Greensleeves LLC
Control of
Ground Source Heat Pump Systems

GSHPA Technical Seminar 2018

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Greensleeves LLC
Overview Agenda
23rd May 2018

- What makes GSHP Different?
- "Simple" Full Load Systems
- Hybrid & Complex Systems
- How it Works
- Project Example
- Questions & Comments

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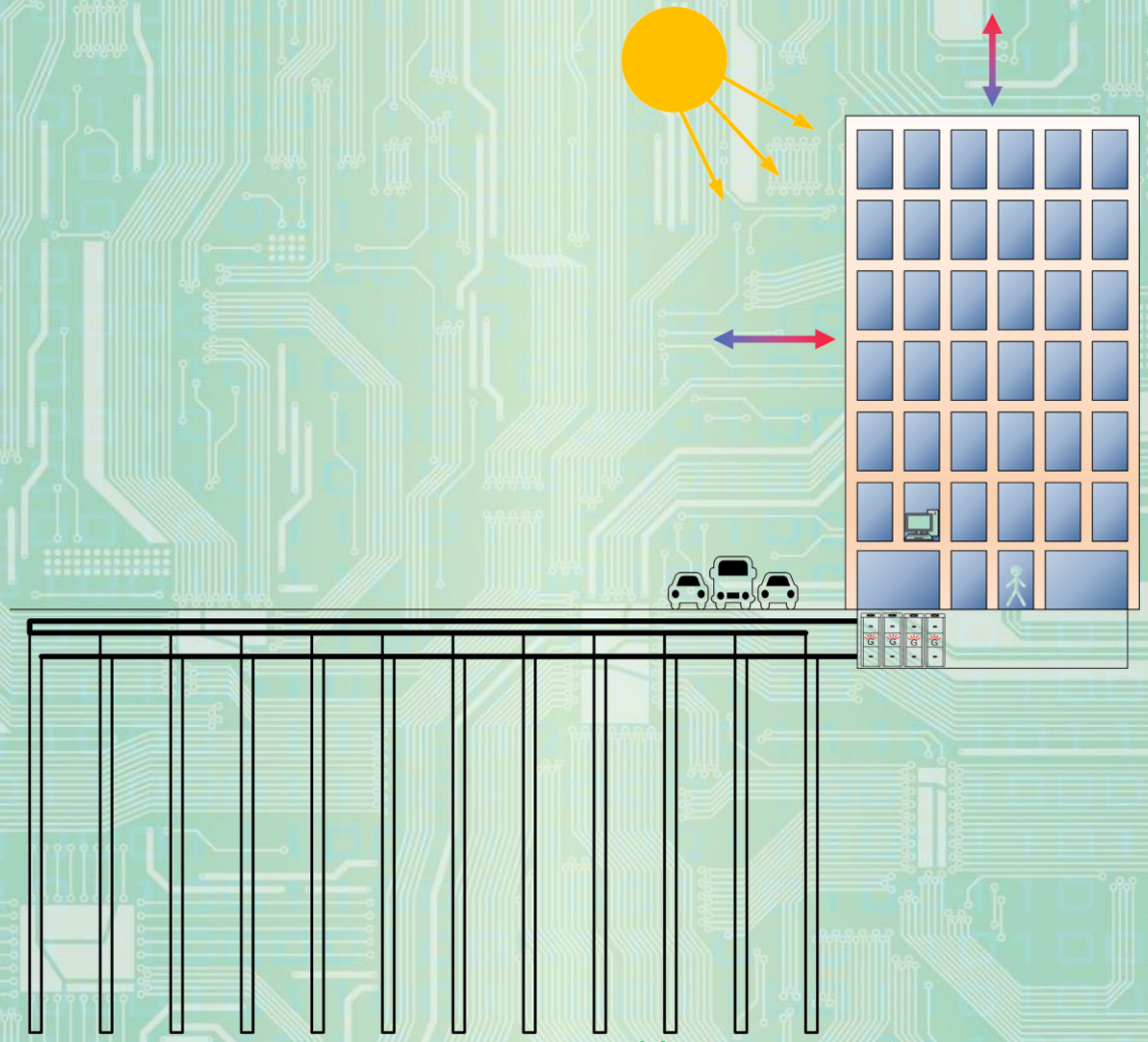
What makes GSHP Different?



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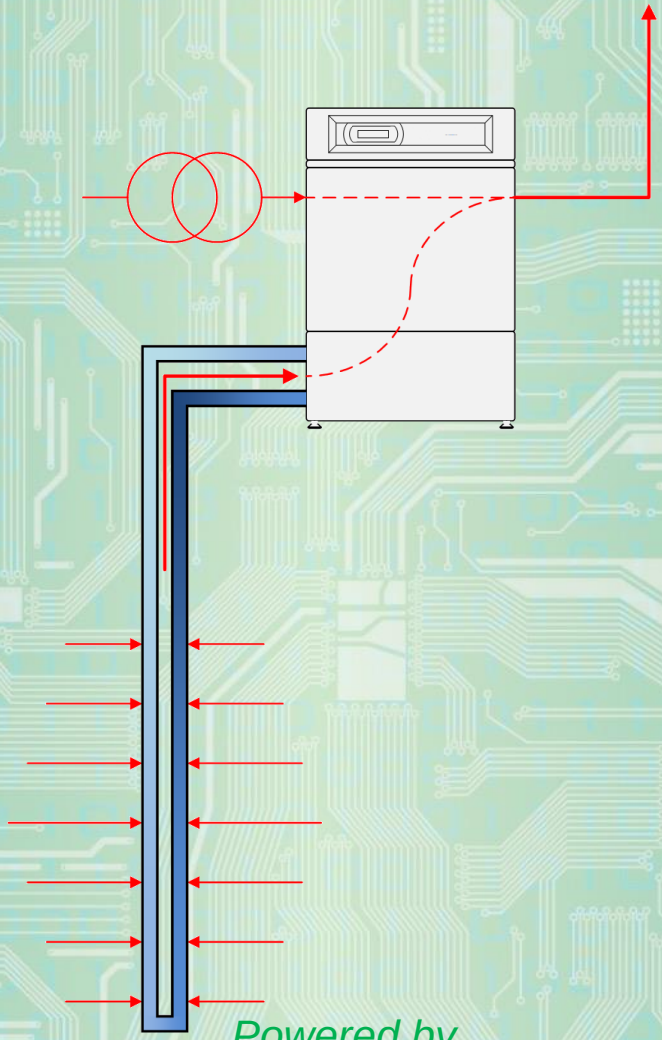
“Simple” Full Load Heating (or Cooling) Systems



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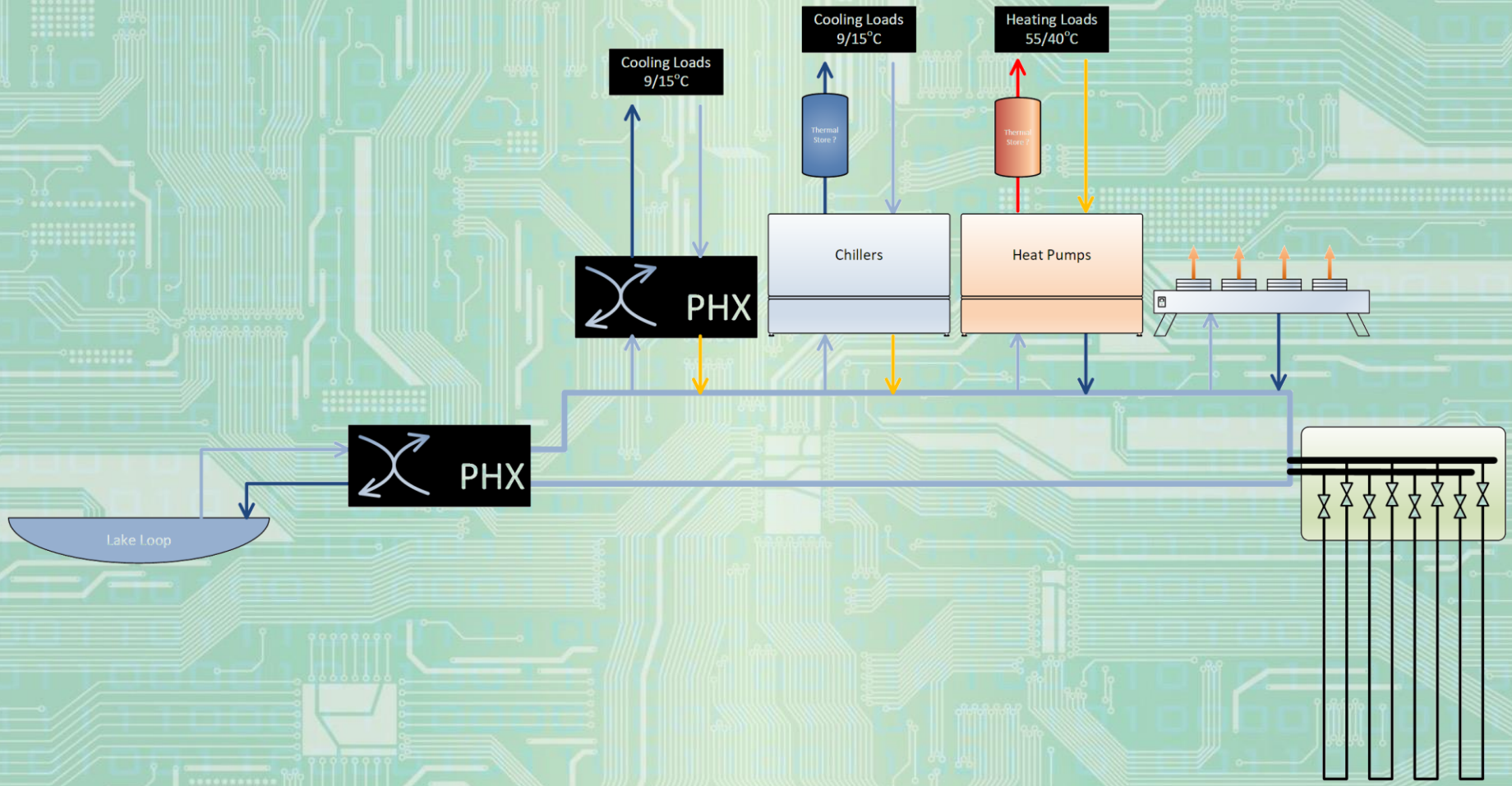
Hybrid & Complex Systems



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Example Project

- This is an actual project that has been installed and is currently operational – the name and location of the project is confidential at the request of the U.S. Government

- Conductivity was found to be 2.59 W/mK
- Ground temperature relatively warm at 20 °C
- Cumulative building loads were extremely cooling dominant
- Limited land available for the Ground Loop

Greensleeves Hardware

DS-1002P

4th Gen. Intel® Core™ i3 / i5 / i7 Superior Performance Fanless Computer
Integrate Q87 Chipset, 2x PCI / PCIe Expansion, 4x PoE and 2x LAN

EN50155 CE FC

Key Features

- Support 4th Gen. Intel® Core™ i3 / i5 / i7 Desktop Processor (LGA1150) and Intel® Q87 Chipset
- 2x DDR3 / DDR3L SO-DIMM Max. up to 16GB
- Three Independent Display from 1x DVI-I and 2x DisplayPort
- 6x Intel® GbE Port with 4x PoE Function, Support Wake-on-LAN and PXE
- 4x USB 3.0 and 4x USB 2.0
- 6x RS232/422/485 Port with 5V/12V Power
- 4x Isolated DI, 4x Isolated DO
- 2x 2.5" SATA SSD/HDD Bay, 2x mSATA (1x Shared by Mini-PCIe Socket), 1x CFast Card and 1x SIM Card Socket
- 9~48VDC Power Input, Support AT/ATX Mode
- 2x Mini-PCIe Slot for Wi-Fi, GSM, or I/O Expansion
- 2x PCI / 1x PCIe x1 and 1x PCIe x16 / 1x PCI and 1x PCIe x16 Expansion
- Power Ignition
- Compliant with EN50155 for Rail Transportation Applications

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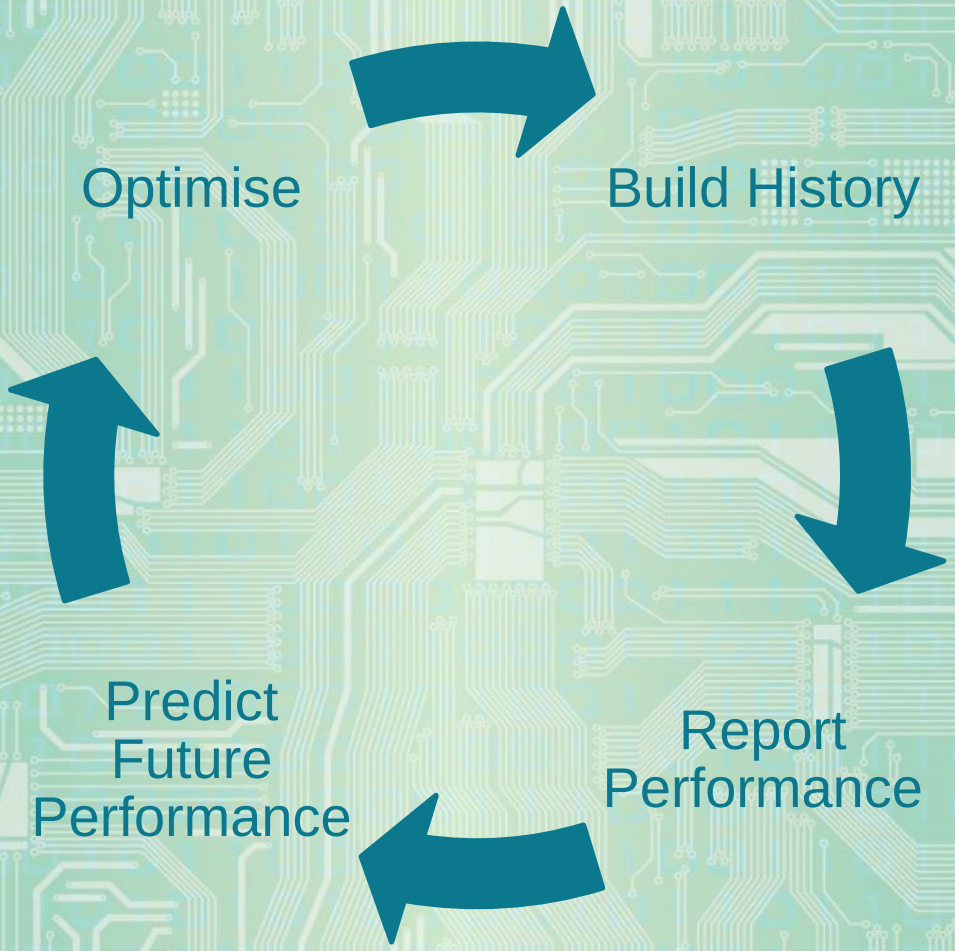
Data Input / Output & Points List

- Bespoke configuration for project
- Modbus TCP/IP
- BACnet IP
- Reads/writes based on user input

Outdoor air dry bulb temperature
Outdoor air wet bulb temperature
Building entering water temperature
Building leaving water temperature
Building water flow rate
Building fluid type
Building percentage by volume of second fluid
Building pump power
Ground Heat exchanger entering water temperature
Ground heat exchanger leaving water temperature
Ground heat exchanger water flowrate
Ground heat exchanger flow signal
Closed circuit cooling tower entering water temperature
Closed circuit cooling tower leaving water temperature
Closed Circuit cooling tower water flowrate
Closed circuit cooling tower power consumption
Closed circuit cooling tower pump power
Closed circuit cooling tower Set point

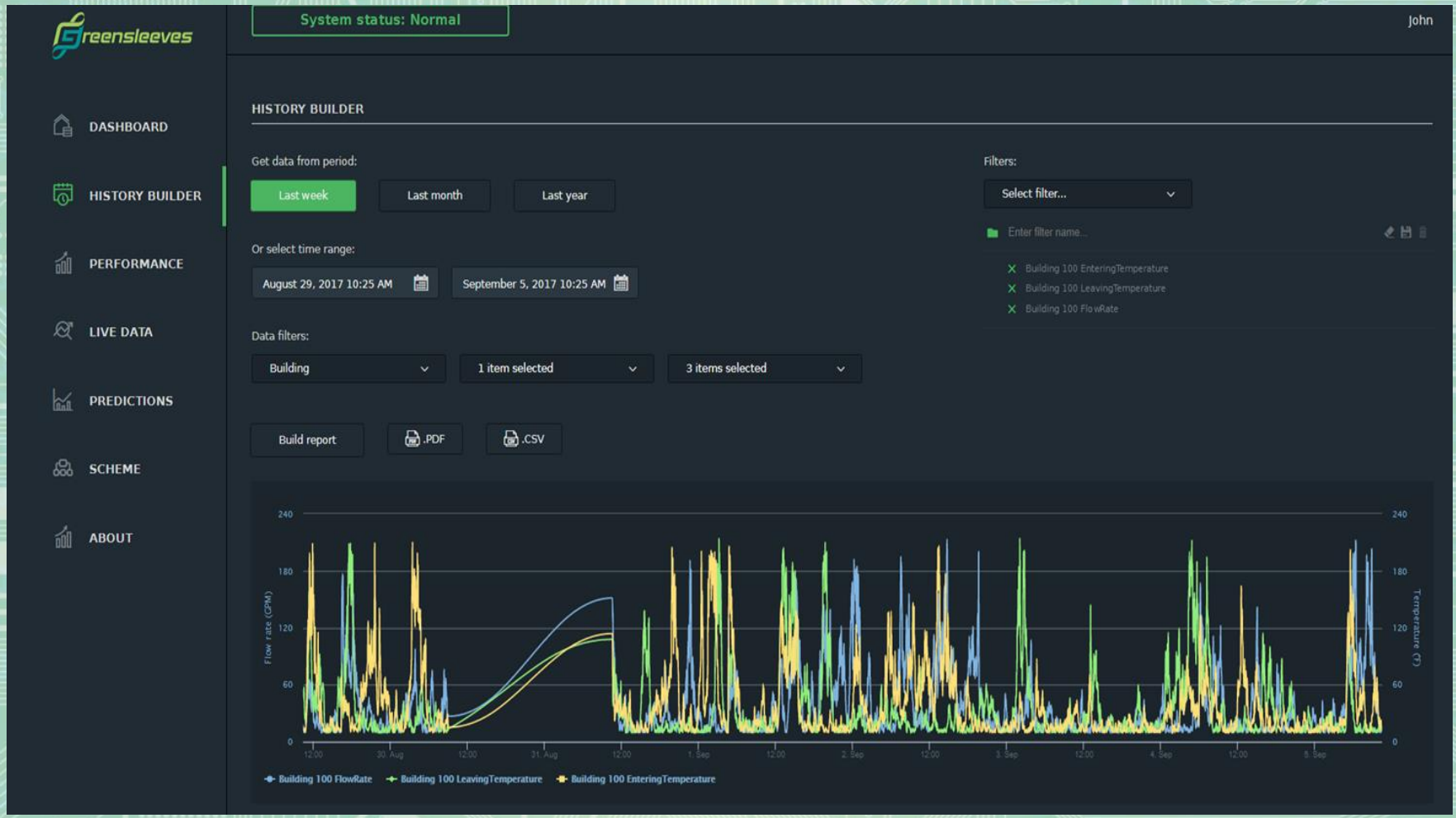
How it Works


Build History
Report Performance
Predict Future Performance
Optimise

History Builder & Reporting

- Understand how the Geothermal System is operating
- Generate custom reports for last week, month, or year
- Easily overlay data
- Export to .pdf or .csv file formats
- Easily view how your building load is performing compared with design data

History Report Builder



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Prediction View

- Updates on a weekly basis
- Gives future set points and flow conditions
- Estimates future ancillaries operation
- Predicts building load based on design and actual data

Predictive View

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Operational Optimization

Overview

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How do we optimize?

- Integrated system modeling
- Particle Swarm Optimization (PSO)
- Alter set points & thresholds to,
  - Maximize heat pump performance
  - Minimize pumping costs
  - Optimize ancillaries
  - Manage the future loop conditions

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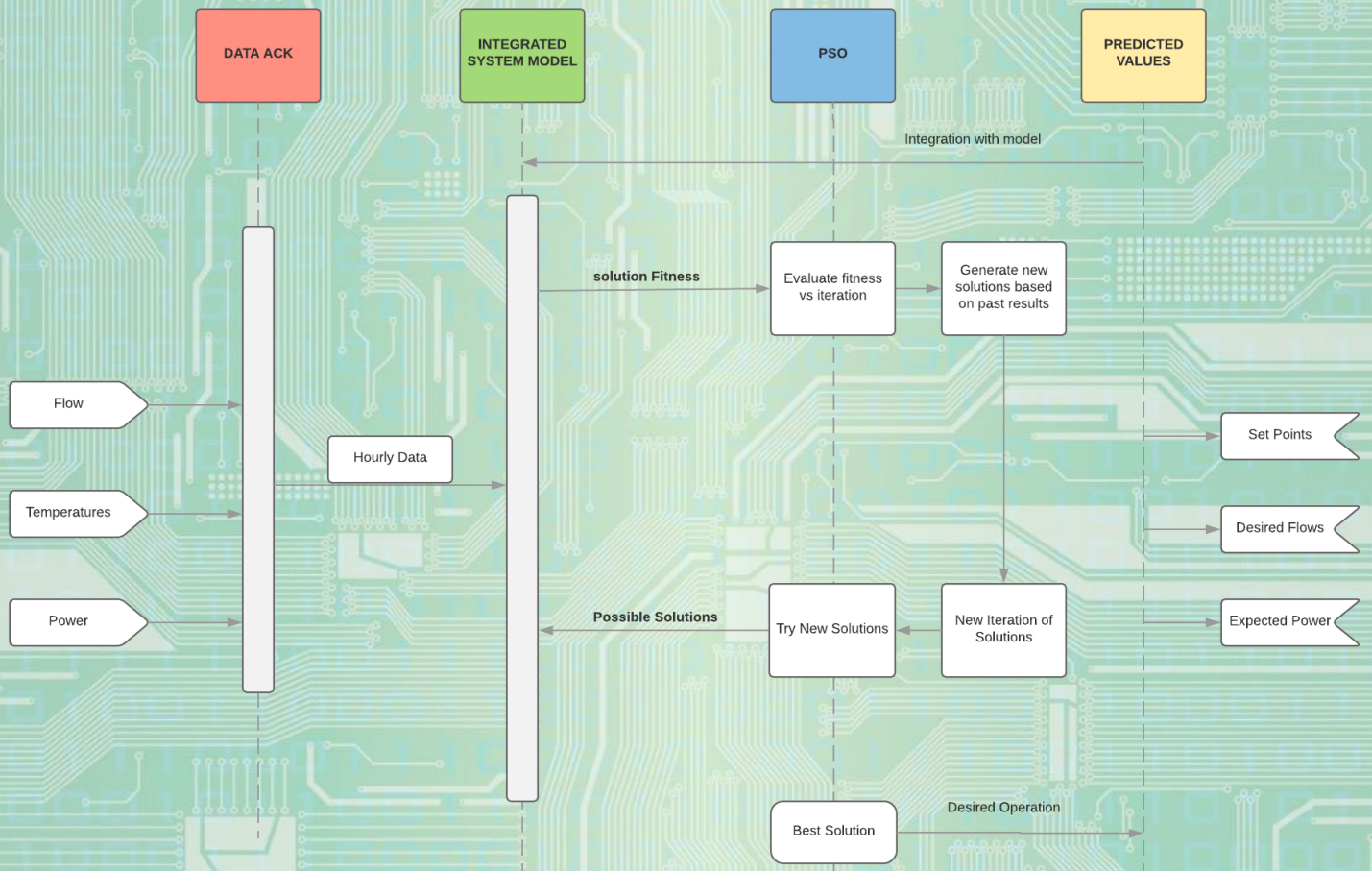
OPERATIONAL OPTIMIZATION



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What is the Integrated System Model?

- Mathematical model for physical system
- Each hydronic and power component is included
- Heat pump, ground heat exchanger, fluid cooler, boiler
- Used to estimate and predict temperatures, usage, and power consumption

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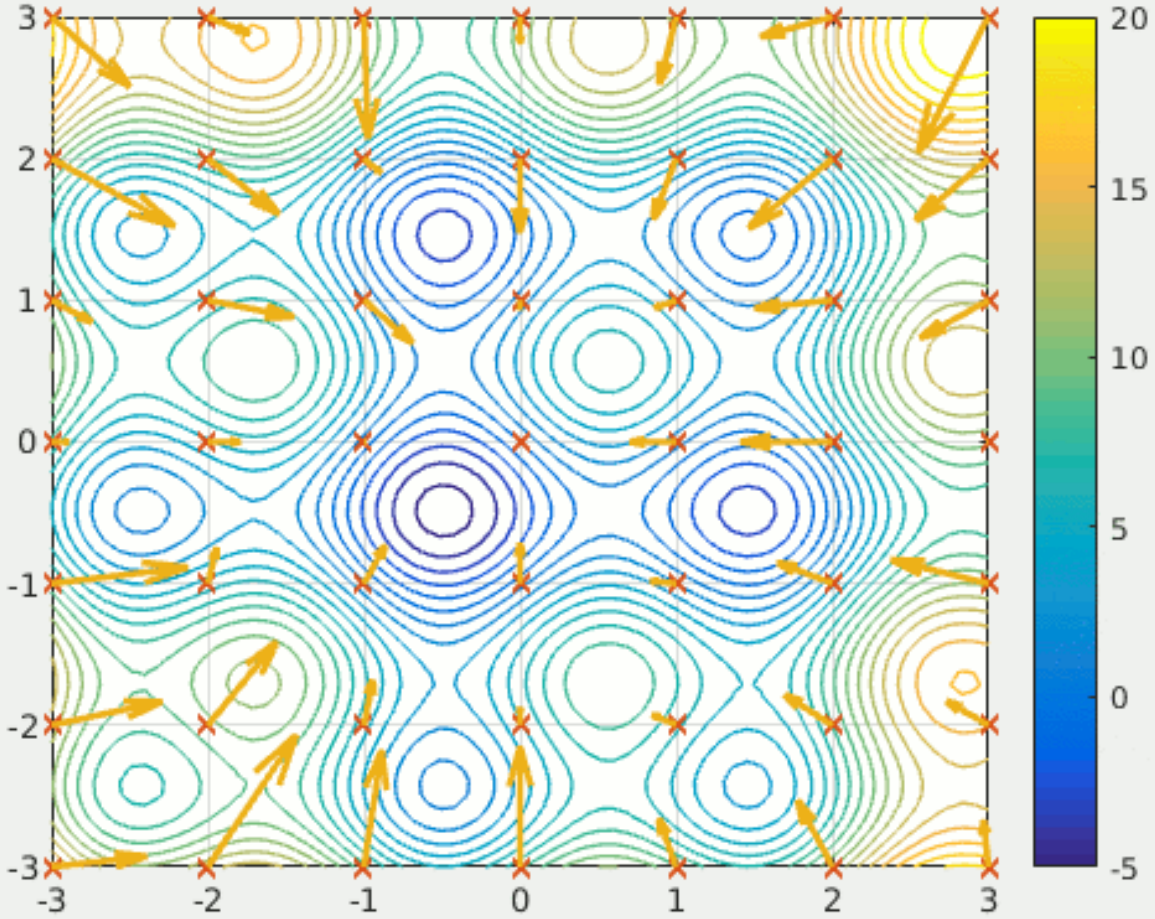
Particle Swarm Optimization (PSO)

- Methodology for finding a global maximum / minimum for problem
- Iterative
- Sets of randomly generated "swarms" get tested
- Each generation "moves" towards global solution

Particle Swarm Optimization (PSO)



What do we optimize?

- Integrates with System Model
- Change set points within controls algorithm
- Get updated on regular basis
- Learn from past values to inform model
- Cooling Tower/Fluid Cooler Energy
- Pump Energy
- Building fluid temperature – enable heat pumps to operate at most efficient point

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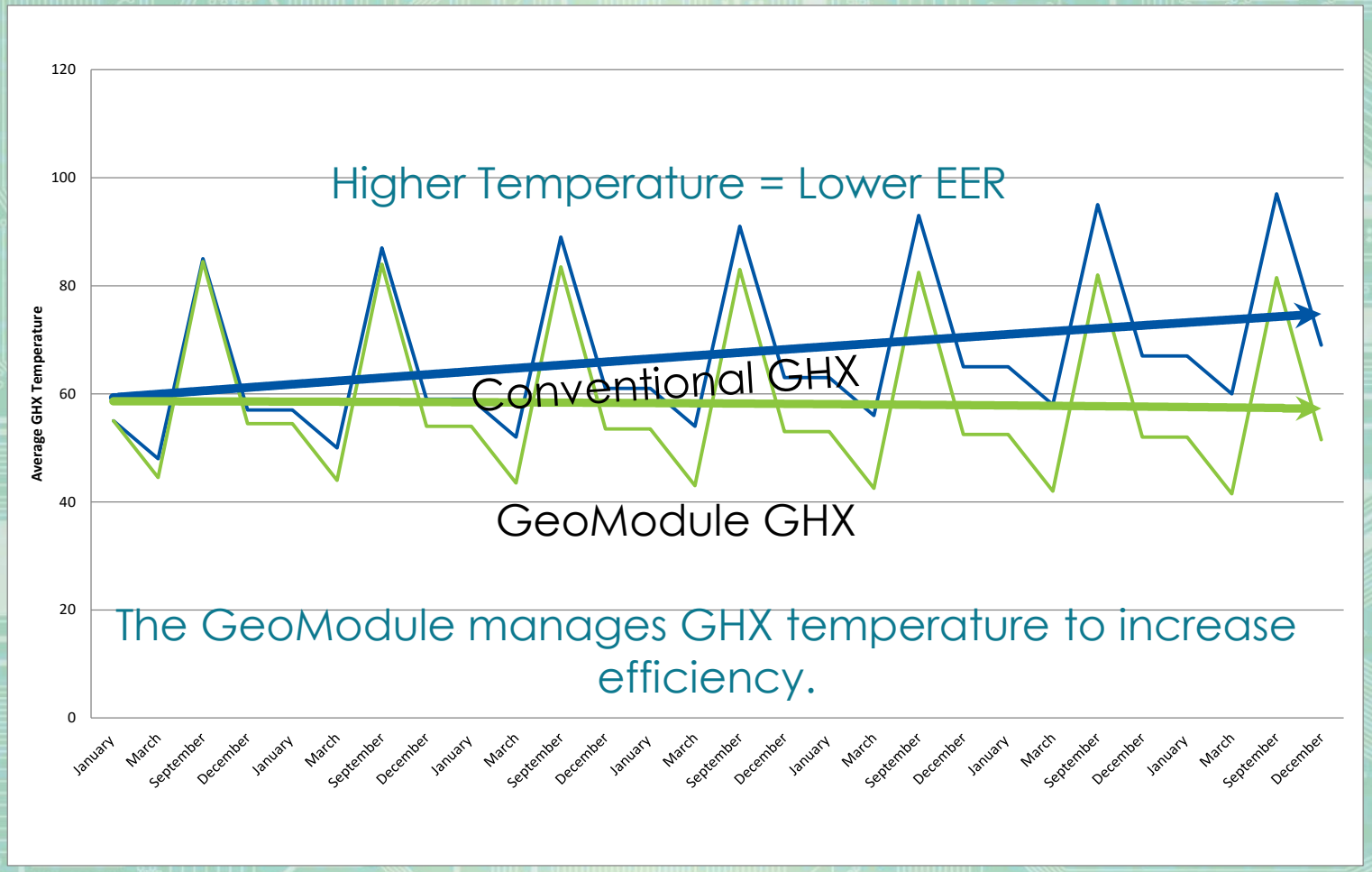
Example Project Outcome



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Questions and Comments?

Want to know more….?
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Who is Greensleeves and what do we do?

- Greensleeves is a software company focusing on Ground Source Heat Pump (GSHP) systems
- Our roots are in the design, control and construction of geothermal HVAC
- Greensleeves provides real world software solutions for new-build construction as well as optimization / "rescue" of failing or failed GSHP systems and system monitoring
- Strong team of software engineers that also have HVAC backgrounds
- More than 2 million SF installed or under contract – USA and Australia

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Greensleeve's Capabilities

- Help Design and Optimize New Ground Heat Exchanger (GHX)
- Borefield Rescue
- Help Retrofit Existing GHX for Size Optimization
- Building Monitoring
- Determine the status of Existing Borefields
- Borefield Capacity Monitoring and Prediction of Failure
- Full Control of GHX and its Systems

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Thank you!

The Greenleeves Team

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