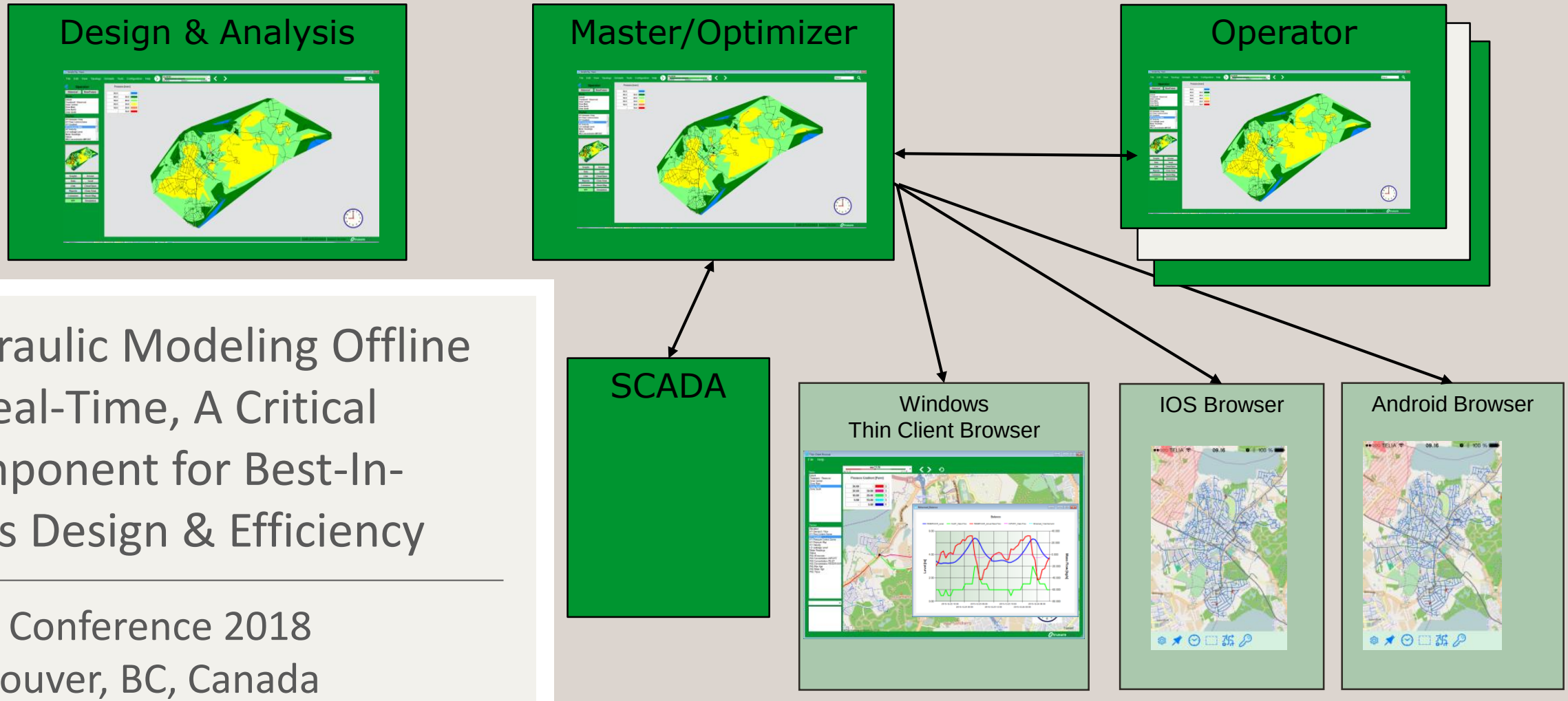


Hydraulic Modeling Offline & Real-Time, A Critical Component for Best-In-Class Design & Efficiency

IDEA Conference 2018
Vancouver, BC, Canada

THOMAS LUND-HANSEN, RELIABILITY EFFICIENCY & OPTIMIZATION

Presenter

- Thomas Lund-Hansen
- President and Founder, Reliability Efficiency & Optimization, www.relopteff.com
- 32+ Years – REO, 7T, B&K Vibro, Siemens, BSG
- Deployed Termis Real-Time hydraulic software solutions in the USA and Canada since 2006
- More than 100 onsite working engagements in the USA and Canada
- Business Planning, Master Planning, Feasibility Studies,….

Termis - the engine of hydraulic software modeling

Static, and dynamic measurements and modeling

Elimination of the ”black hole syndrome”

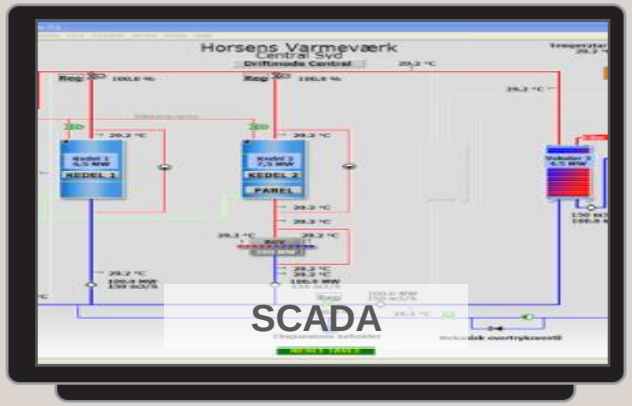
Scalable solution starting simple and adding facilities:

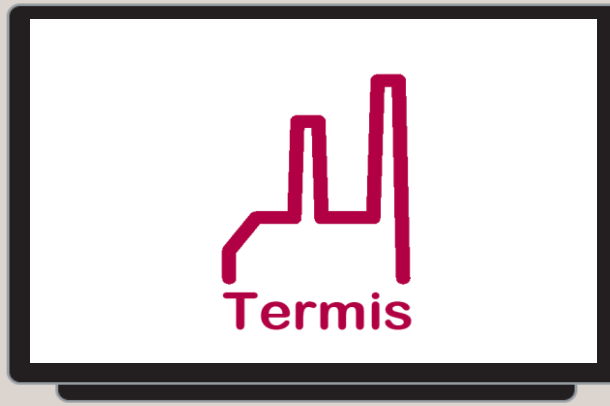
1 Design (offline)

2 Real Time

3 Control Room Operation

4 Optimizers





District energy plant 20 %

Distribution network 80 %

Investment

Steam to Hot Water conversion

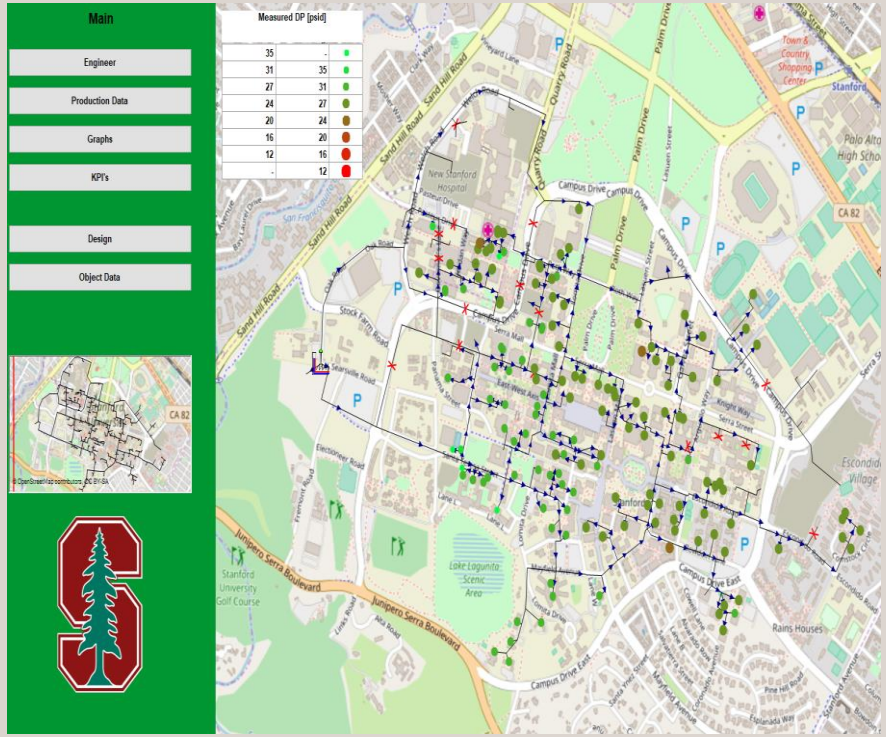
Case: Stanford University

Stanford University (and University of British Columbia)

Steam to Water conversion and Efficiency & Optimization (E&O)

- Hydraulic Modeling for design new hot water system (Offline data)
  - Overview and getting the grib of all relevant data
  - Applying loads from existing Building System
  - Design network, plants and operation

- Improving operational conditions by real-time modeling
  - Real capacity and capability versus design
  - Improving / maintaining dT at a high level
  - Dispatch strategy to ensure low dP to minimize pumping
  - Management of piping losses
  - Identify system bottlenecks
  - Measurements; accuracy watch-dog and location
  - Managing campus building expansions
  - Managing valves and by-passes
  - Visual overview



Energy Managemet and Master Planning

Case: UT Austin

UT Austin Energy Systems

- 100% power, heating and cooling requirements for 20 million sf and 150+ buildings – USD $50 Million Annual
- **Combined Heat and Power Plant and Steam**
  - 135 MW of on-site Combined Heat and Power (62 MW Peak)
  - 1.2 million lb/hr of steam generation (300K Peak/88 MW)
- **Chilled Water**
  - 45,000 tons (157 MWt) capacity in 4 plants, 33,000 tons (116 MW) peak
  - 4 Million Gallon/36,000 ton-hrs TES Tank
  - + 15,000 tons (53 MW) came online June 2016
  - + 5.5 Million Gallon/49,500 ton-hrs TES2 tank came online June 2016
- **Hot Water** – 5 MW

The University of Texas, Austin (UT Austin)

Big 10 University – Hydraulic modeling E&O since 2007

Savings USD $1,000,000+

Goals:

- Keep the energy consumption as low as possible
- Improve contingency planning
- Optimize expansion and maintenance
- Ensure operational continuity and high level of reliability

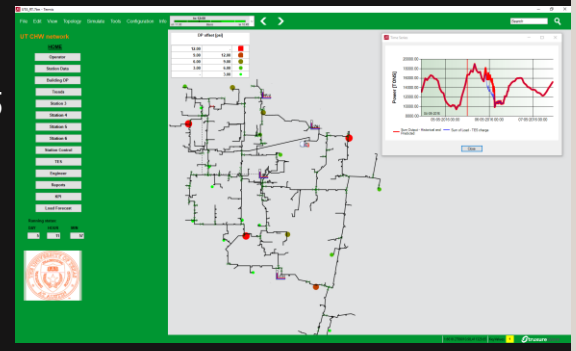
Solution:

- Termis Real-time application for prioritizing production
- Cutting the pumping overhead – Zero dP strategy
- Optimizing system pressures, flow and temperatures
- Knowledge of impact of operational actions beforehand
- Decreased man-hours for operation

”We chose the Termis solution as our backbone optimization and efficiency software tool not only for hydraulic modeling, but also for identification and quantification of strategies for increasing efficiencies and reducing operating costs as well as cutting emission. We use Termis to provide decision-ready information that allows all UTA utility staff to make the best possible decisions. Not only for master planning and engineering design, but also for the system implementation, commissioning, operation, maintenance, overhauls, retrofits and expansions. In addition, Termis provides good reporting to management and external authorities.”

Juan M. Ontiveros, Vice President of Utilities and Energy Management at University of Texas at Austin

- More than 200 MW cooling and 75 MW heating capacity
- No. of campus Buildings: 160
- No. of CHW plants and chillers: 5/15
- 2 thermal storage tanks
- Piping: 2x20 km / 2x12 miles
- Supply Temperature: 4°C / 39°F



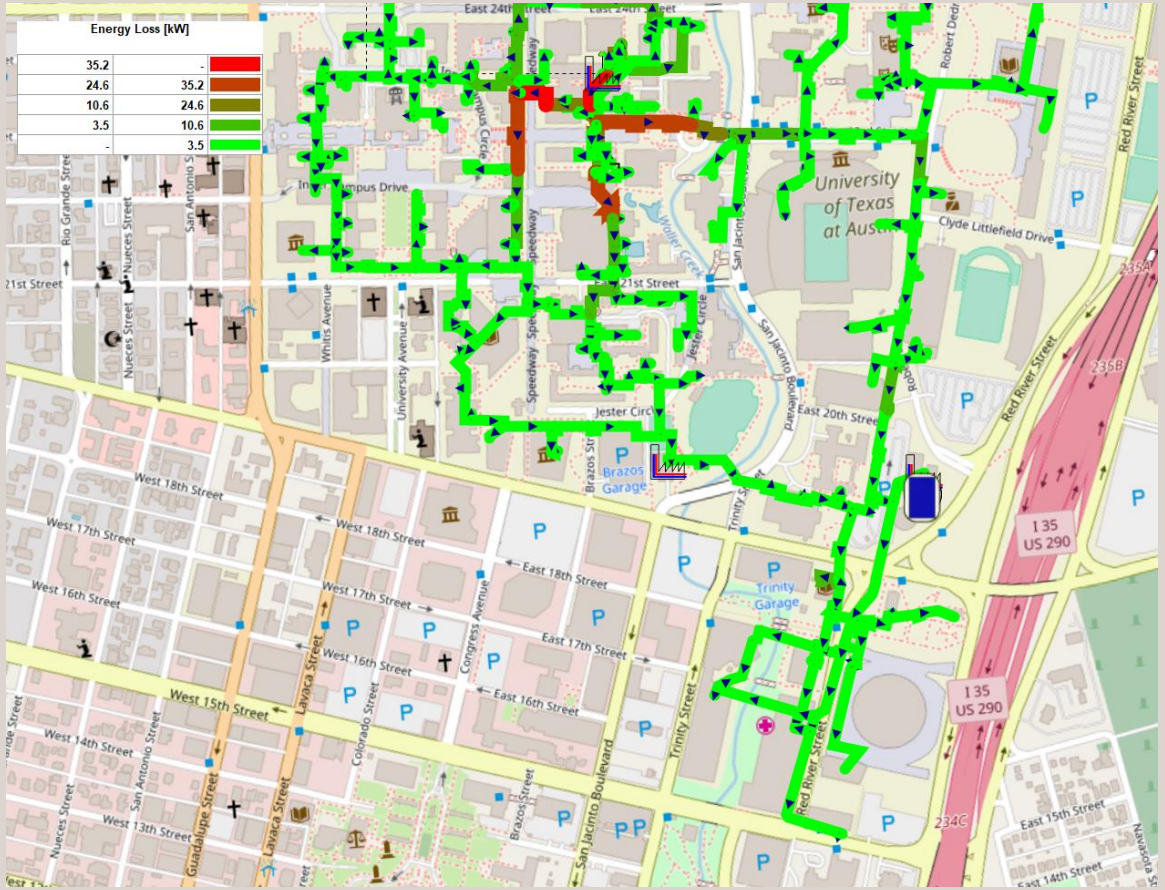
UT Austin – Innovative Master Planning

Utility Master Plan in 3 months record time for new research medical center and two major buildings – USD $2.7B, 3.2 million SF/320,000 m2

Over Arching E&O Objectives:

- Prevent existing combined heat and power plant expansion
- Prevent a conflict between Peak Steam and Peak Power
- Expand existing chilled water system loop by adding new chilling station
  - Capacity & efficiency enough to prevent negative impact to campus
  - Expandable to address subsequent phases of district
- Serving heating requirements using low temperature by converting steam to hot water

New Campus Master Plan



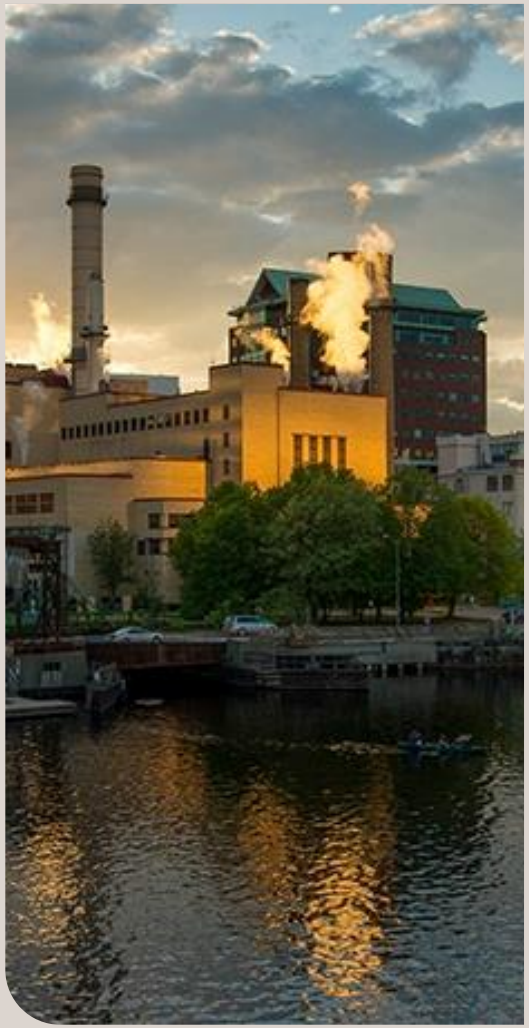
UT Austin Journey with Termis

- **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**

Veolia Energy - Hydraulic Modeling
Driving the Business Case

Boston & Cambridge Steam Distribution Systems

Managing an Intersection of Events



- Kendall Station Repowering in 2002
- Kendall Station Elimination of River Water Cooling
- Veolia expansion of cogeneration
- Veolia long term management of aging infrastructure

Boston & Cambridge Distribution Systems

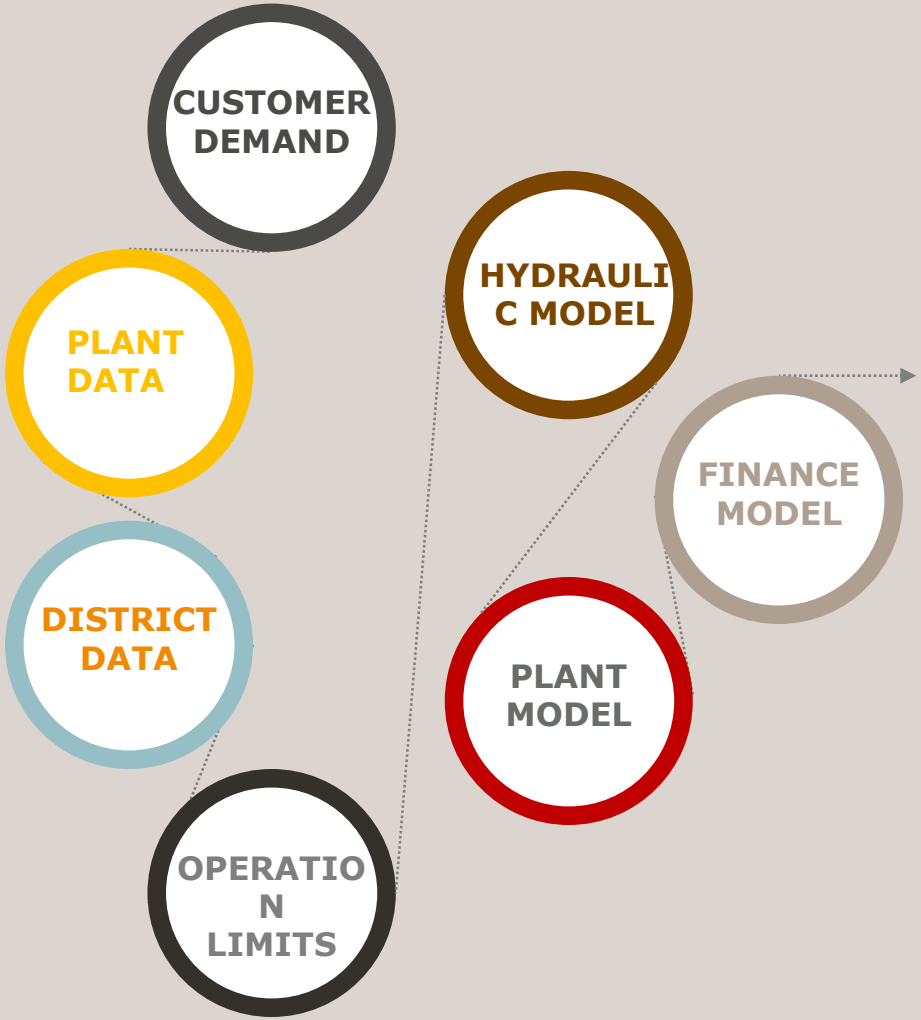
22	Miles of Piping
16	Boilers
2	Cogenerators
262	MWe
3,200,000	lb/hr Installed
1930-1949	Established

Kendall
1940's (2002 repower)
256 MW Combined Cycle
1 x Gas Turbine & HRSG
3 x Steam Turbines
2 District Boilers
3 Power Boilers
1,500 Mlb/hr capacity
Natural Gas

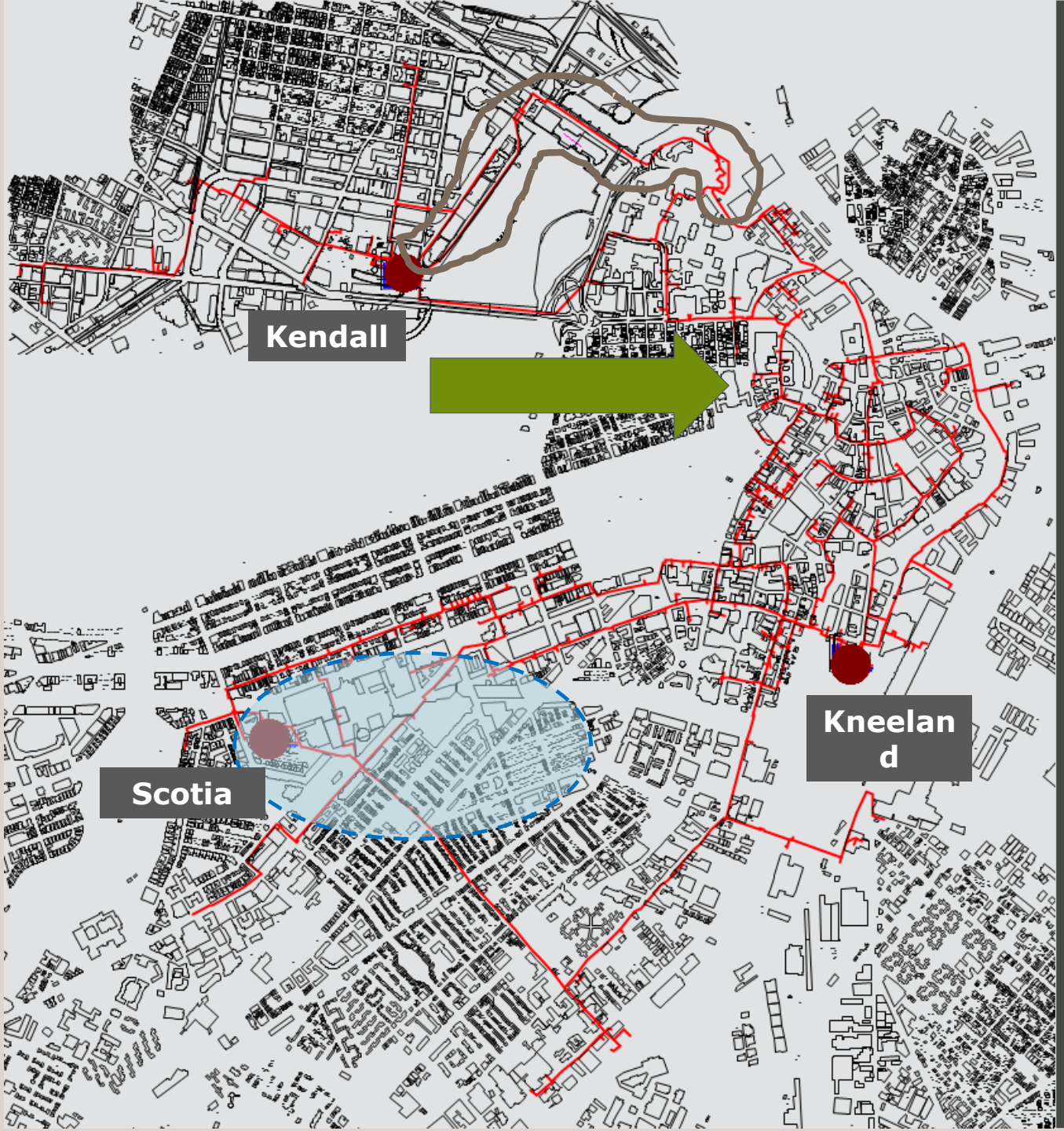
Kneeland
1930's
4 x District Boilers
1,300 Mlb/hr capacity
Natural Gas

Scotia
1960's
3 x District Boilers
360 Mlb/hr capacity
Oil

Energy management



- **Needed a hydraulic modeling tool to validate existing design decisions being discussed**
- **Needed insight into system-wide hydraulic relationships**
- **Needed insight into how plant efficiencies vary with different operating regimes**
- **Needed resulting fuel, power and dispatch information to flow easily into financial models for decision making.**
- **Needed to be flexible and easy to manipulate to deal with consistent "what if" scenarios**



Improved system cogeneration steam use from 30% to 65%

Reduced Boston GHG emissions by 475,000 tons annually.

6% reduction of non-transportation carbon emissions for both Boston and Cambridge

Reduced heat rejection to Charles River by 30%

Improved air quality by reducing NOx and SO2 emissions by 31% and 61% respectively

References

Partial listing of the Termis utility users in USA and Canada

- **University of Texas at Austin**
- **University of Virginia**
- **Princeton University**
- **Stanford University**
- **University of Maryland at College Park**
- **University of Chicago**
- **NRG Energy Center Minneapolis**
- **Veolia Energy Boston-Cambridge**
- **Veolia Energy Baltimore**
- **University of New Mexico**
- **University of British Columbia**
- **ENMAX**
- **Lonsdale Energy City of North Vancouve**
- **NASA Johnson Space Center**
- **PAE**
- **Merck West Point**
- **GDF Suez North America**

Questions?

Reliability Effeiciency & Optimization LLC
1440 Brickell Bay Drive, Suite #1003
Miami, FL 33131

T: (845) 270-3897

E energyoptimizationeffeciency@gmail.com

www.releffopt.com

Contact: Thomas Lund-Hansen