS AIR BUBBLES

Elimination of the ”black hole syndrome”





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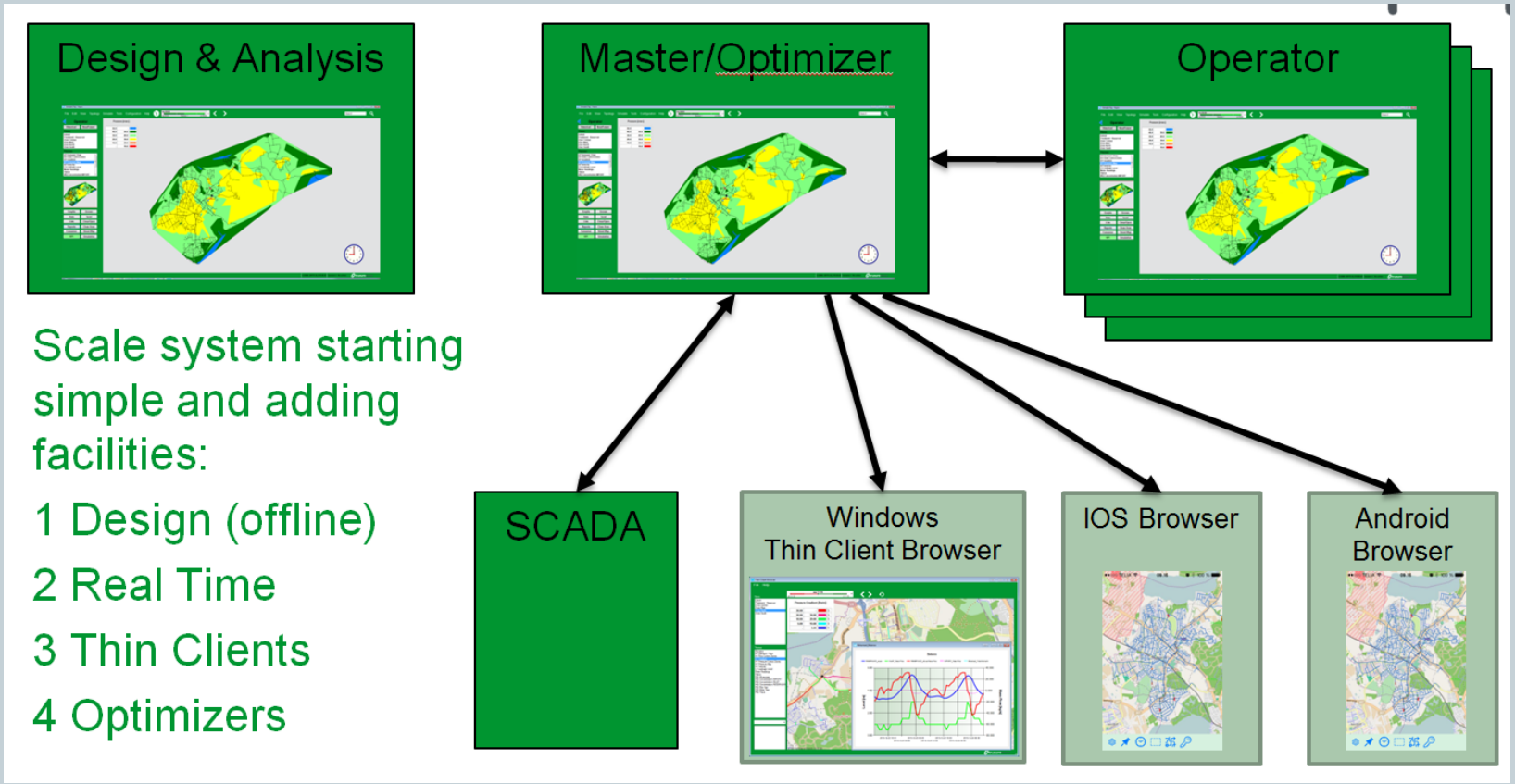
Investment

Management and Operation
UT Austin – Accomplishments 2016

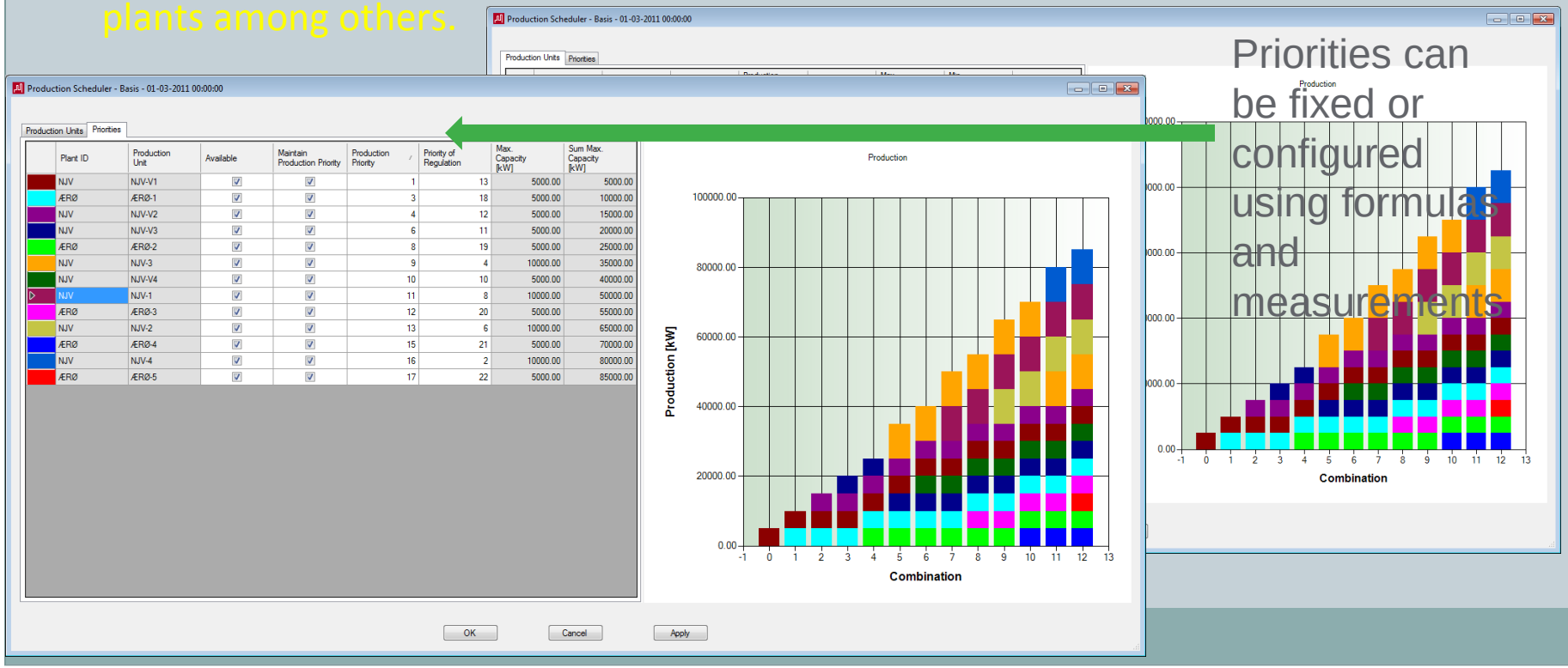
- **Management - Decision Support Information** for all staff in the organization and externally – Monitor Wall, Desktop, Laptop, Tablets, Smart Devices



Management and Operation
UT Austin - 2016

- **Design:** Real-Time hydraulic and thermal modeling based on the full annual load profile and fast full perspective “What-If” scenarios.

- **Operation:** Complete and detailed overview of the complete energy system: Generation + Distribution + Utilization = Plants + Piping + Buildings. staging of plants and chillers on plants among others.

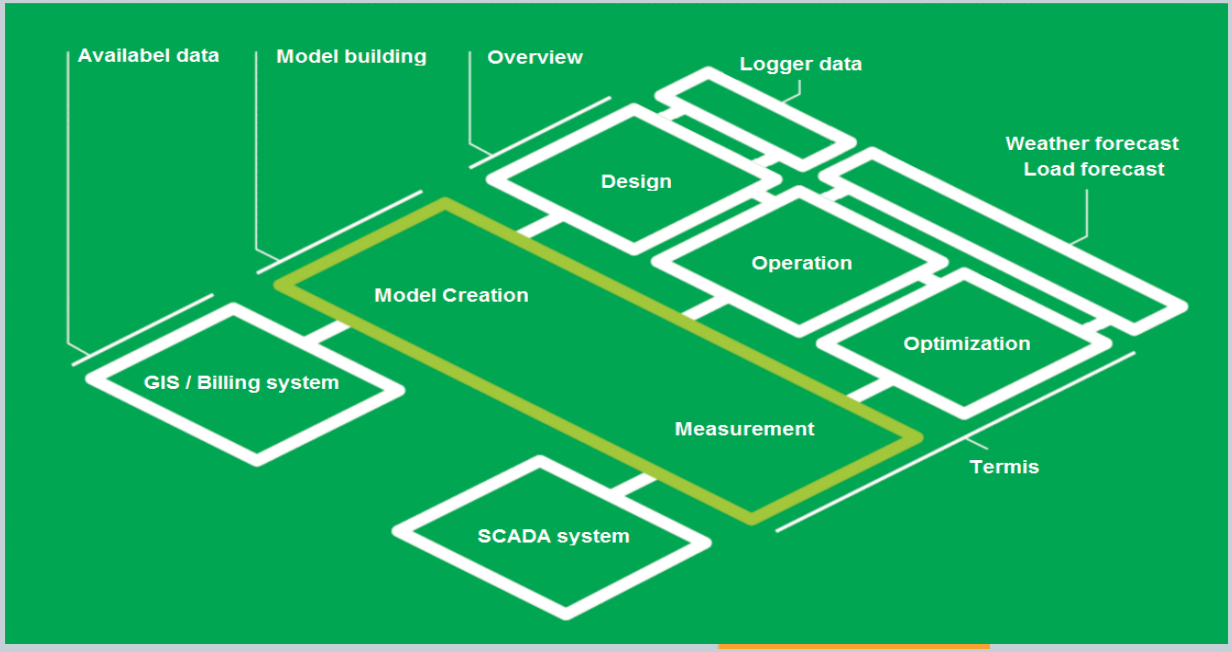


Management and Operation
UT Austin - 2016

- **Control Strategy – Optimization:** Dynamic set-points calculated by the Real-Time hydraulic and thermal modeling based on forecasted loads enabling optimization of temperature, flow, pressures, velocities, pressure gradients, losses,

Optimization method	Period	Method	Network Requirement
Termis Temperature Optimization	24 or 48 hours ahead	• Dynamic Optimization • Minimizing costs via control of supply temperature	Tuned model allowing simulation within defined period.
Termis Pump Optimization	Current time	• Exhaustive search • Minimizing costs via dynamic control of pump set points	Pumps in a tree structure or insignificant flow changes in loops due to changed pump head.
Termis Return Temperature Evaluation	Weeks, months or year	• Semi-automatic • Warning for changing behavior • Qualifying service pipes	Smart meters Tuned real time model

Real-Time Distribution System Hydraulic and Temperature Modeling - 101

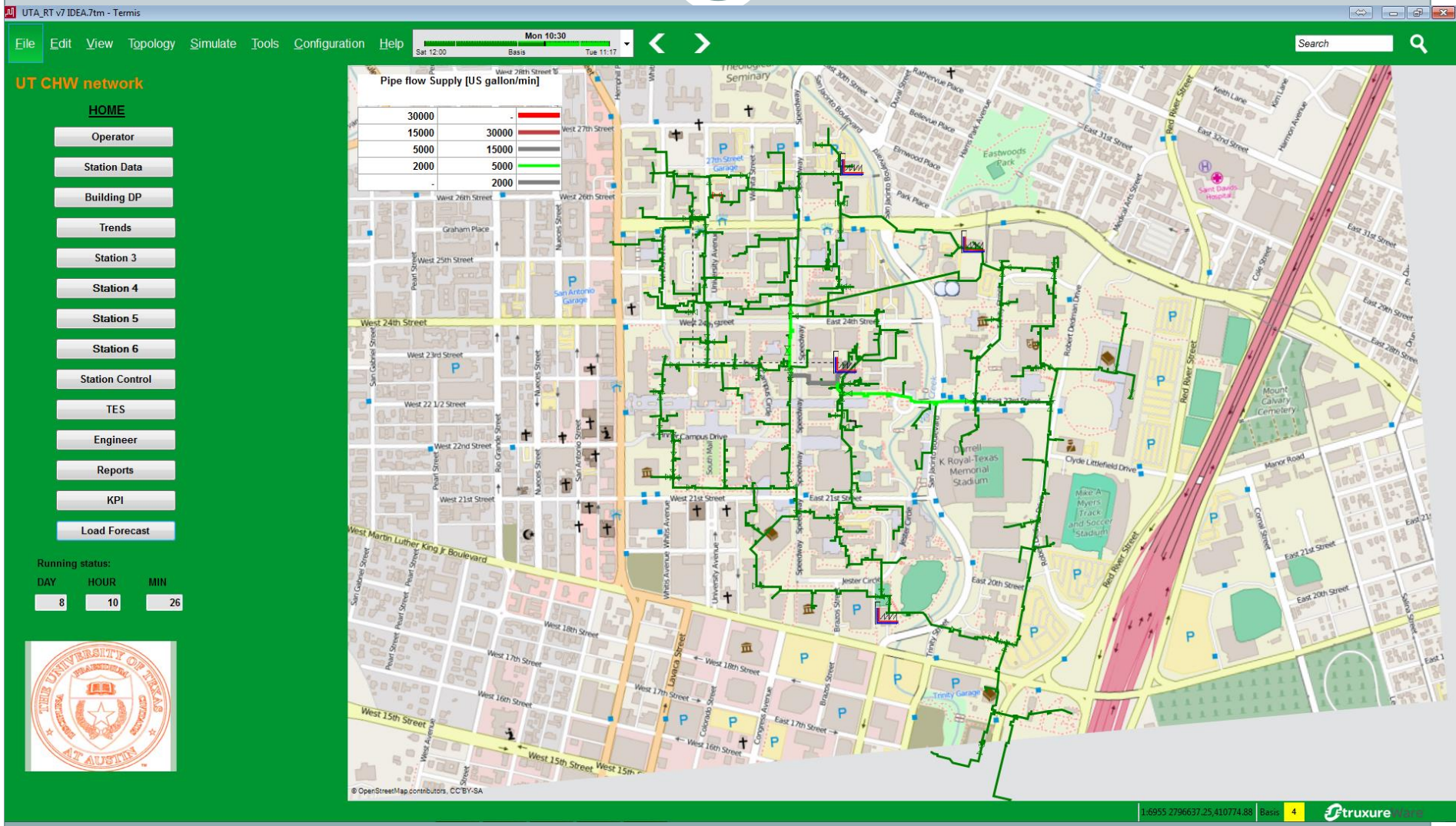


Real-Time measurements - about 600 building, network and plant meters/sensors (P,T, Tons and Q among others) - Every 5 minutes import of measurements and simulation. 146 buildings in model – 118 measured

Use of Real-Time Hydraulic and Temperature Modeling CWS Management and Operation

- 2007 – Offline model design, build and attempts to calibration
- 2008 - Real-Time Implementation and Calibration
- 2009 – Distribution System Trouble Shooting, Identification of P, dP, T, dT and Q Instrumentation and Installation
- 2010 – Optimization Test, Study and Analysis. New Operation Strategy
- 2011 – Implementation of phase #1: P, T and Q optimization
- 2012 – Commissioning of use in the control room (CS#6)
- 2013 – Building pump information, Medical Center Feasibility Study
- 2014 – Load Forecasting Trial and Evaluation
- 2015 – Thin Clients and App Users
- 2016 – Expansion of the modeling system to include the new infrastructure i.e. Medical Center, Engineering Building, Plant CS#7, TES#2

Use of Real-Time Hydraulic and Temperature Modeling CWS Management and Operation



Dashboard

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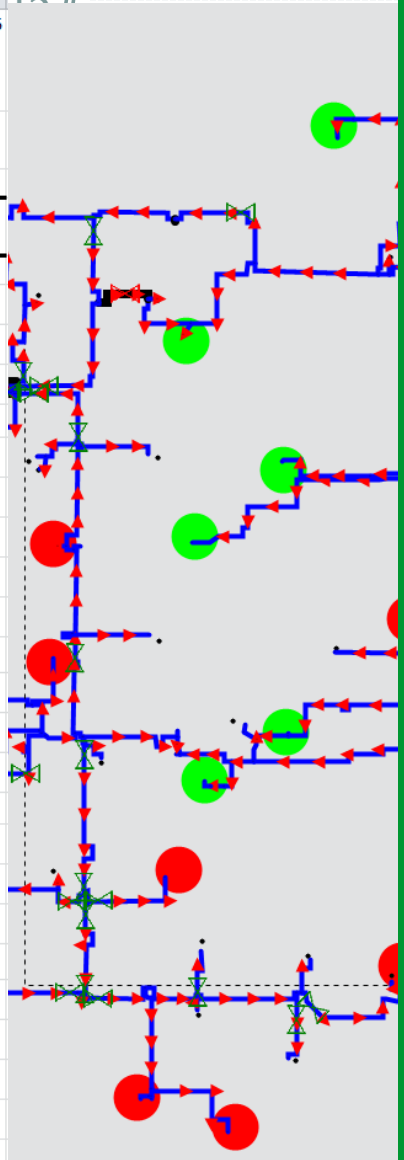
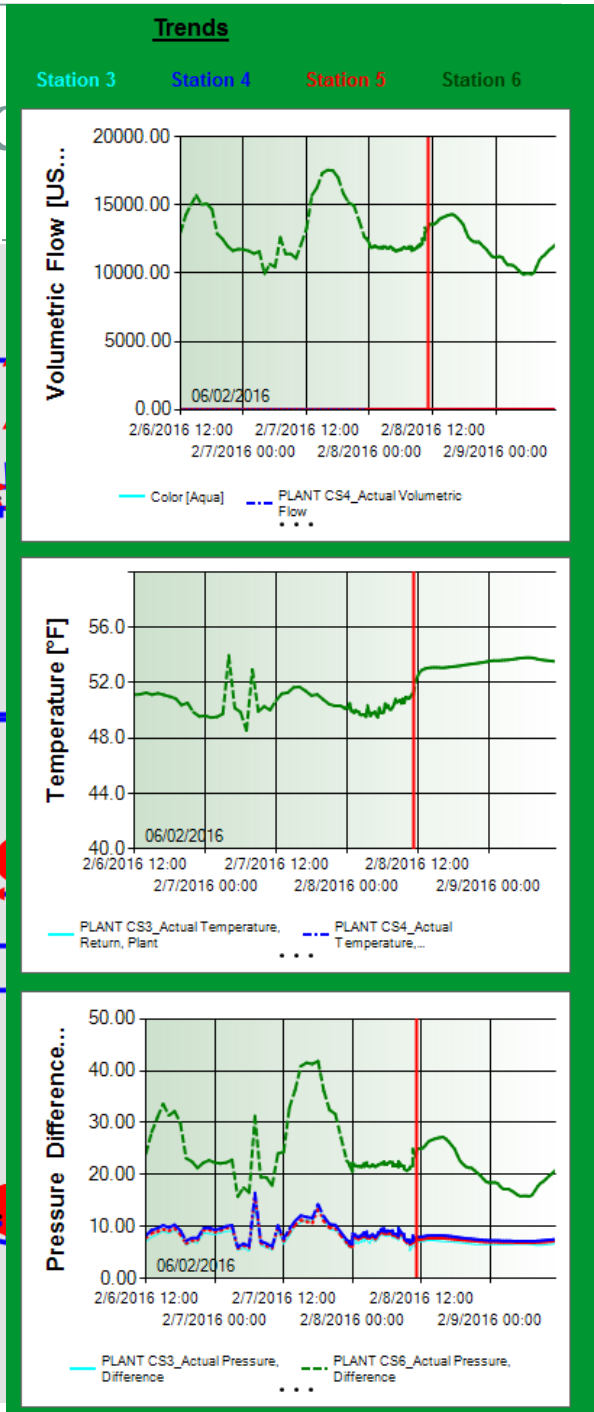
Termis

Total values for all Flow Control Zones

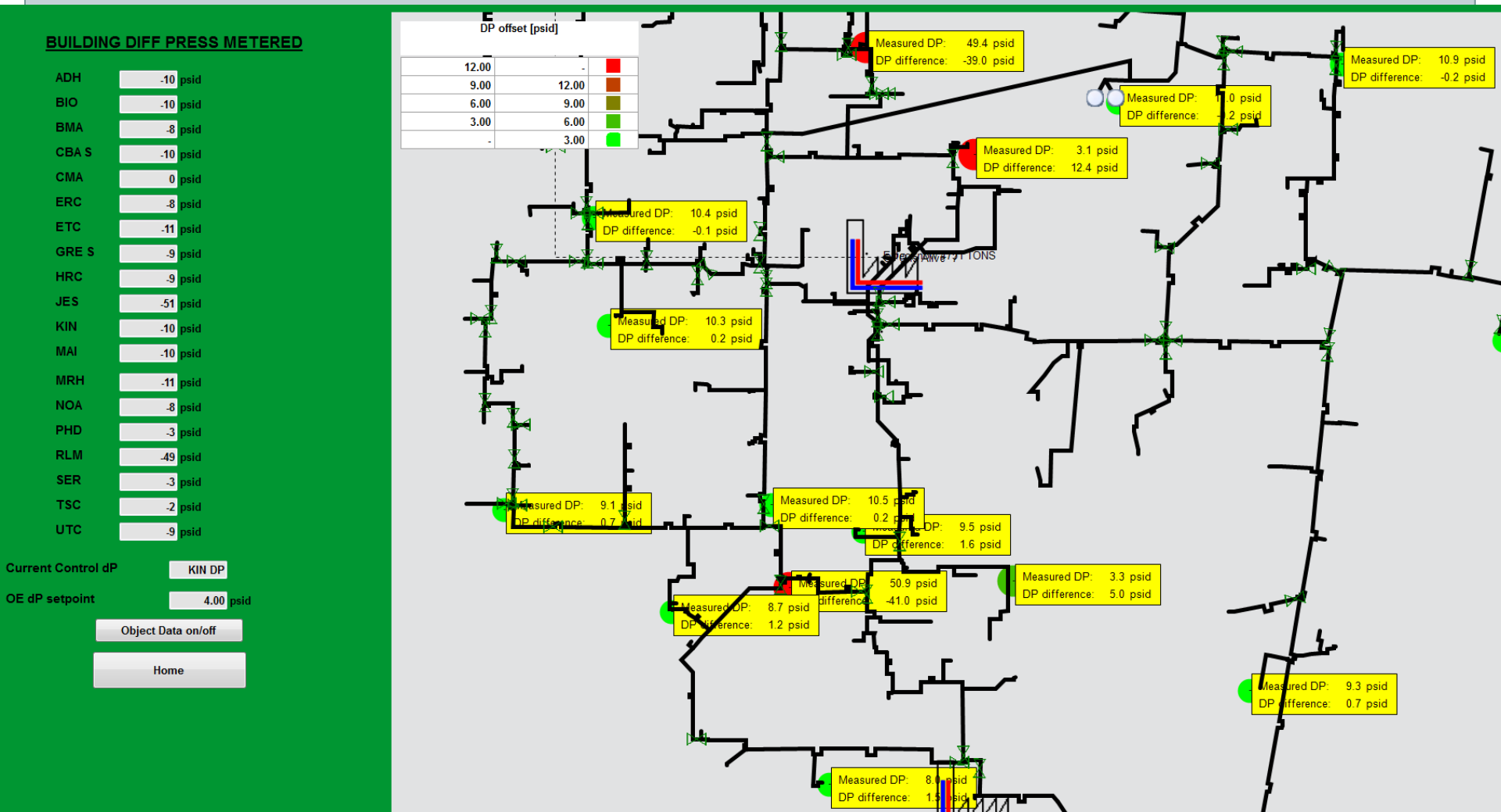
Description	Value	
Production	-5071.80	MBTU
Accumulators	0.00	MBTU
Consumption	0.00	MBTU
HeatLoss Disttribution Supply	-204.73	MBTU
HeatLoss Disttribution Return	-150.48	MBTU
HeatLoss Service Pipes Supply	0.00	MBTU
HeatLoss Service Pipes Return	0.00	MBTU
Total HeatLoss	-355.21	MBTU
Booster Pumps Energy	0.00	MBTU
Pump Energy at Plants	35.17	MBTU
Total Pump Energy	35.17	MBTU
Aggregated Demand Mass Flow	460313360.17	(GPM)
Aggregated Bypass Mass Flow	0.00	(GPM)
Total Aggregated Mass Flow	460313360.17	(GPM)
Costs Booster Pumps	0.00	$
Costs Pumps at Plants	0.00	$
Total Costs Pumps	0.00	$
Costs Plants	0.00	$
Costs Accumulators	0.00	$



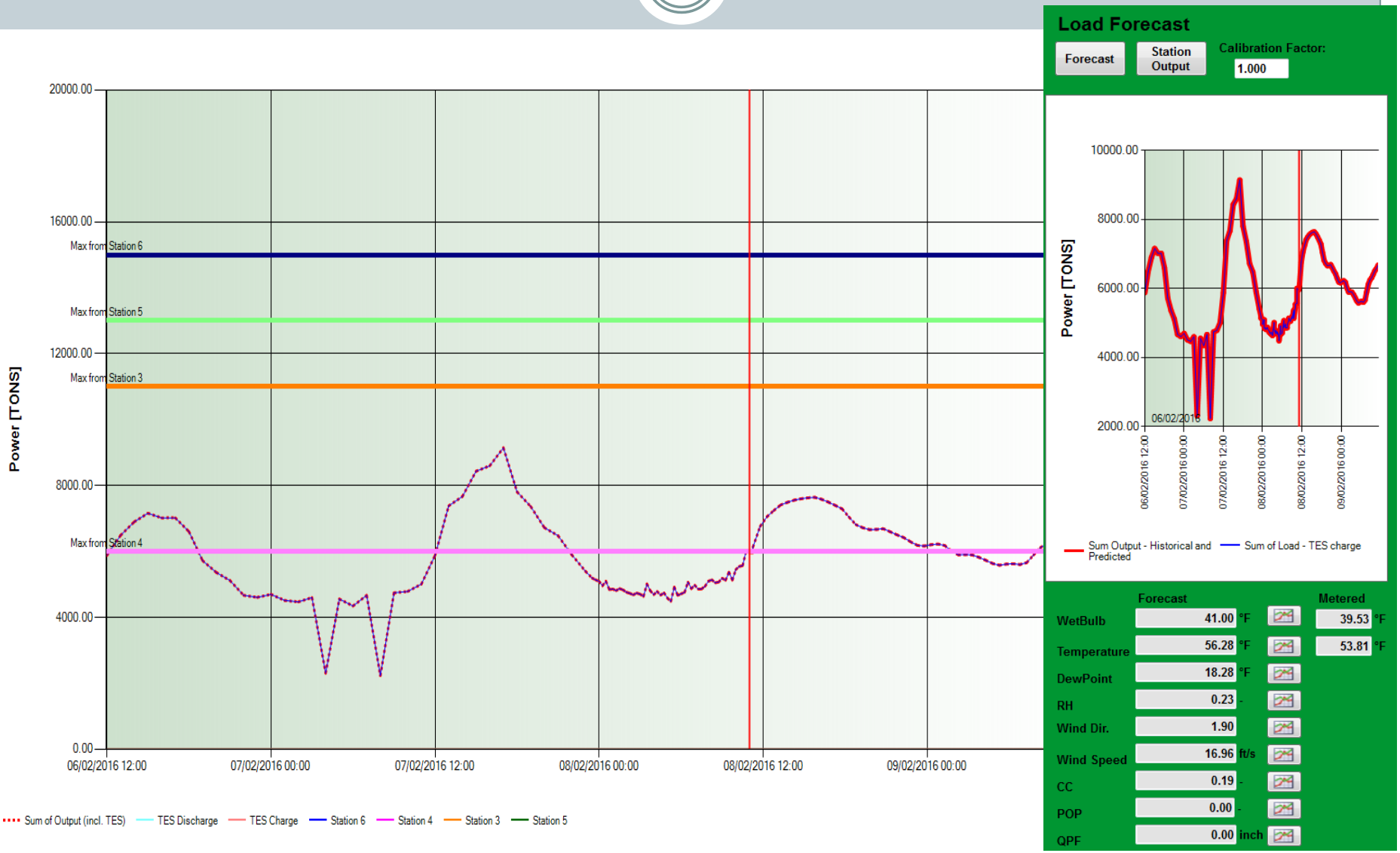


Metered vs calculated

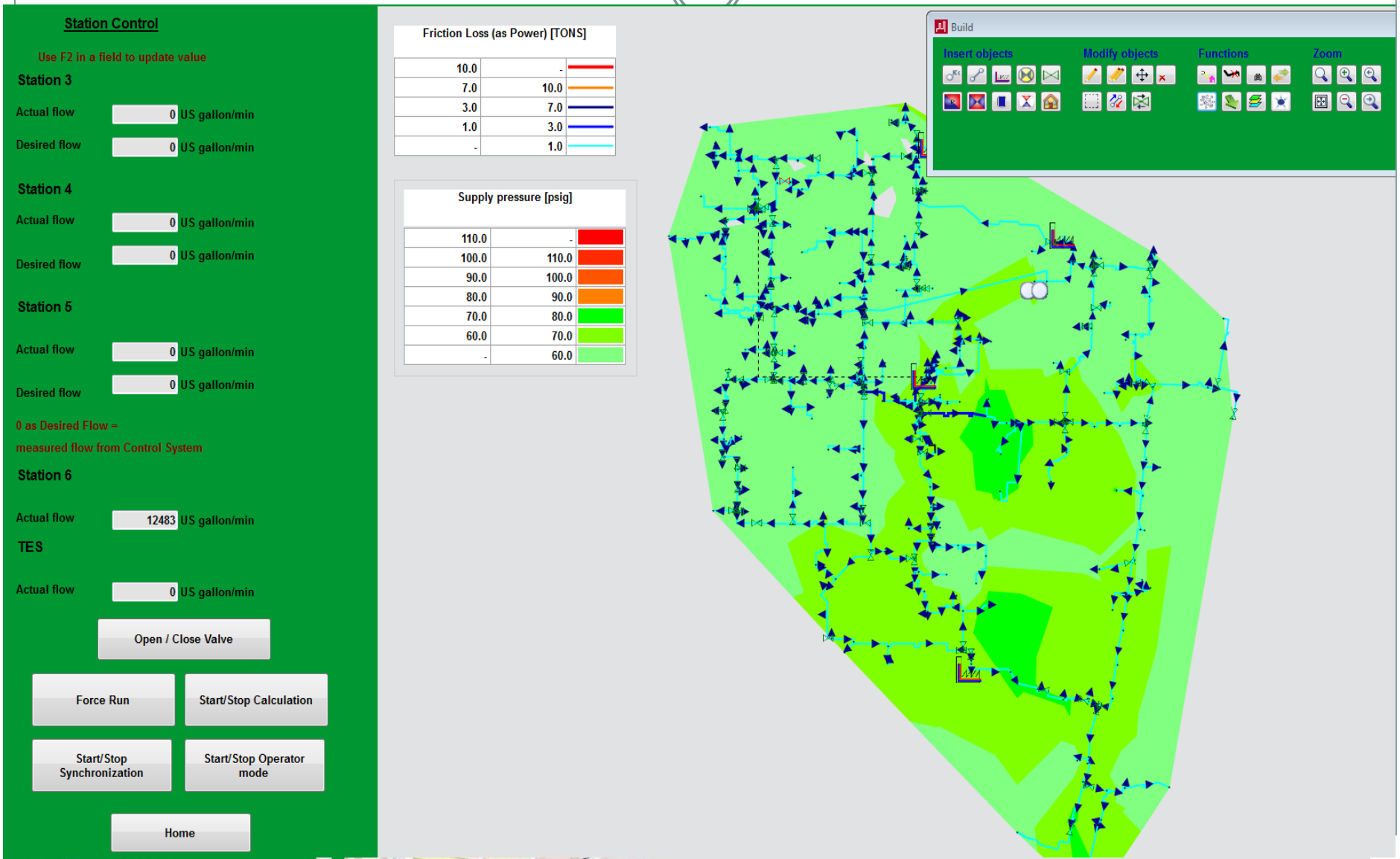
- **Meters has to be evaluated.**



Load Forecast for decision



Engineering tool



KPI's

Operational Data

Low DT vs Flow factor:

ID	DT vs flow rating
JCDW	324.8
FAC	251.3
ERC	212.1
PCL	198.3
WAG	193.7

Show

Lowest delta T (Actual):

ID	Temperature Difference [°F]
LDH	0.92
FAC THEATER	0.94
AND	1.29
JON	1.54
LLC	2.49

Show

Lowest delta T (last 24 hours):

ID	Min. delta T [°F]
PPE	-3.67
LDH	0.91
JON	0.91
BRB	0.91
FAC THEATER	0.91

Highest velocity (last 24 hours):

ID	Max. Velocity [ft/s]
K196-WAG	9.51
K234EXP 34A	8.25
K167SER AHU	7.93
K15SER DP	7.73
K78-JCDW	7.50

Show

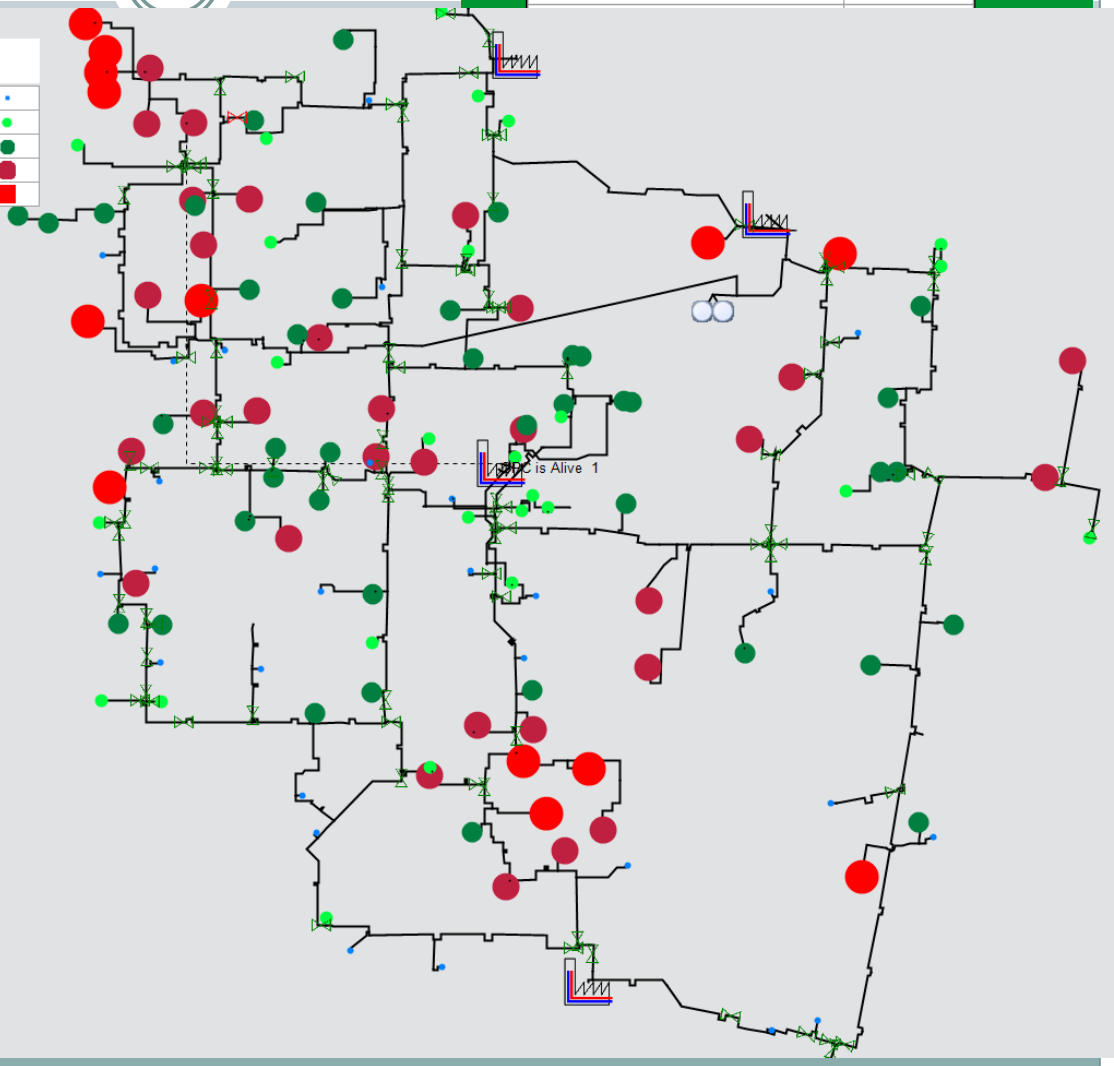
Friction Loss as Power:

ID	Friction Loss as Power [TONS]
K152-K56	3.35
30 BY 24 SPL	2.12

Low DT vs Flow factor:

ID	DT vs flow rating
TES - C	1186.0
JCDW	246.1
FAC	157.0
CPE	152.3

Temperature Difference [°F]		
20.00	-	
15.00	20.00	
10.00	15.00	
5.00	10.00	
-	5.00	



Results, Savings and Benefits (1)

- Real-Time Model located two (2) main loop valves that upon opening the valves, we were able to immediately shut down two (2) 250 HP pumps; saving in total 500 HP
- Identified building pumps "over pumping" and artificially raising the return pressure in a section of the loop, reducing the differential pressure between supply and return for other buildings in the area forcing those building pumps to also ”over pump. Easy control setting change solved it.
- Identified a building that had been flowing 200 gpm at a 9 degree delta T and due to a building control issue the delta T dropped to 1 degree and the flow rate jumped to 1,800 gpm. The problem was quickly and easily solved significantly reducing the building pumps’ HP
- Found that two new loop valves installed during the Chiller Station # 6 project had never been opened. Remedying this reduced pumping power at station 6 by approximately 100 HP.
- Identified instrumentation issues.
- Back-bone for the feasibility study and design of the Medical Center, College of Business, Engineering Building Complex new infrastructure

Results, Savings and Benefits (2)

- Is used with great success to plan loop outages such that a minimum number of customers are affected. Example: Modeling several different approaches to a recent loop shut down identified a chiller/valve combintation that completely mitigated all of the issues that had arisen during a previous outage for the same section of line!

- As an aside, TERMIS technical support is very effective and their support is excellent. As identified needs, and "nice to haves" REO/SE has been very responsive in adding new features and solving problems as they arise.

- Total pumping energy savings thus far is estimated at approximately 1,100 HP increasing delta T by having the model calculate the critical dT points .

- Providing the decision making information to move towards a "zero dP" optimization and operation strategy.

- **Contributed to $1,000,000+ in annual savings giving TERMIS a simple payback of less than 6 months**

Next steps

- 2016 – Expansion of the modeling system to include the new infrastructure i.e. Medical Center, Engineering Building, Plant CS#7, TES#2
- 2016 – What-If scenarios for preparation of operation of the expanded infrastructure
- 2016 – Roll-out of UT Austin Staff User Access
- 2016 – Commissioning of the Load Forecaster
- 2016 – Pressure optimization study including the building pumps and trial of dynamic set-point for P and T
- 2016 – Expansion of the modeling system to serve the Building Energy Management Portal with real-time distribution system information

Questions?

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Thank you!

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