



NY - GEO 2025
APRIL 23-24, 2025 | SARATOGA SPRINGS, NY



Thermal Energy Network Design Modeling Tools

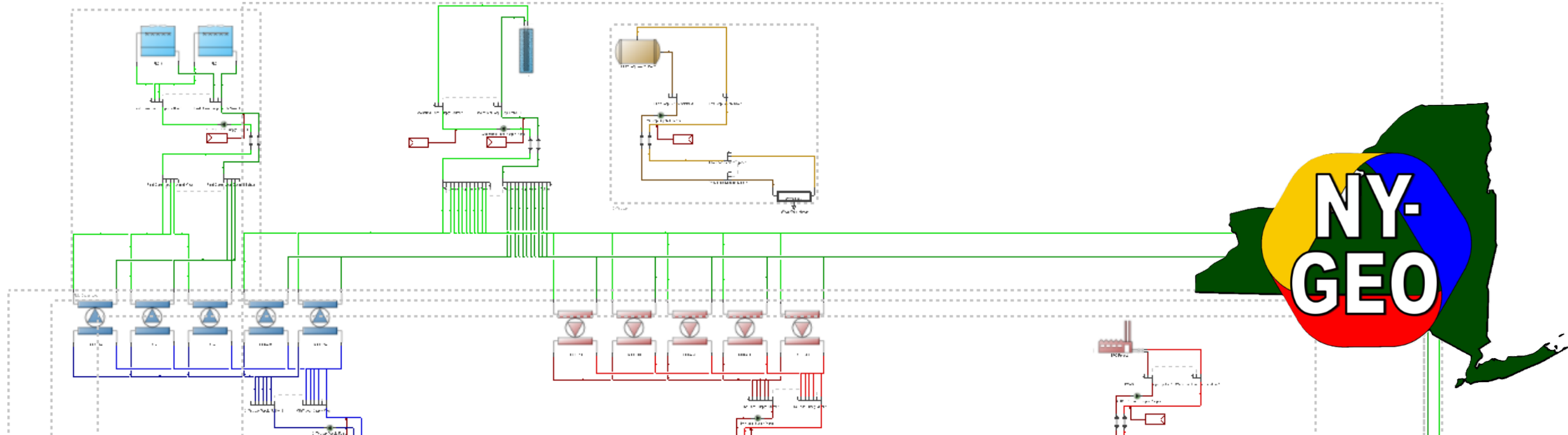
Moderator: *Aeowyn Kendall / Aztech Geothermal, LLC*

Panel: *Brendan Hall / CHA Solutions*

Jason Willeford / Jacobs

Victor Braciszewski / SmithGroup

Brian Urlaub / Salas O'Brien



Thermal Energy Network Modeling Tools

Brendan Hall, PE, BEMP

April 23, 2025



Obligatory Log Rolling Slide

- ASHRAE Building Energy Modeling Professional (BEMP)
- Designbuilder Webinars (2022)
 - Design and Modelling of Ground Source Heat Pump Systems
 - <https://www.youtube.com/watch?v=MsuNGGb26VQ>
 - Using Energy Modelling to Optimize GSHP System Design
 - https://www.youtube.com/watch?v=VEJ_3vdpk1I



Network Modeling Categories

Scoping / Feasibility Tools

- High level assessment of potential.
- Excel and GIS Based Tools

Building Level Modeling

- Whole Building Energy Modeling, Load Forecasting
- EnergyPlus , eQuest

Component Level

- Ground Heat Exchanger Design Tools
- GLD, GLHEPro

Urban Scale Modeling

- Object Oriented modeling
- Powerful, complex, flexible tools

Find the right hammer for the right nail.

Scoping Tools

Data Collection
Site Selection
Economic Potential
Urban Planning
Master Planning

Building Modeling

Site specific energy use

Reconciling existing buildings to utility usage.

Quantifying energy use, cost and savings

Component Level

Sizing of GHX

Evaluation of effect of options on sizing.

Energy Usage Estimate

Urban Scale

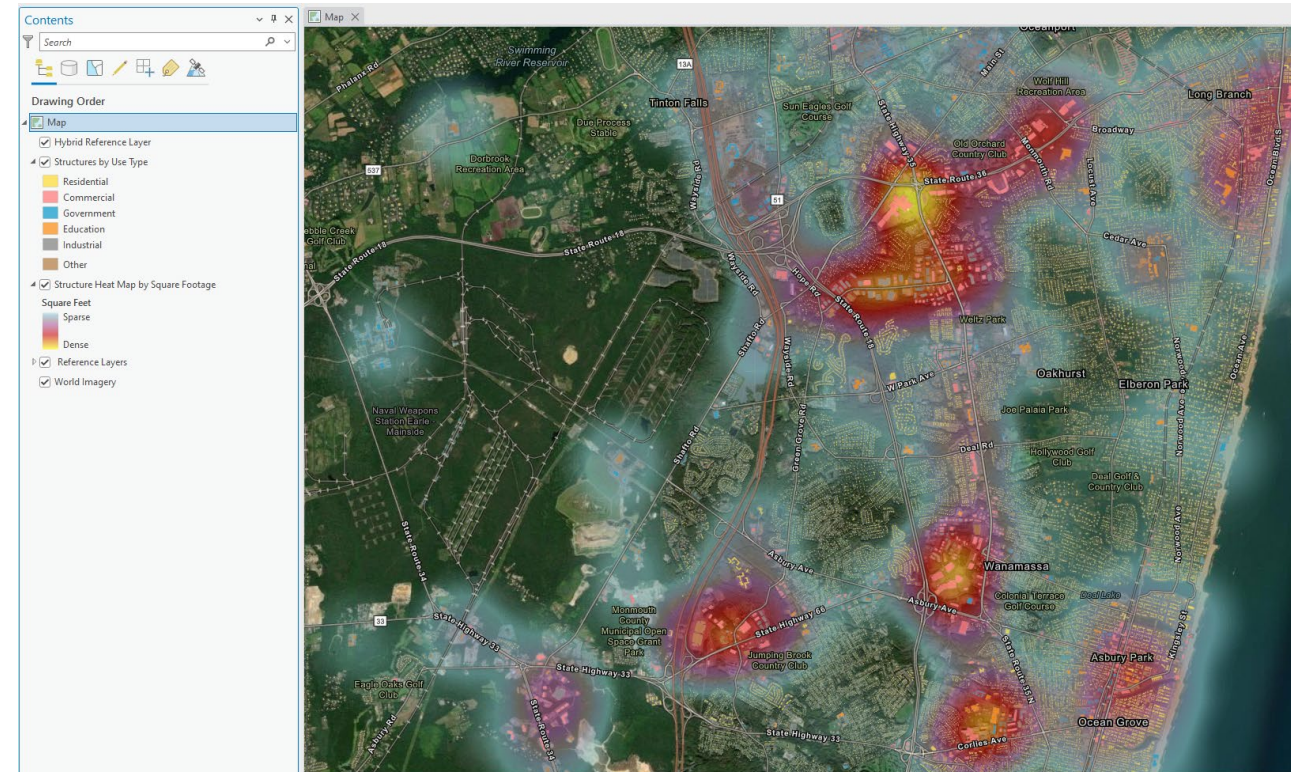
Multiple Building Dynamics

Pipe Network Dynamics

Energy Sharing

Scoping and Feasibility Tools

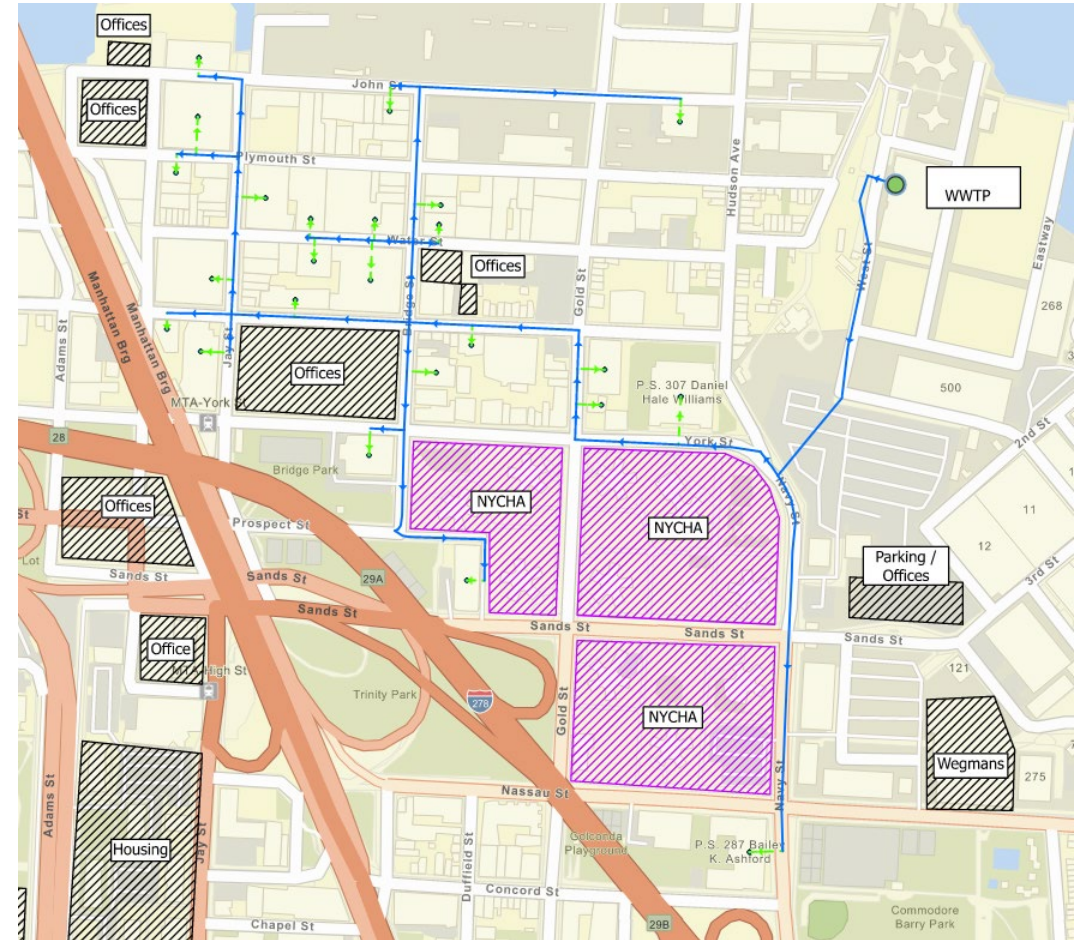
- Custom Spreadsheets
 - Load Estimation
 - Load Aggregation
 - Scoring Rubrics
 - Financial Models
- GIS Tools
 - Data mapping
 - Layering available data sets
- Purpose Built Commercial Software Tools



Sample ArcGIS Heat Map of Building Area

Commercial Tools

- Data Collection
- Data Visualization
- Cost Estimating
- Economic Analysis
- Examples:
 - nPro (Web-Based Tool)
 - Comsof Heat (ArcGIS Plug-In)
- Municipal Level District Heating systems are much more common in Europe so many of the tools are created toward that market.



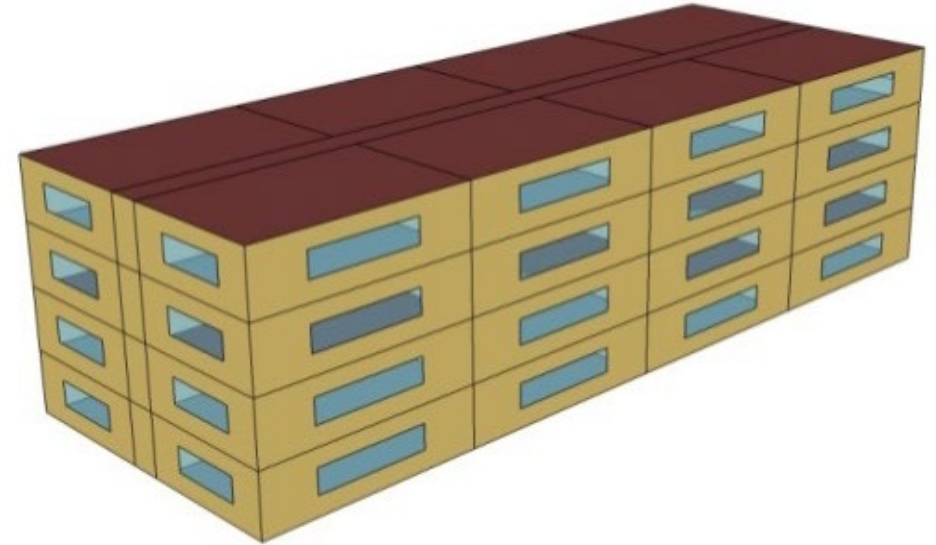
Sample System layout in Comsof Heat

Data Sources

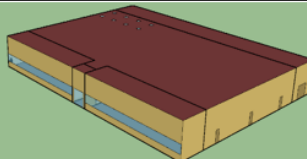
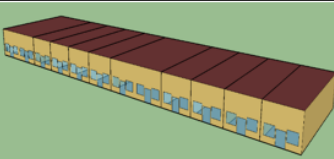
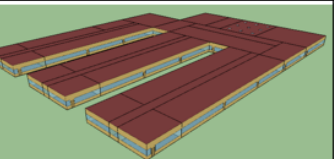
- Property Tax Records
 - Many municipalities have property tax records in GIS format.
 - Building area, usage, and age.
 - Formatting various, making universal sorting of data difficult.
- Economic Development Organizations
- Field Surveys
- Utility Bills
- DOE Reference Building Sets
- Energy Information Agency (EIA.gov)
- NIST Life Cycle Analysis Guidelines

DOE Prototype Building Set

- Developed by the U.S. Department of Energy (DOE) in collaboration with national laboratories and maintained by the Pacific Northwest National Laboratory (PNNL), to represent typical commercial building types in the U.S.
- Provide standardized building energy models for use in energy simulations, helping to assess new technologies and support the development of energy codes.
- Include 16 building types that cover approximately 70% of the commercial building stock in the U.S., across all climate zones
- Regularly updated to comply with newer versions of energy standards like ASHRAE Standard 90.1 and the International Energy Conservation Code (IECC)



Reference Building Scope

Stand-alone Retail	Strip Mall	Primary School
		
1	1	1
7.1%	10.5%	35.0%
Concrete Block Wall 8 in. CMU+Wall Insulation+0.5 in. gypsum board	Steel-framed Wall 1 in. Stucco + 0.625 in. gypsum board + wall insulation + 0.625 in. gypsum board	Steel-framed Walls (2x4, 16" OC) 0.75" stucco + 0.625" gypsum board + cavity insulation + 0.625" gypsum board
Nonresidential	Nonresidential	Nonresidential
Built-up roof: Roof membrane+roof insulation+metal decking	Built-up Roof: Roof membrane+Roof insulation+metal decking	Built-up roof Roof membrane + roof insulation + metal decking
Nonresidential	Nonresidential	Nonresidential

All Parameters are defined in a spreadsheet for review and simulation files are available as *.eps files (Energy Plus Format)

<https://www.energycodes.gov/prototype-building-models#Commercial>

Building Types

- 1.Large Office
- 2.Medium Office
- 3.Small Office
- 4.Warehouse
- 5.Stand-alone Retail
- 6.Strip Mall
- 7.Primary School
- 8.Secondary School
- 9.Supermarket
- 10.Quick Service Restaurant
- 11.Full Service Restaurant
- 12.Hospital
- 13.Outpatient Health Care
- 14.Small Hotel
- 15.Large Hotel
- 16.Midrise Apartment

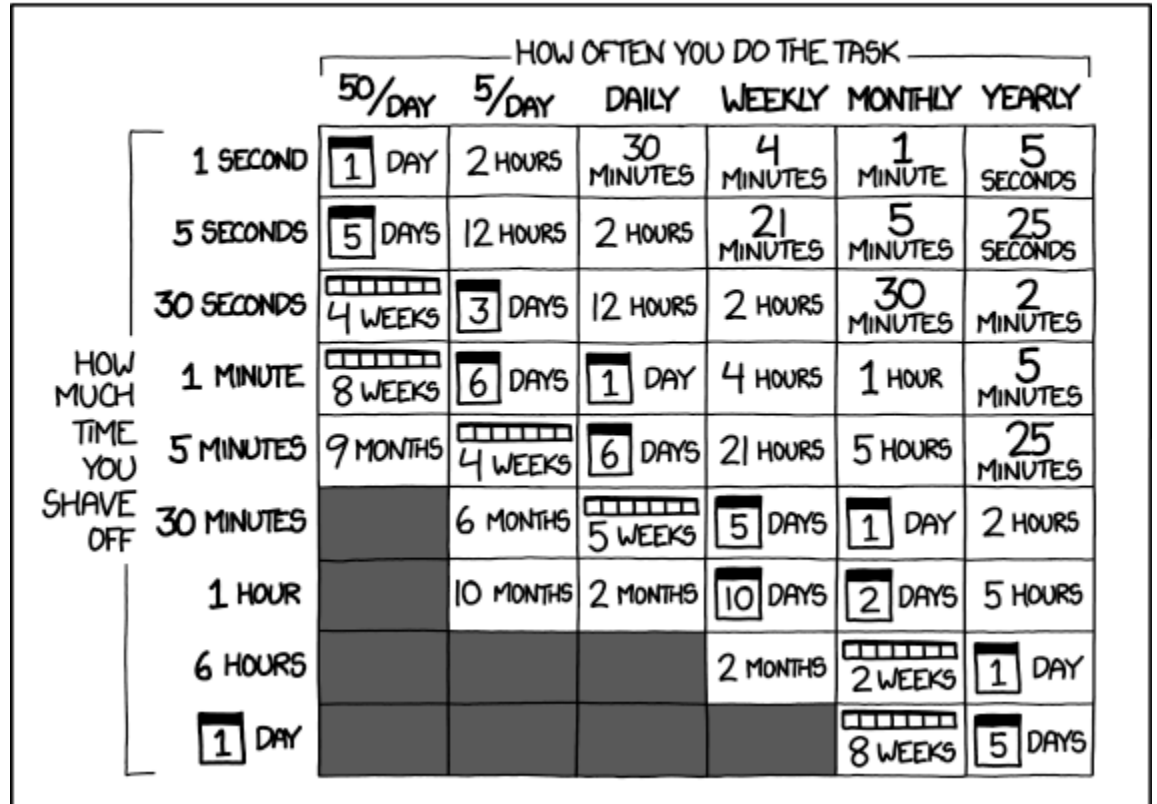
Building Vintage

- Pre-1980 (Before Energy Codes)
 - Post-1980
 - New Construction
 - Any energy code version since 2004
- HVAC Systems – Set based on 90.1 modeling guidelines
 - Envelope – Code minimum for the specified timeframe
 - Usage are either by code min or defined based on usage research for that building type.

Custom vs Commercial Tools

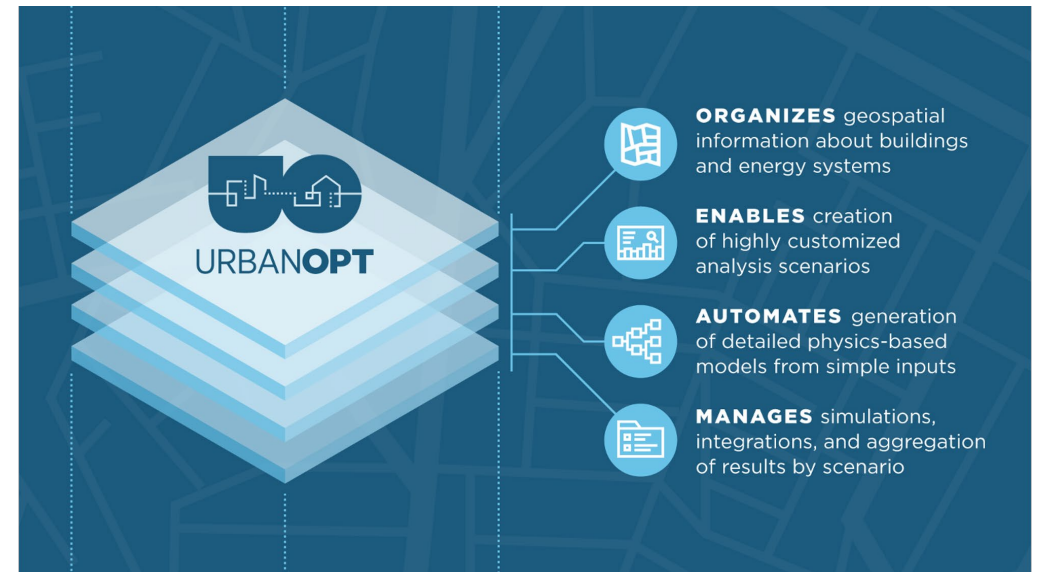
HOW LONG CAN YOU WORK ON MAKING A ROUTINE TASK MORE EFFICIENT BEFORE YOU'RE SPENDING MORE TIME THAN YOU SAVE?
(ACROSS FIVE YEARS)

- Most current tools are custom excel or GIS tools within firms that are doing projects.
- As US/CAN market grows there will be more room for commercial tools and GUIs for this project type.



Room for Development

- NREL Development Platform
 - Open Source
 - Modeling Shared Thermal Systems
 - Grid and Distributed Resource Integration
 - Integrations over a variety of software platforms.



Thermal Energy Network Modeling Tools

Masterplans

Jason Willeford

- Jacobs, Energy & Power
- Senior Mechanical Engineer and Manager
- Austin, Texas
- Campus heating and cooling systems for universities, utilities, national labs, data centers
- Decarbonizing district energy through geothermal exchange systems and associated thermal energy networks



BY THE NUMBERS

40+
COUNTRIES

400
OFFICES

45K+
TALENT
FORCE

\$27.9B
BILLION IN
BACKLOG

\$2.5B
BILLION IN
CLIENT
SAVINGS

\$16B
ANNUAL
REVENUE

Net Zero
Carbon for operations
and business travel

Engineering News-Record 2023 Rankings

Overall

#1

Top 500 Design Firms
Top 100 Pure Designers
Top 50 Program
Management Firms

Relevant Disciplines

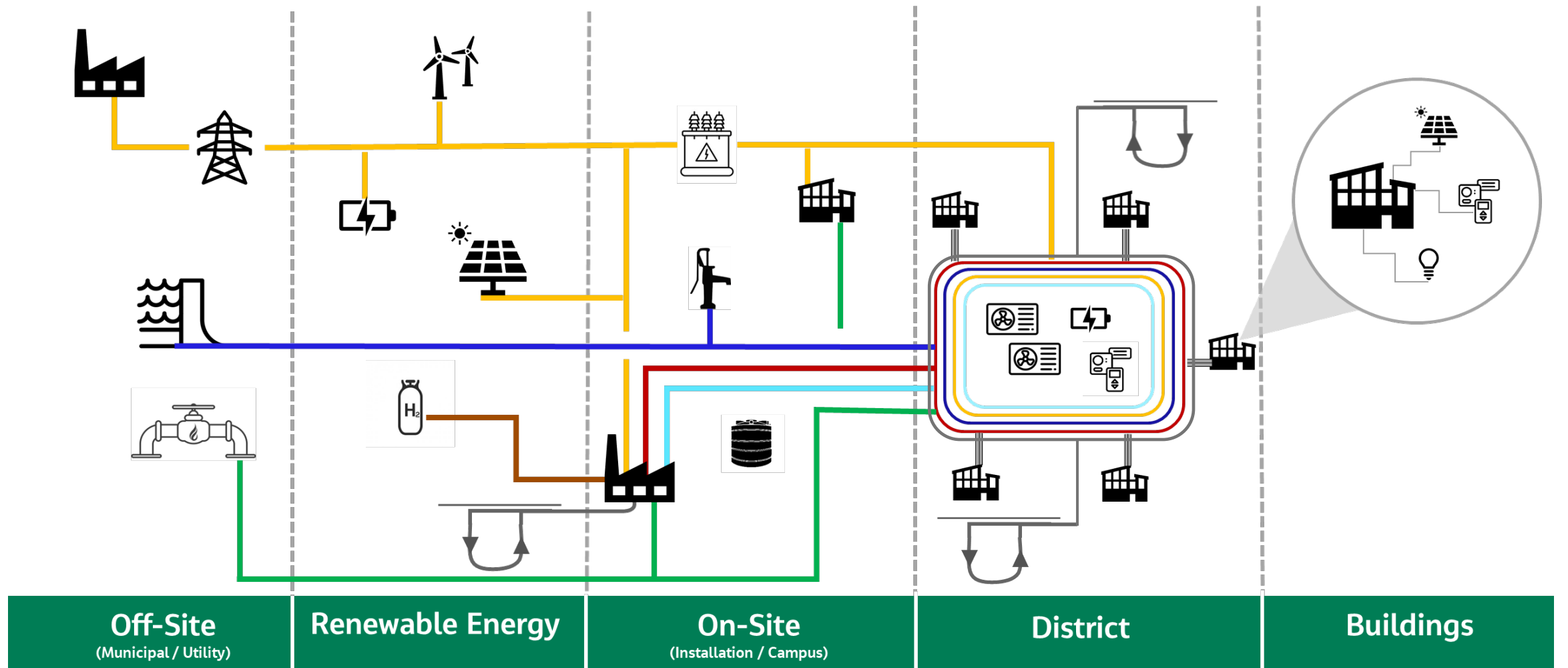
#1

Solar Power
Environmental Consulting and
Clean Air Compliance

**Top
10**

Transmission Lines & Cabling
Transmission & Distribution
Wind Power
Co-Generation Power
Marine & Port Facilities
Transportation

Planning Complex, Interdependent Energy Infrastructure

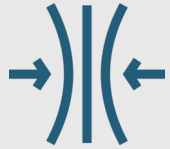


Virtual Infrastructure (VI)



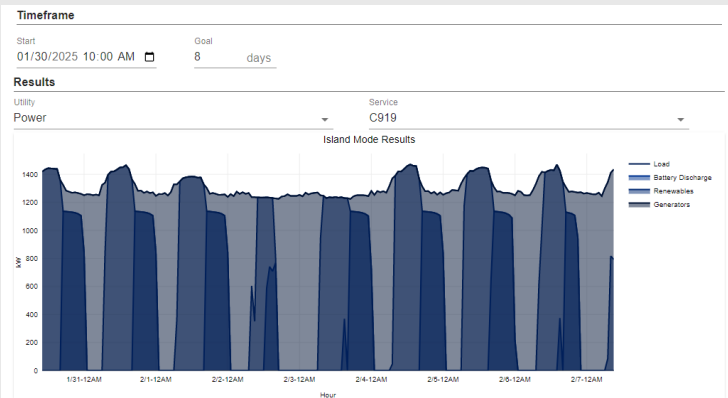
Virtual Infrastructure is a utility infrastructure digital twin that provides dynamic, data driven solutions which are easily digestible to efficiently and accurately inform stakeholders on complex challenges including **decarbonization, resiliency, and cost optimization** while offering a holistic modeling engine that is fluid with future development

VI allows a clear and comprehensive path to goals



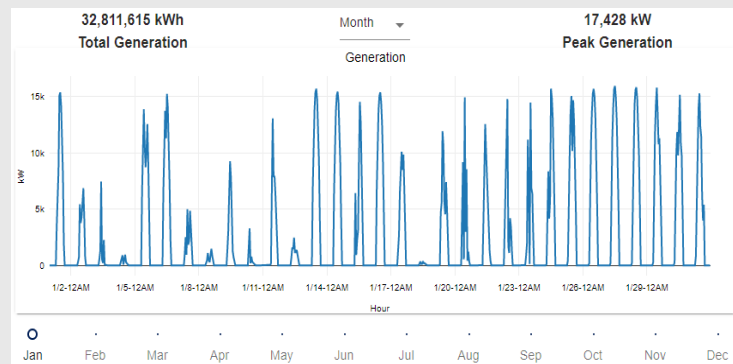
Improve Reliability

- Project system performance and resources for any utility outage during the analysis timeframe.
- Anticipate how growth will affect sitewide resiliency



Increase Sustainability

- Measure goals related to NetZero Emissions (onsite renewables, energy storage, hourly emissions calculations, etc.)
- Analyze performance enhancements from building to production levels



Reduce Expenses

- Plan for future build out with organized equipment capital management
- Develop CapEx, OpEx, or TOC optimized scenarios

Project Information						
Tag	Springfield Plant Build Out	Start Year	End Year			
		2024	2030			
Capital	0					
Funding Source	Description					
None	Springfield Chiller Plant build out to serve additional customers.					
List of Items						
Buildings	Equipment	Pipes	Pathways	ECMs	Renewables	Batteries
<input checked="" type="checkbox"/>	Plant	Utility	Type	Tag	Year	Capital
<input checked="" type="checkbox"/>	Springfield Chiller Plant	Chilled Water	Pump	PP-04	2024	\$289,800
<input checked="" type="checkbox"/>	Springfield Chiller Plant	Chilled Water	Chiller	CH-08	2025	\$1,579,410
<input checked="" type="checkbox"/>	Springfield Chiller Plant	Chilled Water	Pump	PP-05	2025	\$289,800
<input checked="" type="checkbox"/>	Springfield Chiller Plant	Chilled Water	Chiller	CH-07	2024	\$1,843,200

Modeling Capabilities

Physical Assets

- Generation
- Distribution
- Thermal Storage
- Electrical Storage
- Renewables
- Geothermal Heat Pumps
- 3rd party data
- GIS Integration/Export

Operations

- Emissions
- Heat Recovery
- Ambient/5th Generation Thermal Systems
- Hourly Hydronic Flow Analysis
- Hourly Feeder Utilization
- Utility bills/meter data
- Island Mode Operations

Financial

- Unlimited Scenario Modeling
- Full LCCA
- Real Time Pricing & Demand Charges
- Renewable Energy Credits
- Physical Asset Bundling
- Funding Sources

Detailed Building Utility Demands

Jacobs VIRTUAL INFRASTRUCTURE
University of Florida
Scenario 1
2023 Analysis Year

- Col. Edger S. Walker Hall
- West Chiller Plant
- Lacy Rabon Chilled Water Plant (CWP2)
- Holland Law Chilled Water Plant (CWP7)
- McCarty Chilled Water Plant
- SE Chilled Water Plant (CWP8)
- Mowry Chilled Water Plant (CWP10)
- Central Energy Plant
- SW Chilled Water Plant
- West Chilled Water Plant
- New Chilled Water Plant

Name	Number	Type	Year Built	Year Demo	Size	Footprint	Floors	Occupancy
Peter Rolfs Hall	0012	Medium Office	1956	9999	38253	7749	4	43
Phillips Addition	455	Large Dorm	2027	9999	20000	10230	2	40
Phillips Center For The Performing Arts	0315	Medium Office	1971	9999	68039	40836	1	1700
Physics Building	0602	Medium Office	1987	9999	234537	88355	2	383

Peter Rolfs Hall

[Edit Geometry](#) [New Building](#) [Delete](#)

Building Info Chilled Water Hot Water Steam Power Water Natural Gas ECMS Equipment

Service

Year	Service Type	Plant Connection	Head (Ft)	Supply	Return
1956	District	McCarty Chilled Water Plant	0	45	57

[Add](#)

Load Data

Baseline 2017 Add Data

Monthly **Hourly** [Edit Table](#) [Replace](#)

Hour	Load (Tons)
1	32.447
2	36.51
3	39.6782
4	38.7774
5	33.4846
6	32.5983

1-100 of 8760

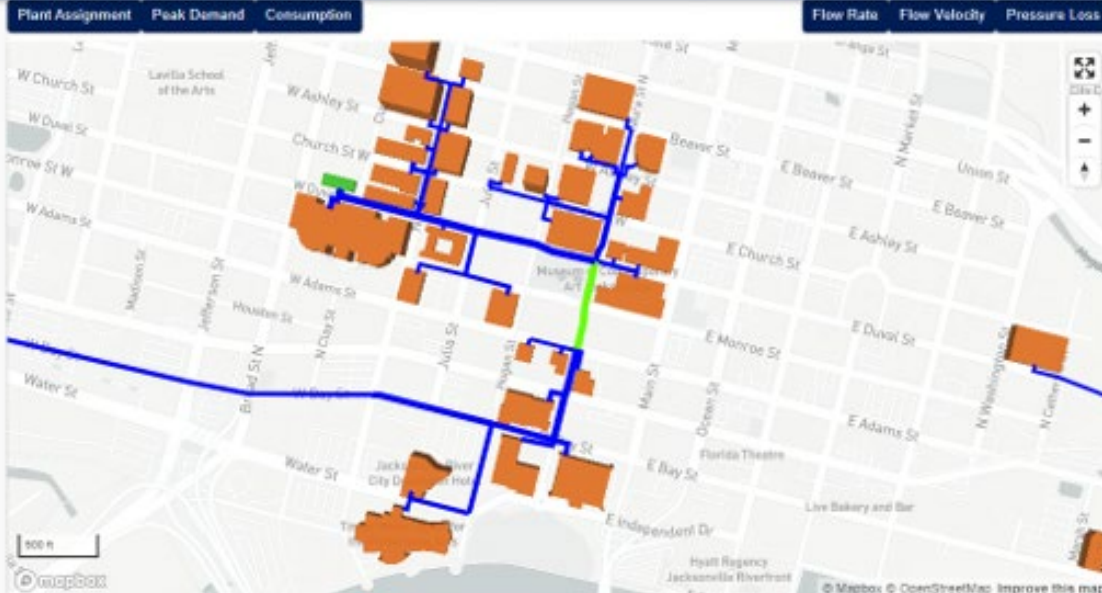
Demand Curve

Hourly Hydronic Flow Analysis

Jacobs VIRTUAL INFRASTRUCTURE
JEA
Scenario 1
2030 Analysis Year

Plant Assignment
Peak Demand
Consumption

Flow Rate
Flow Velocity
Pressure Loss



Id	Material	Schedule	Nominal	Install Type	Year Install	Length	Flow	Velocity	From Pressure	To Pressure	Pressure Loss
1	Carbon Steel	STD	30	Direct Bury	2000	361	13425	6.4	105	104	0.52
2	Carbon Steel	STD	30	Direct Bury	2000	281	5747	2.7	104	104	0.07
3	Carbon Steel	STD	20	Direct Bury	2000	272	7336	8.1	104	103	1
5	Carbon Steel	STD	20	Direct Bury	2000	701	4113	4.5	103	102	0.88
6	Carbon Steel	STD	20	Direct Bury	2000	588	1098	1.2	102	102	0.05

Rows per page: 5 1-5 of 109

Analysis Hour: 01/01/2030 12:00 AM

[Edit Geometry](#) [New Pipe](#) [Delete](#)

Pipe

Material: HOPE	Schedule: DR 11	Size: 30	Install Type: Direct Bury
Year Installed: 2024	Year Demo: 9999	Length: 567	Capital: 1200634

Losses

Loss Coefficient: 0 [Add](#) **Fittings**

Analysis

Flow (GPM): 12425	Velocity (ft/s): 8.6	Pressure (psi): 82.3	Pressure Loss (psi): 1.64
-------------------	----------------------	----------------------	---------------------------

Equipment Operation and Sequencing

Jacobs VIRTUAL INFRASTRUCTURE

California

 Scenario 1 ▼
2030
Analysis Year

Select Plant
Energy Exchange Center Edit Plant

Plant Production

Chillers	Pumps	Heat Rejection	Economizers	Setpoints	TES																								
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Tag</th> <th>Capacity (Tons)</th> <th>Heat Rejection</th> <th>Manufacturer</th> <th>Model</th> <th>Year Online</th> <th>Year Offline</th> <th>Capital</th> </tr> </thead> <tbody> <tr style="background-color: #e0f0ff;"> <td>CH-1</td> <td>750</td> <td>Geothermal</td> <td>York</td> <td>Geothermal</td> <td>2028</td> <td>2053</td> <td>1,727,999</td> </tr> <tr> <td>CH-4</td> <td>750</td> <td>Geothermal</td> <td>York</td> <td>Geothermal</td> <td>2028</td> <td>2079</td> <td>1</td> </tr> </tbody> </table>	Tag	Capacity (Tons)	Heat Rejection	Manufacturer	Model	Year Online	Year Offline	Capital	CH-1	750	Geothermal	York	Geothermal	2028	2053	1,727,999	CH-4	750	Geothermal	York	Geothermal	2028	2079	1					
Tag	Capacity (Tons)	Heat Rejection	Manufacturer	Model	Year Online	Year Offline	Capital																						
CH-1	750	Geothermal	York	Geothermal	2028	2053	1,727,999																						
CH-4	750	Geothermal	York	Geothermal	2028	2079	1																						

CH-1

Tag	Capacity (Tons)	Heat Rejection	Manufacturer	Model	VFD
CH-1	750	Geothermal	York	Geothermal	<input checked="" type="checkbox"/>

Priority	Efficiency (kWh/Ton)	Chiller Loading	Year Online	Year Offline	Capital	OSM
1	0.62	31	% 2028	2053	\$ 1727999	\$ 22600

Delete

0.85
Avg. kWh/Ton
4,822,402
Annual Tonhours
2,693
Peak Tons

Plant Service

Service
Annual Performance
Projected Performance

Service Week ▼

1/1 1/29 2/26 3/25 4/23 5/21 6/16 7/16 8/13 9/10 10/6 11/5 12/3

Visualization of Electrical Systems

The screenshot displays the Jacobs Virtual Infrastructure software interface. The top navigation bar includes the Jacobs logo, 'VIRTUAL INFRASTRUCTURE', 'UGA', 'Scenario 1', and '2023 Analysis Year'. The main interface is divided into a map area on the left and a data panel on the right.

Map Area: The map shows a district with buildings represented by orange polygons. A green line indicates a feeder route starting from a substation (blue dot) and connecting to several buildings. The map includes a scale bar (0 to 200 ft) and a copyright notice for Mapbox and OpenStreetMap.

Data Panel: The data panel is titled 'Peak Hour' and contains the following information:

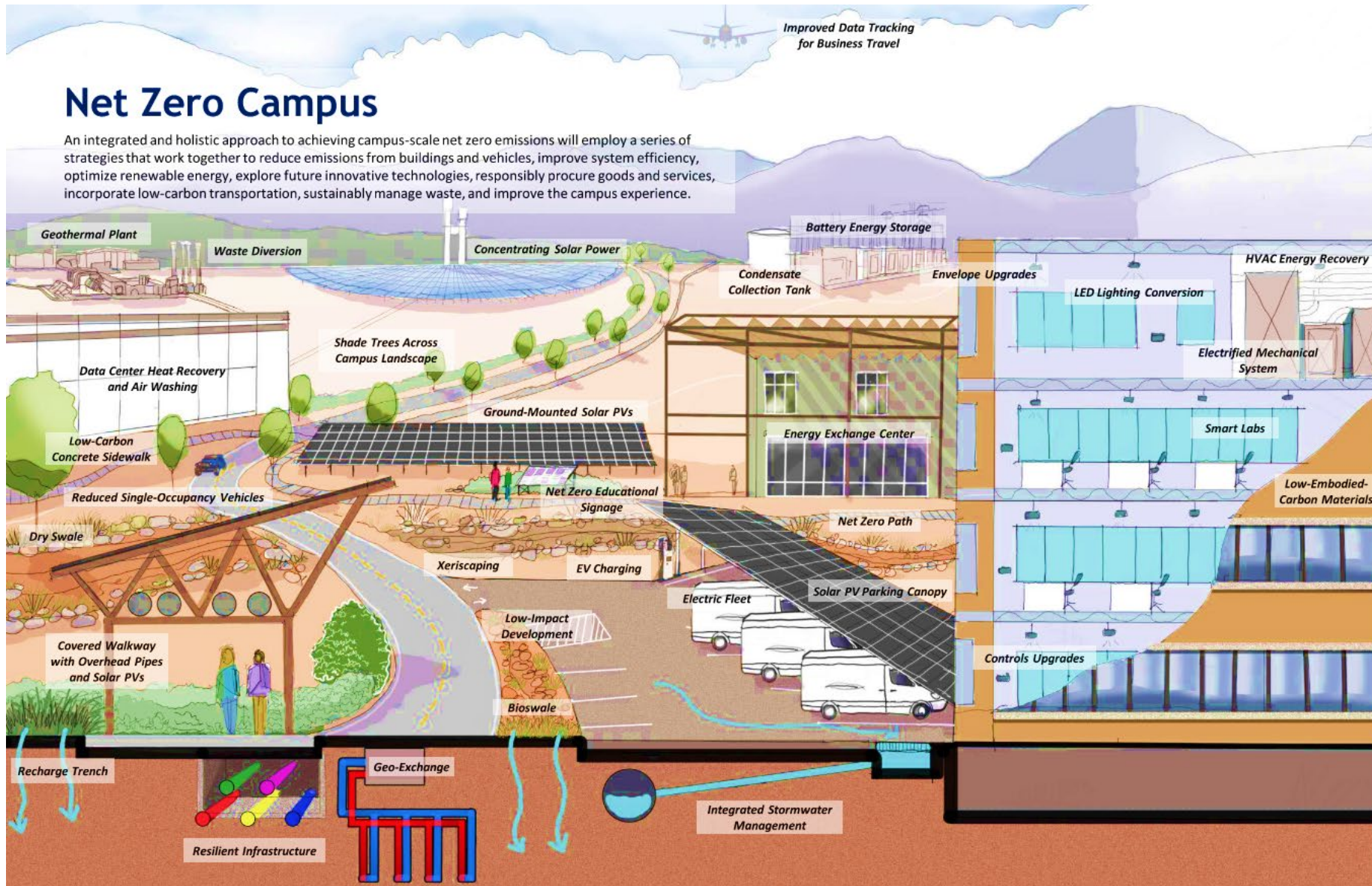
- Analysis Hour:** 01/01/2023 12:00 AM
- Select Plant:** Main Substation
- Select Feeder:** Buildings
- Feeder Details:**
 - Tag: Buildings
 - Material: Aluminum
 - Rating: 5
 - Size: 500MCM
 - Capacity: 380
 - Year Installed: 1960
 - Capital: Capital
- Analysis Summary:**

Voltage (kV)	Capacity (MVA)	Load (MVA)	Utilization (%)
4	3291	1676	51

Universities and Research Centers

Net Zero Campus

An integrated and holistic approach to achieving campus-scale net zero emissions will employ a series of strategies that work together to reduce emissions from buildings and vehicles, improve system efficiency, optimize renewable energy, explore future innovative technologies, responsibly procure goods and services, incorporate low-carbon transportation, sustainably manage waste, and improve the campus experience.



Scopes 1 & 2 Operational Net Zero Principles

-  Reduced Emissions from Buildings and Vehicles
-  Improved System Efficiency
-  Renewable Energy
-  Future Technologies

Scope 3 Value Chain Net Zero Principles

-  Responsible Goods and Services Procurement
-  Low-Carbon Transportation
-  Waste Management

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Let's connect!

jason.willeford@jacobs.com



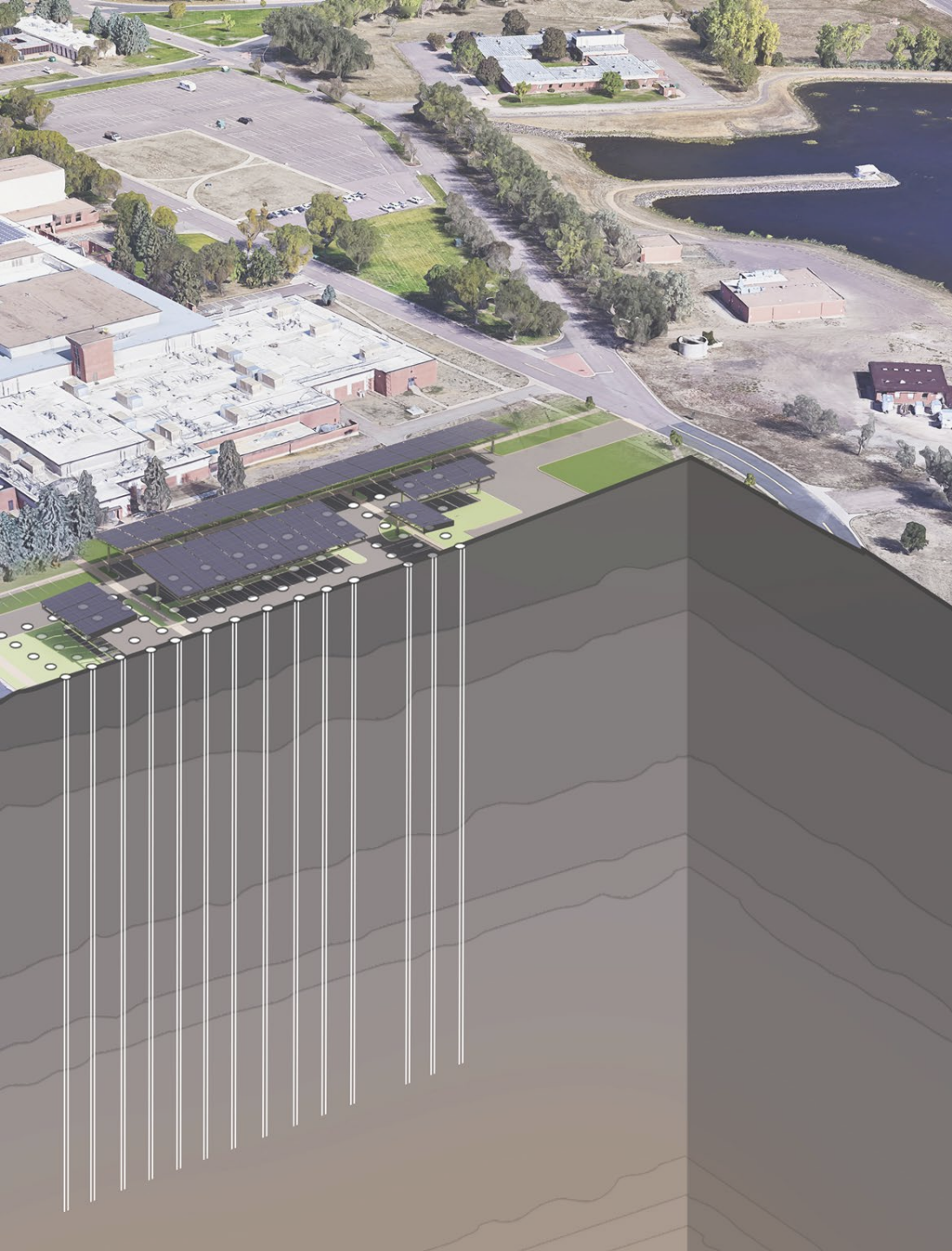
Challenging today.
Reinventing tomorrow.



A modern building with a blue glass facade and a courtyard with greenery. The building has a grid-like pattern of windows and is illuminated from within, showing a warm interior. The courtyard in the foreground is filled with lush green plants and has some outdoor seating. The sky is a clear, light blue.

NETWORK MODELING TOOLS

Enter the Modelica Universe



VICTOR BRACISZEWSKI

PE, LEED GREEN ASSOCIATE

Associate | Mechanical Engineer | IMPACT

301 Battery Street, 4th Floor

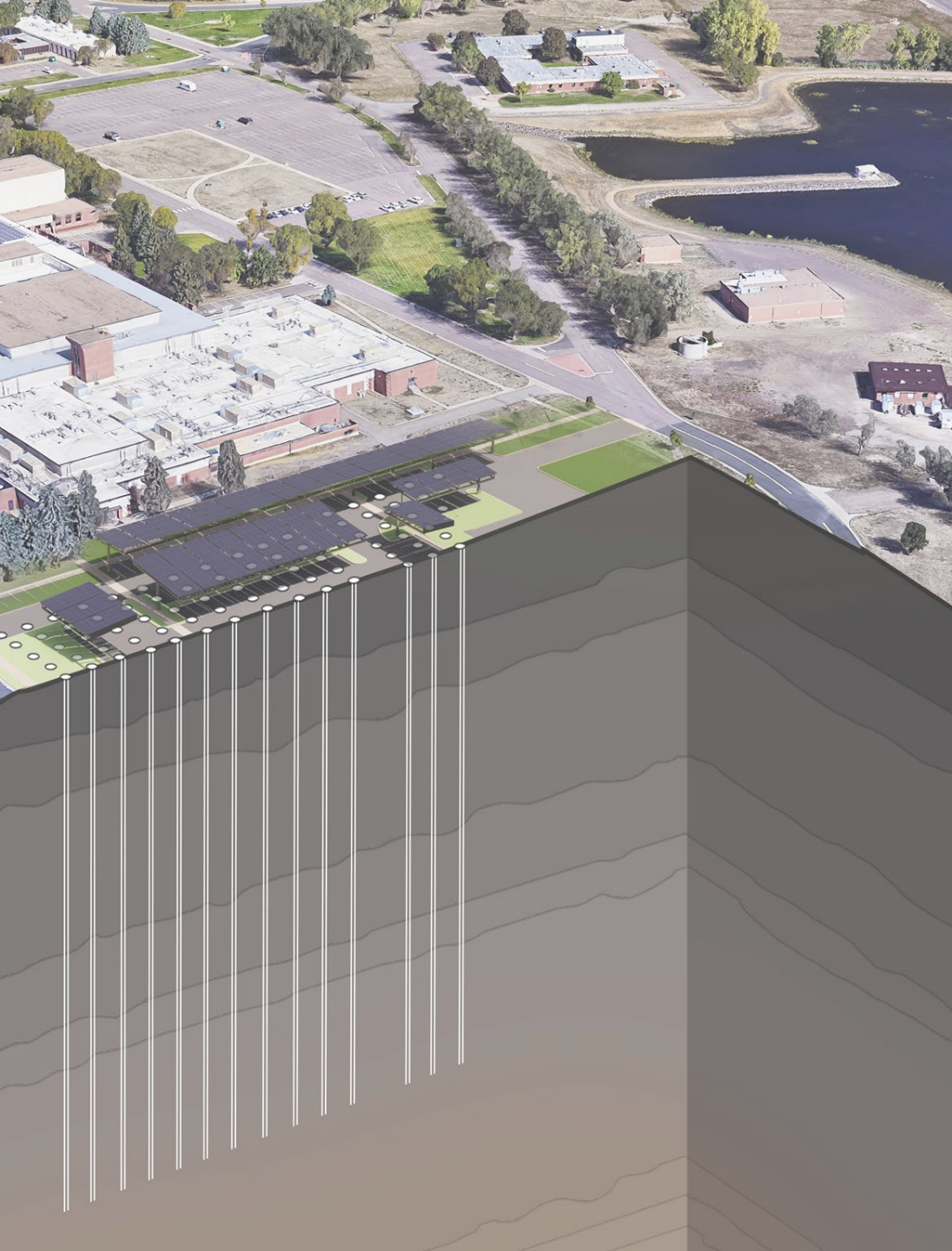
San Francisco, CA 94111

T 312.641.6714

Victor.Braciszewski@smithgroup.com

SMITHGROUP

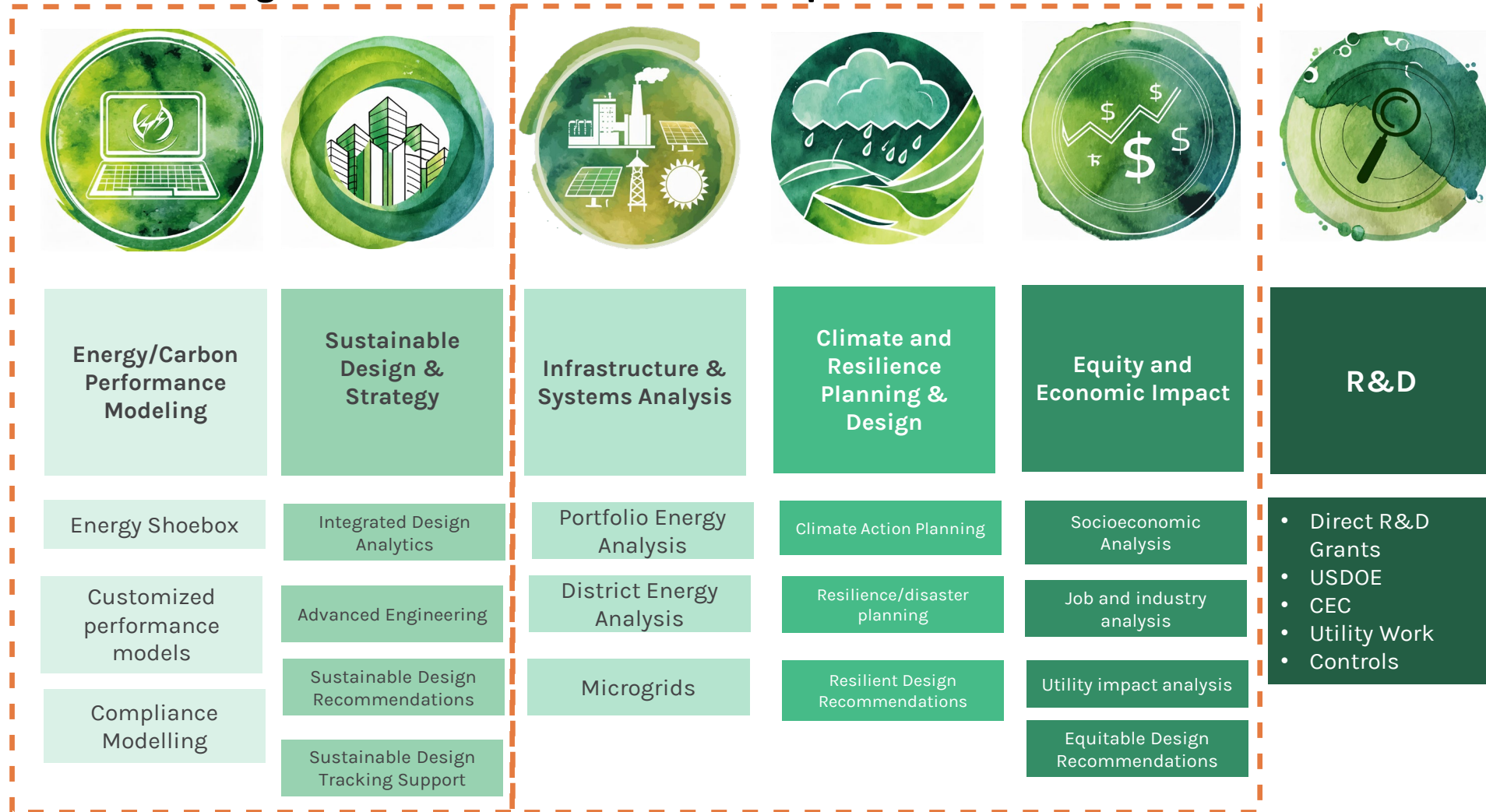
Design a Better Future



DEFINING IMPACT

Building Scale

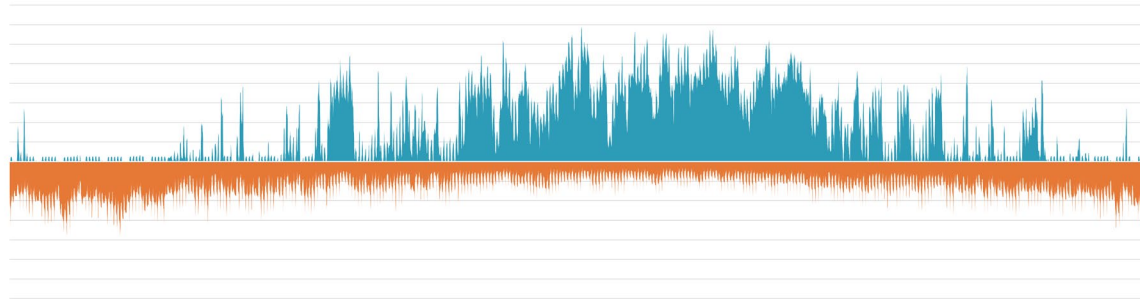
Campus Scale



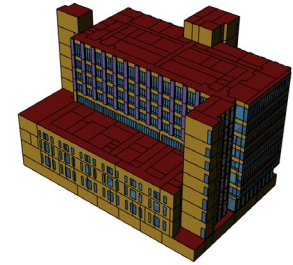
TYPICAL DISTRICT MODELING PROCESS

BUILDING HEATING AND COOLING

HISTORICAL LOADS



BUILDING ENERGY MODEL



DISTRICT MODELING PLATFORM

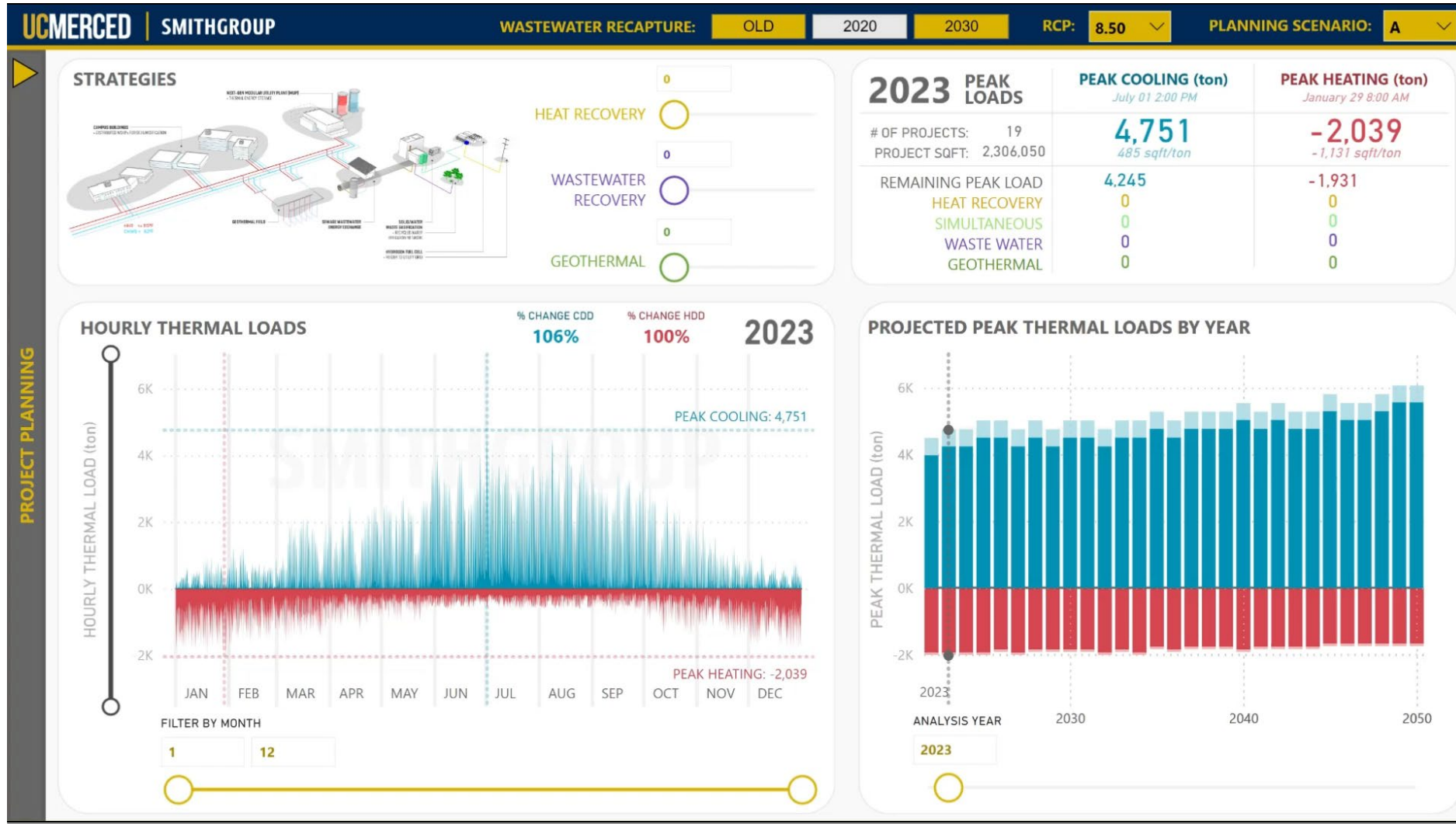
RESULTS

SCENARIO &
INFRASTRUCTURE PLANNING

ENERGY USE / COST / EMISSIONS

CONTROLS
VALIDATION/OPTIMIZATION

DISTRICT MODELING



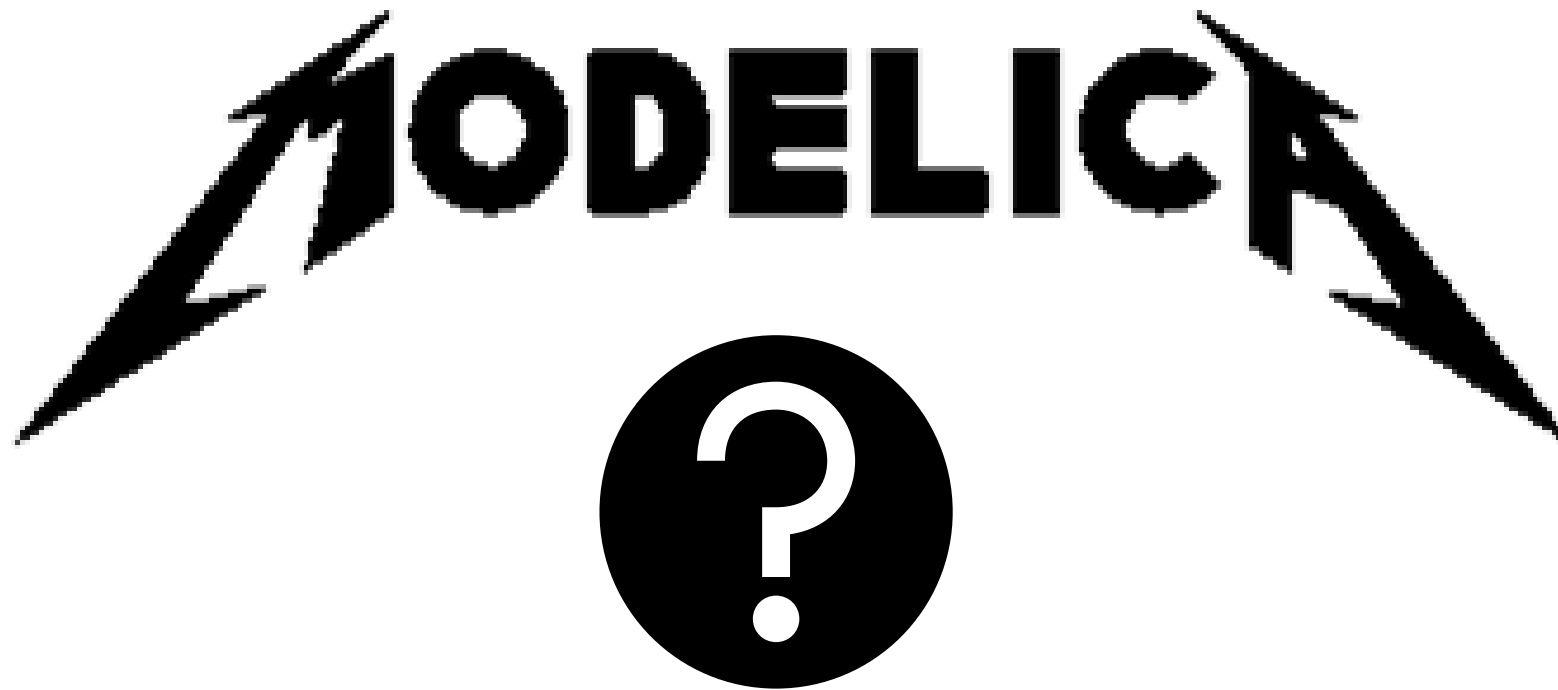
WHAT ABOUT....

COMPLEX PLANT DESIGNS?

CONTROLS TESTING?

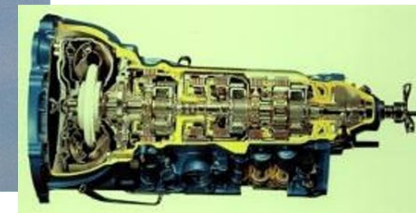
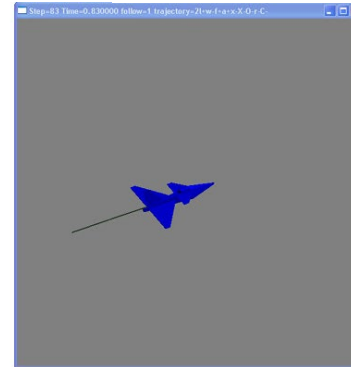
AMBIENT LOOPS?

MORE ACCURACY?



MODELICA MODELING

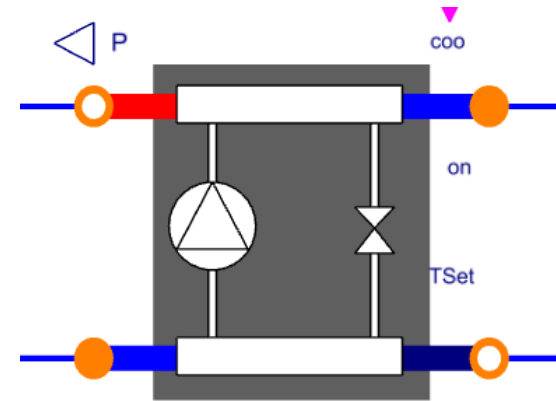
- Modelica > ~~tool~~ language for modeling
 - Building systems
 - District energy systems
 - Power plants
 - Robotics
 - Automotive
 - Aircraft
 - Satellites
- First released in 1997 > Gen Z



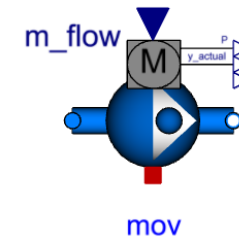
Source: openmodelica.org (April 2025)

MODELICA MODELING

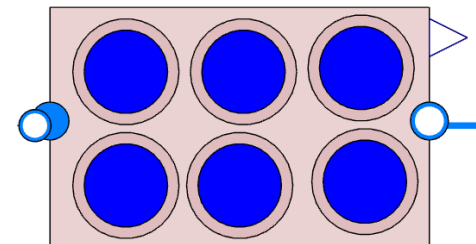
- **Object oriented** > **Connect realistic components to create a system**
- Acausal > Pipe doesn't need to know direction of flow
- Multidomain > **Combine Electrical + Mechanical**
 - Mechanical
 - Hydraulic
 - Electrical
 - Thermodynamic
 - Controls



HEAT
PUMP



PUMP



BOREFIELD

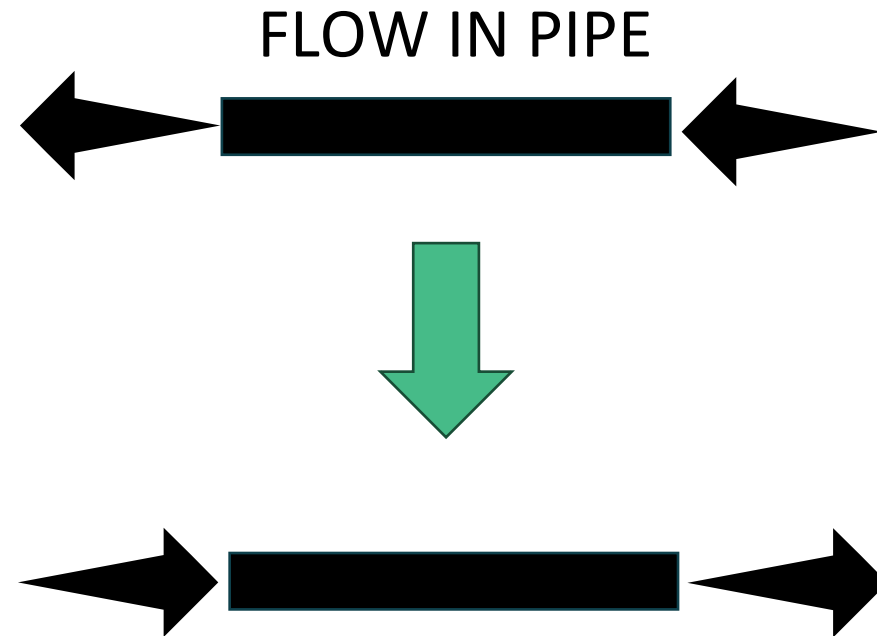
MODELICA MODELING

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MODELICA MODELING

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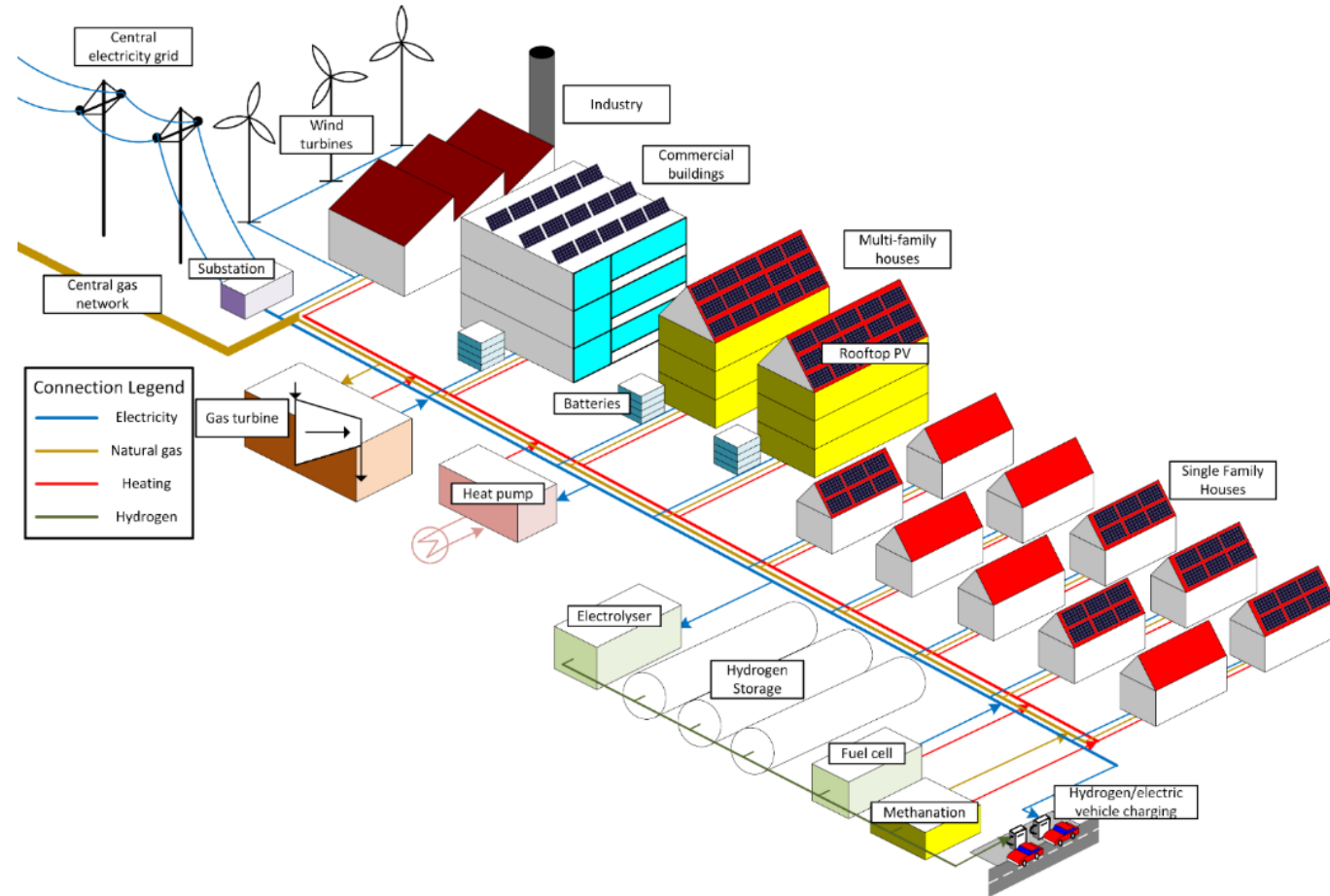
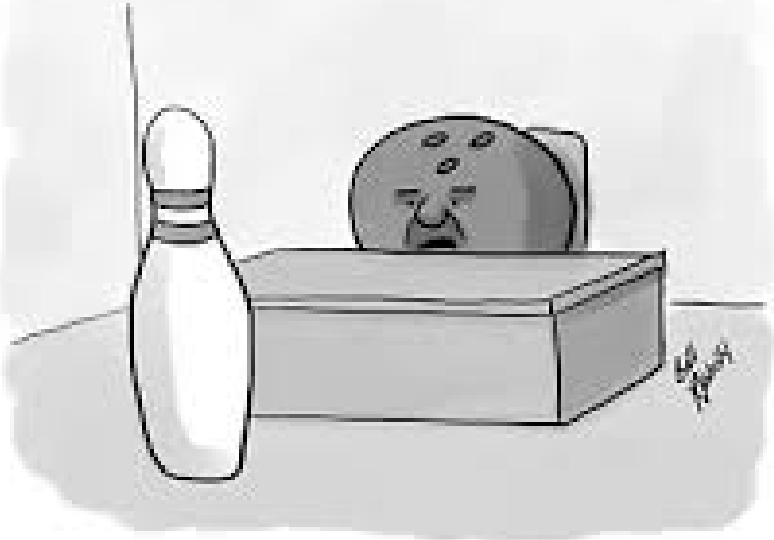


Figure: EMPA

TRADITIONAL ENERGY MODELING VS MODELICA

Traditional Energy Modeling



“I think you’ll find my management style pretty direct”

Modelica Modeling



TRADITIONAL ENERGY MODELING VS MODELICA

Traditional Energy Modeling

— Pros

- “Simple”
- Building loads

— Cons

- Single building
- Simple controls
- Less flexible system customization
- Less open-source
- Less data access
- Limited hydraulic/flow analysis

Modelica Modeling

— Pros

- **More flexibility: model atypical systems**
- **Single building plant or district**
- **Advanced controls:** Real life control 1:1 translation options between digital twin and BAS control
- **Expanded Hydraulics / flow analysis**
- **Multi-domain:** thermal + electrical + controls
- More open-source
- More data accessible

— Cons

- **Generating building loads**
- Limited CAD and BIM integration (e.g., for piping takeoffs)
- Learning curve

MEET THE MODELICA FAMILY

MODELING
LANGUAGE

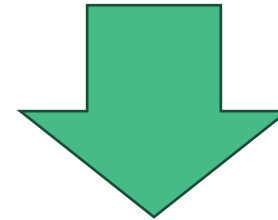


MODELING ENVIRONMENTS

Modelon Impact

Dymola

OpenModelica

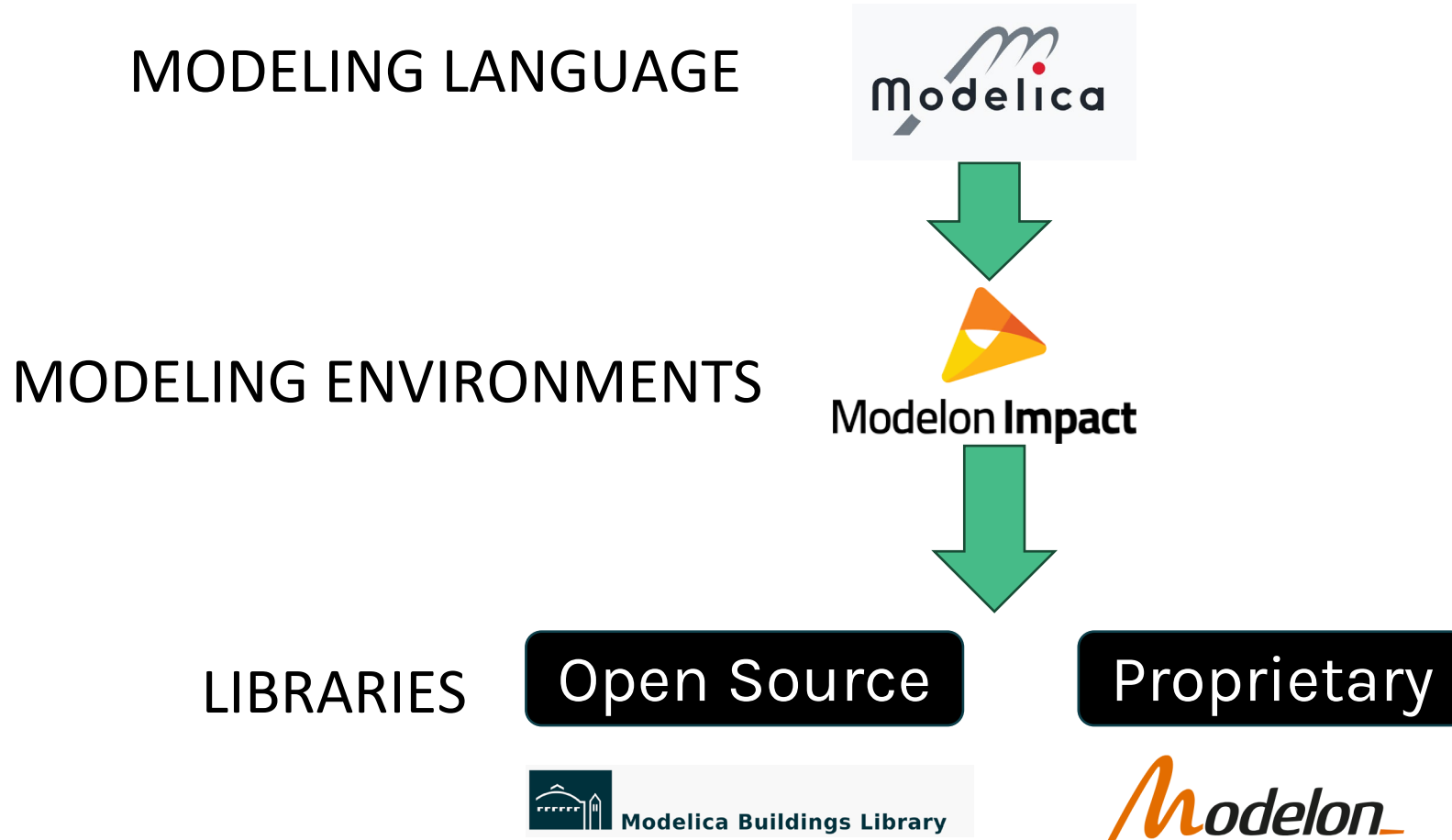


LIBRARIES

Open Source

Proprietary

MEET THE MODELICA FAMILY

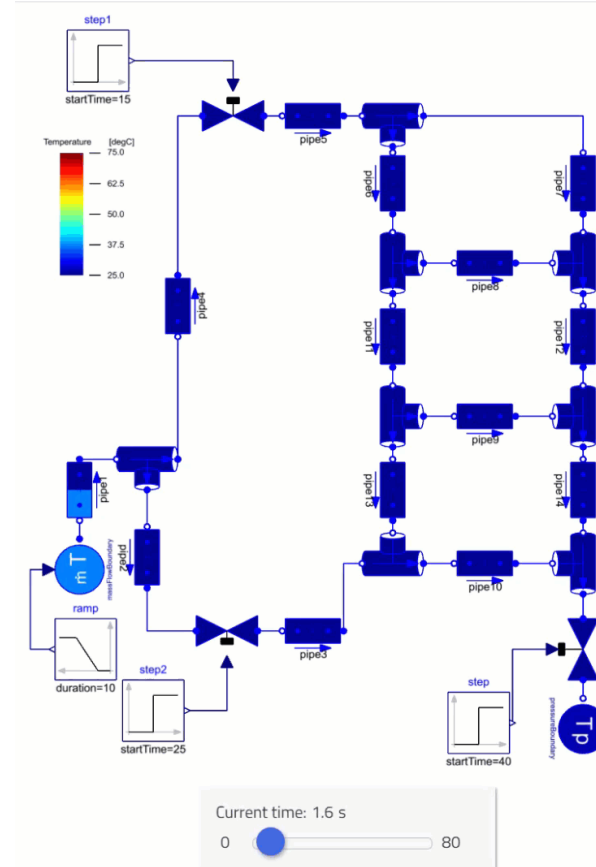


MODELING ENVIRONMENT: MODELON IMPACT



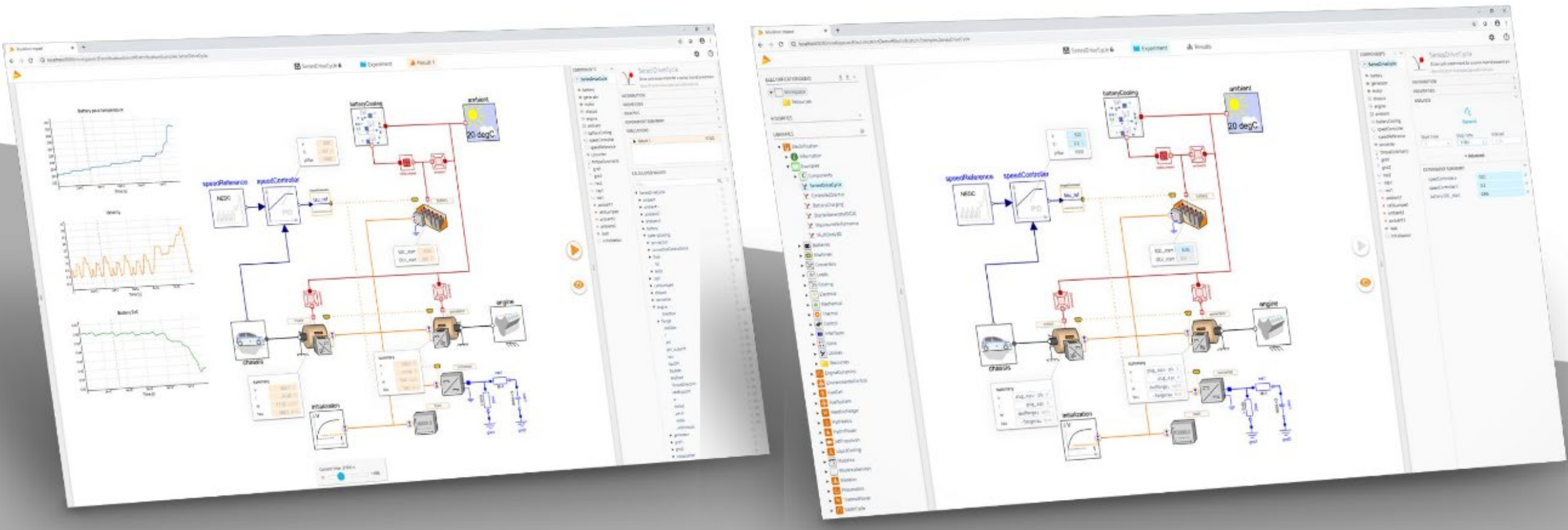
Modelon Impact

- **Cloud Platform**
 - Ease of collaboration
 - Rapid simulation
 - Multiple deployment options
- **Includes Libraries**
- **Includes Support**

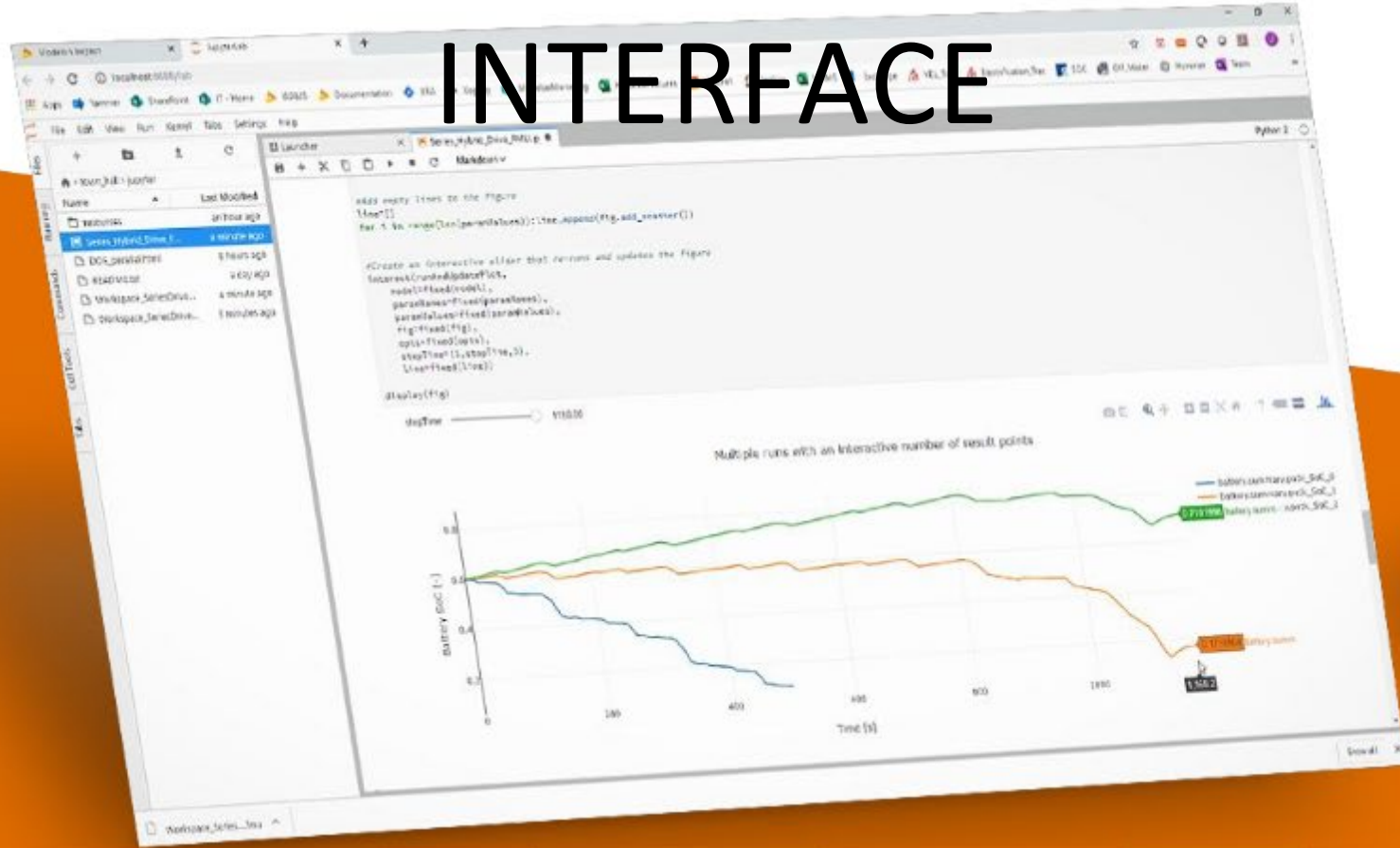


MODELON IMPACT

MODELING INTERFACE



MODELING + CODING INTERFACE



MODELICA LIBRARIES: BUILDINGS LIBRARY

CO-DEVELOPED WITH IBPSA MODELICA LIBRARY, INCLUDING DISTRICT HEATING AND COOLING SYSTEMS

+2000 VALIDATED OPEN-SOURCE MODELS

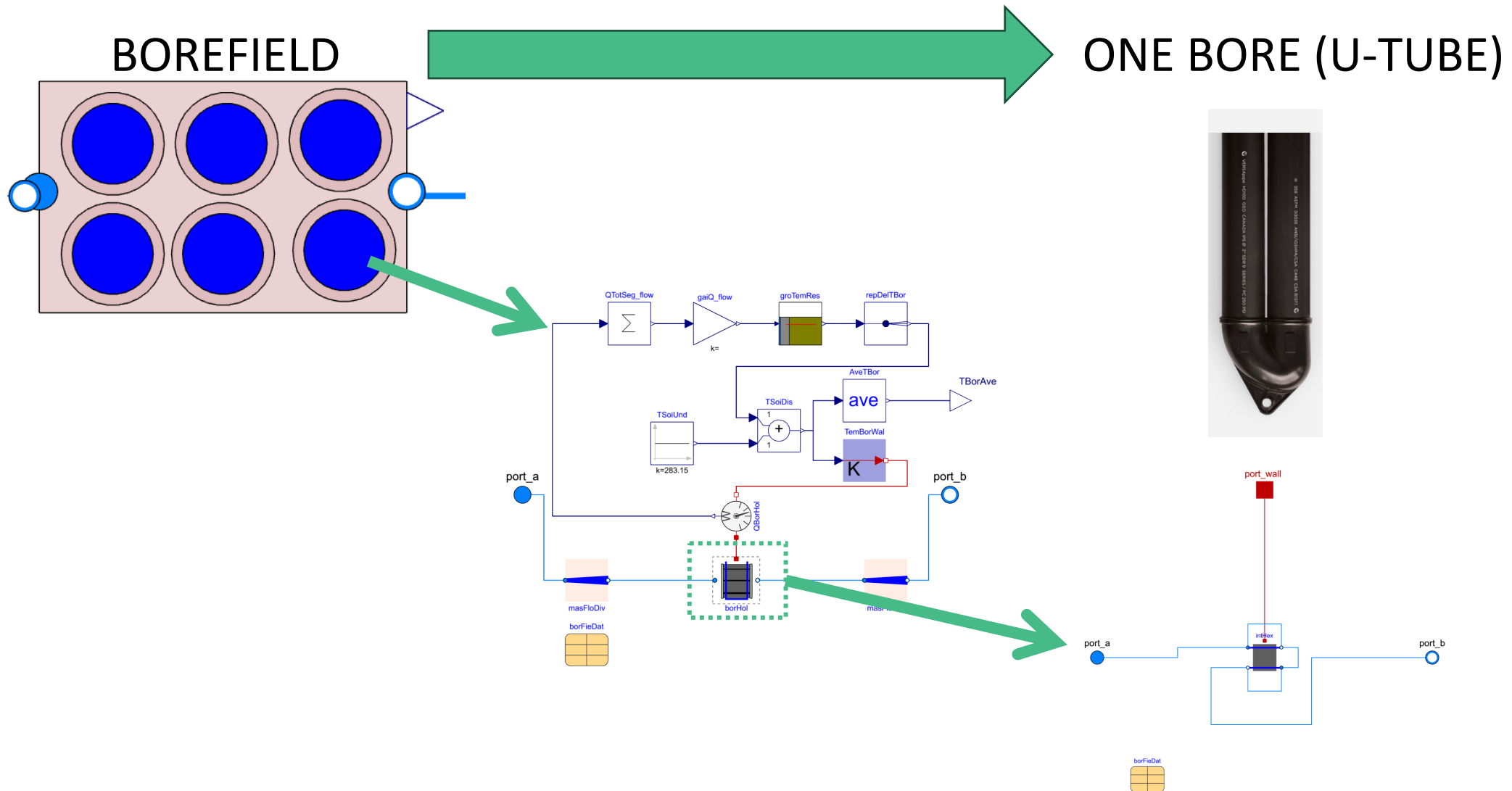


Modelica Buildings Library

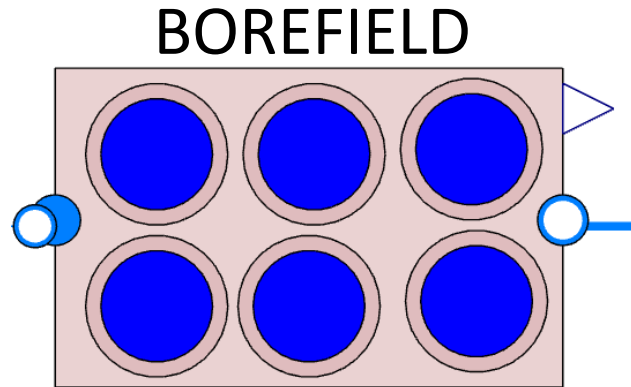
<p>Air-based HVAC</p>	<p>Hydronic heating</p>	<p>Chiller plants</p>	<p>Solar thermal plants</p>
<p>Embedded Python</p>	<p>Natural ventilation, multizone air exchange, contaminant transport</p>	<p>Airflow (CFD)</p>	<p>Room heat transfer, EnergyPlus coupling, detailed and reduced order</p>
<p>FLEXLAB</p>	<p>Electrical systems</p>	<p>District heating and cooling systems</p>	<p>Control design & deployment, including ASHRAE G36</p>

<https://simulationresearch.lbl.gov/modelica/>

BUILDINGS LIBRARY: BOREFIELD MODEL



BUILDINGS LIBRARY: BOREFIELD MODEL

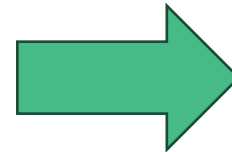
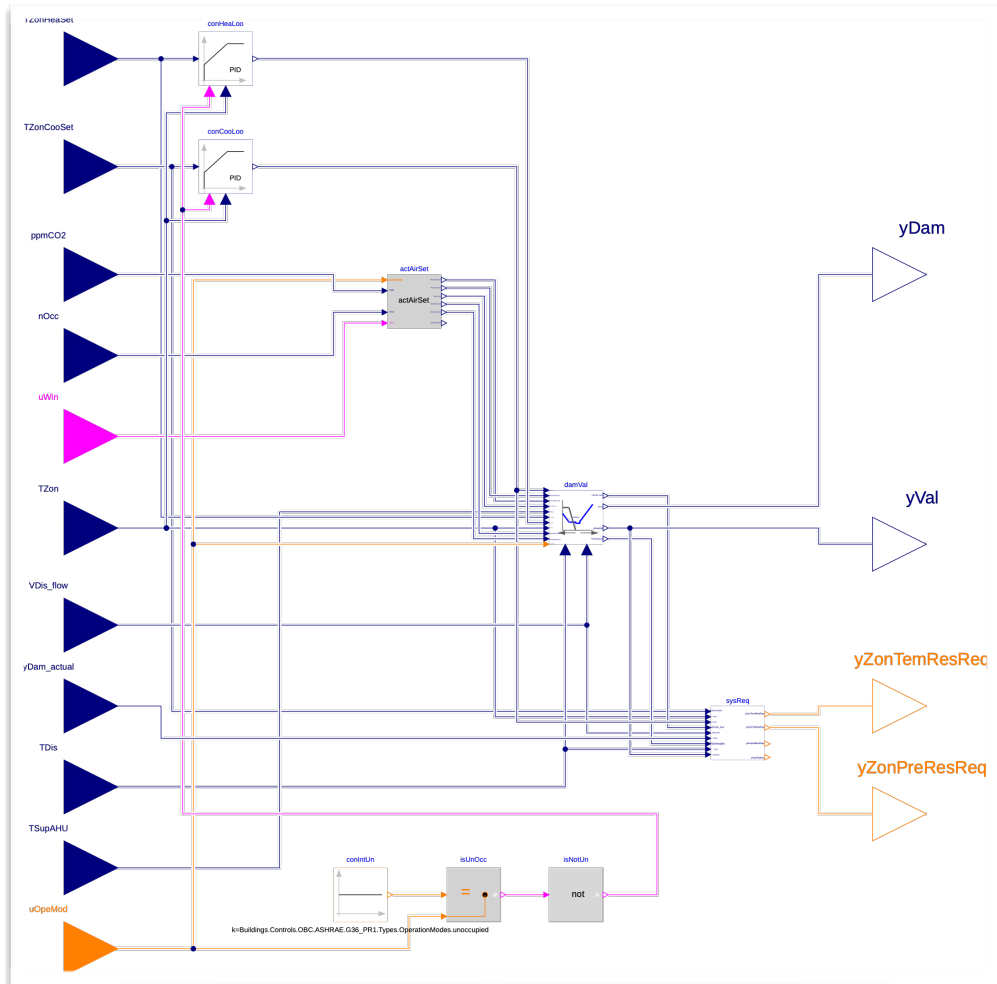


- **Short Term Response** > Manage electrical demand charges and peak building load
- **Long Term Response** > Inform seasonal load imbalance
- **Real controls with dynamic flow rates** > Trust the results

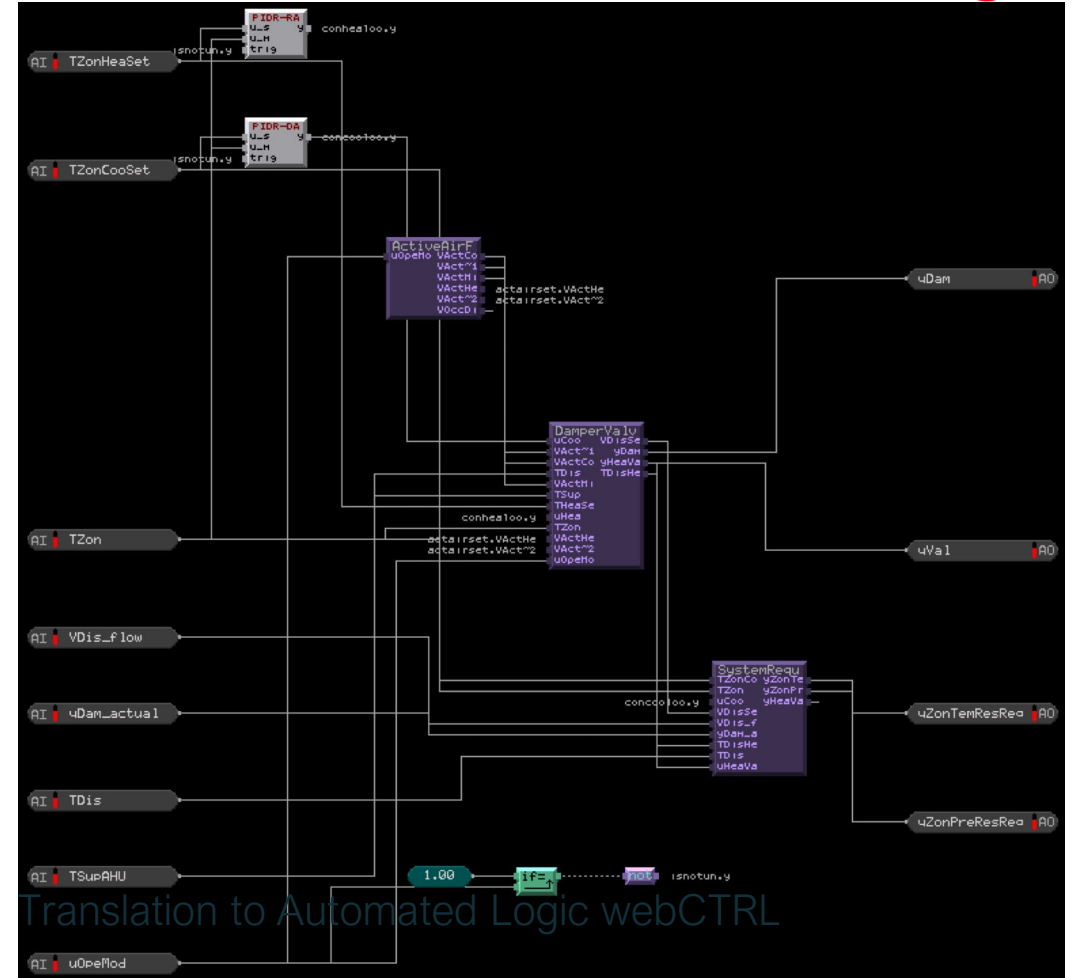
BUILDINGS LIBRARY: CONTROL DESCRIPTION LANGUAGE (CDL)



DIGITAL MODEL

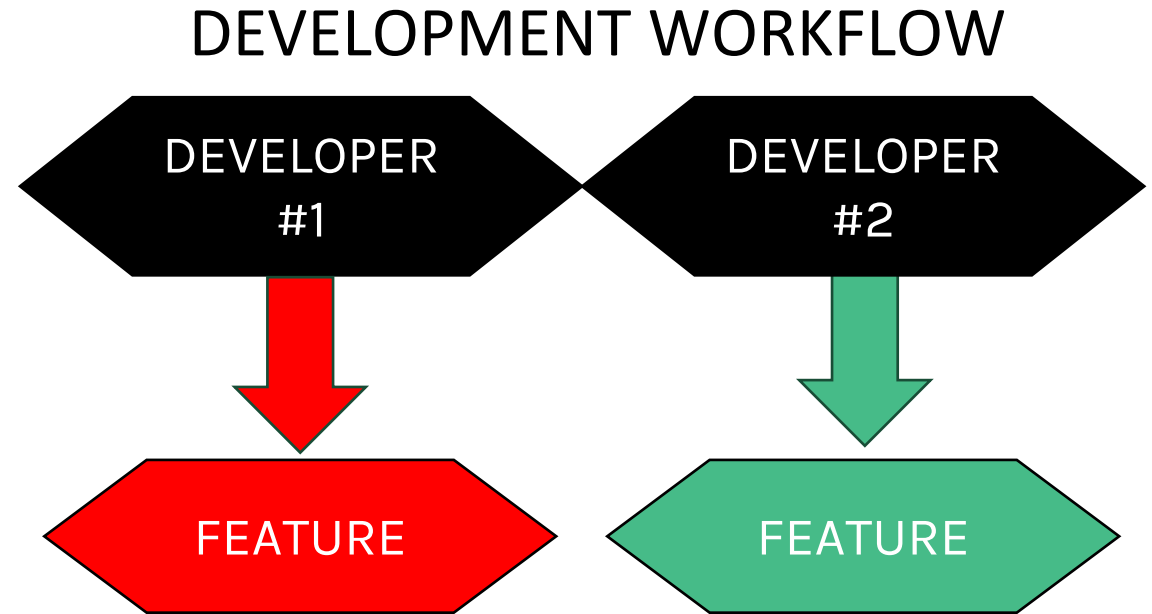


BUILDING CONTROLS



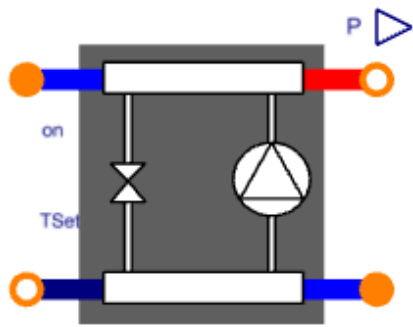
MODELICA LIBRARIES: CONSTANT DEVELOPMENT

- **Worldwide development**
 - Modelica Buildings Library (Lawrence Berkely National Lab)
 - **Modelica International Building Performance Simulation Association (IBPSA) Library**
 - Modelica Standard Library
 - Modelon: ~17 Libraries



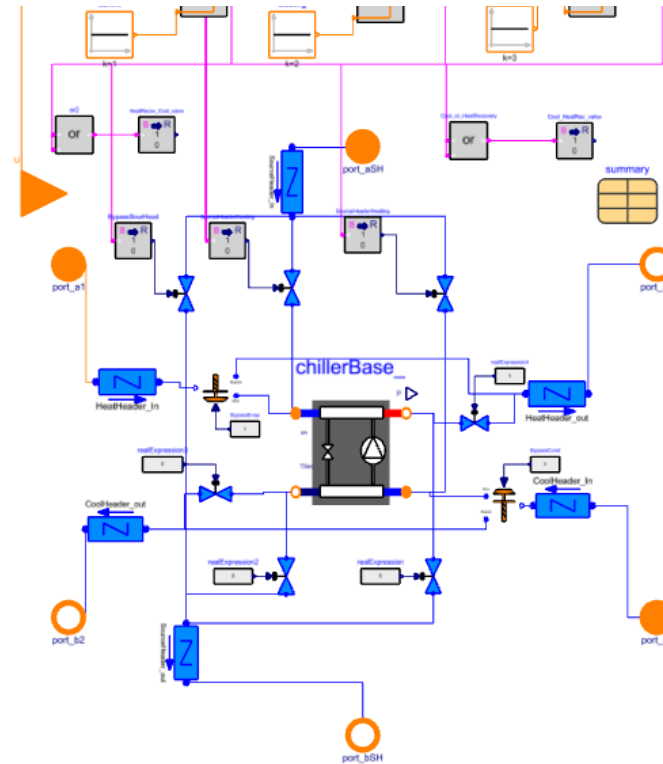
RAPID MODEL DEVELOPMENT

BASE 4 PIPE HEAT PUMP

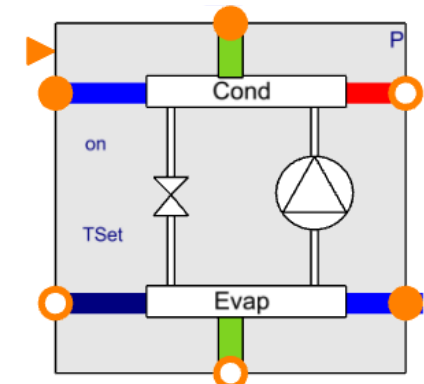


HEATING
OR
COOLING

COMPONENT DEVELOPMENT

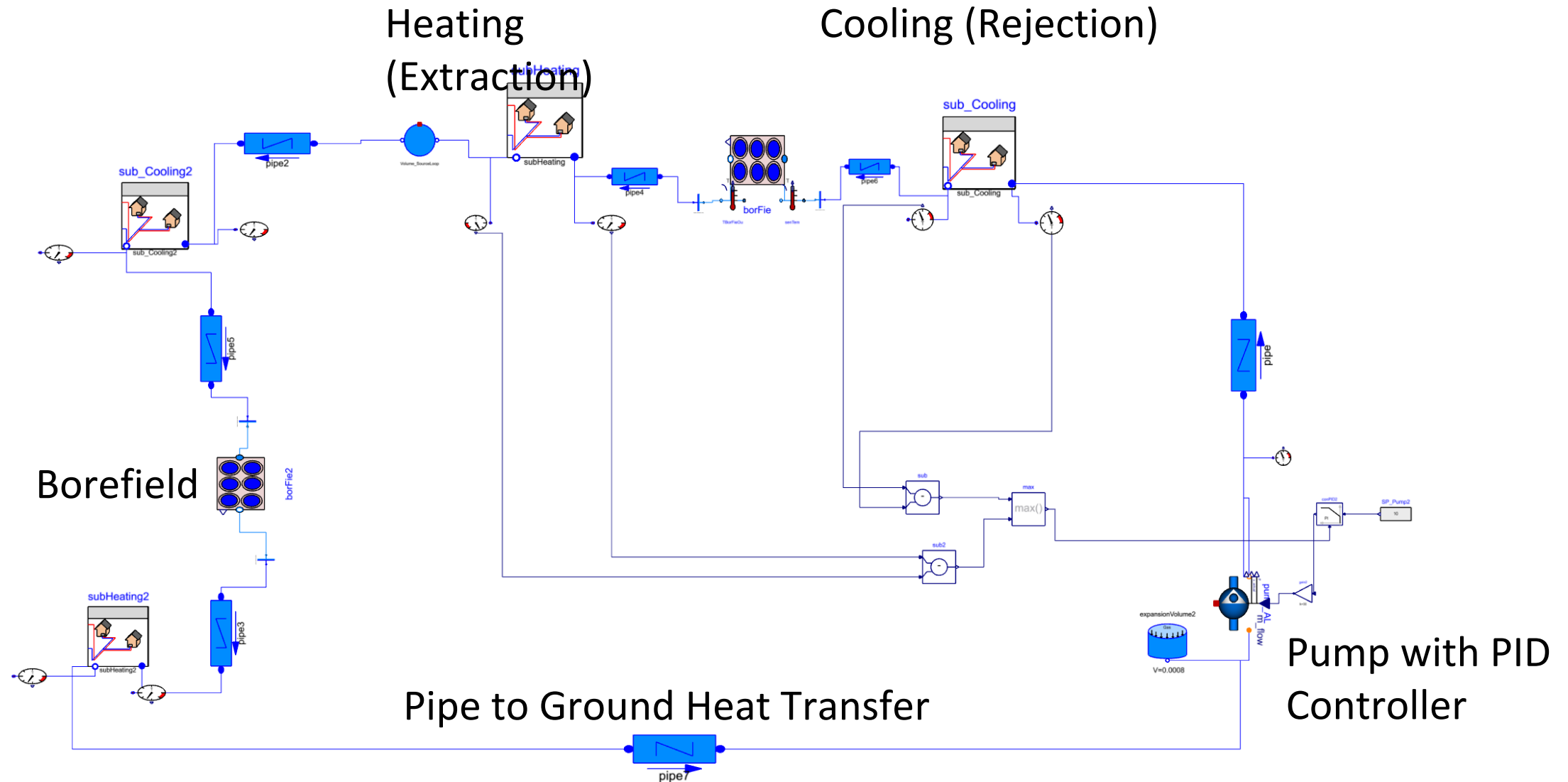


NEW 6 PIPE HEAT PUMP

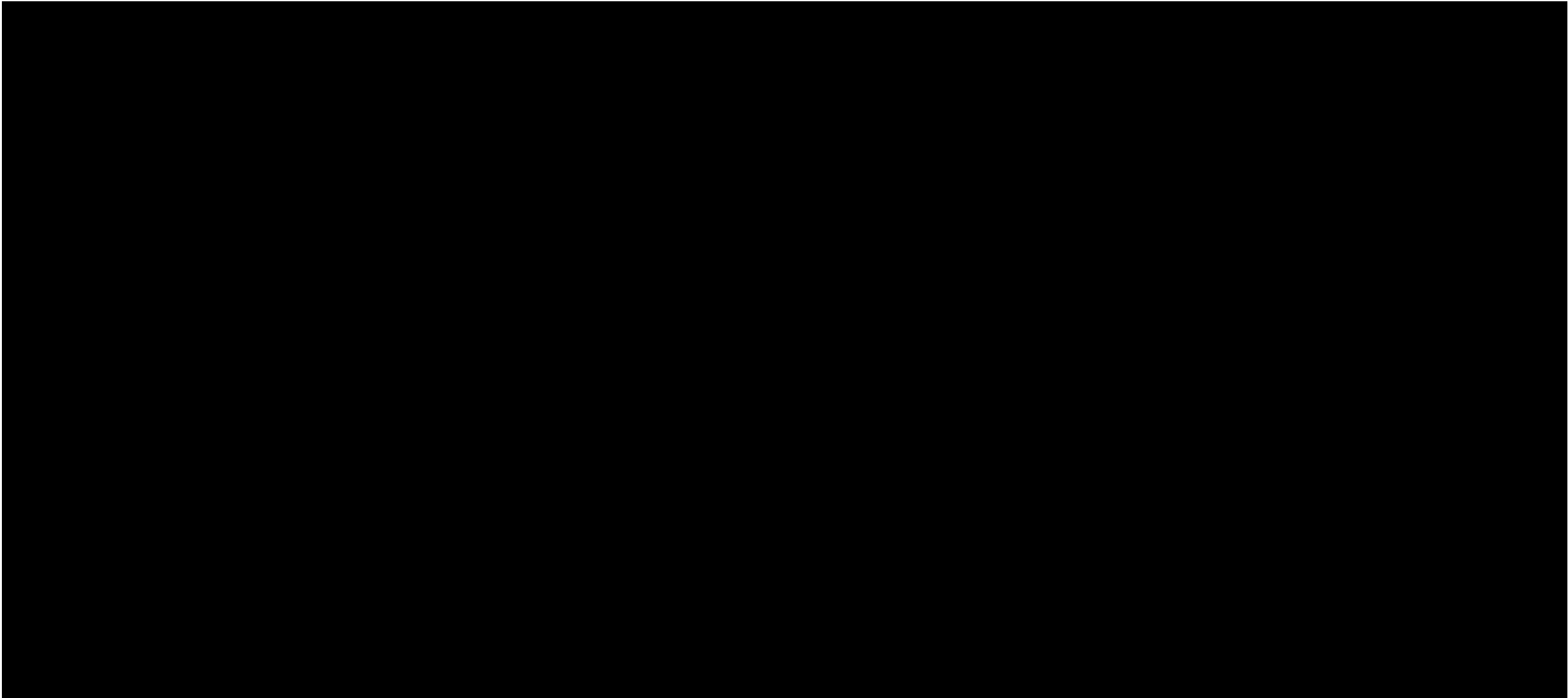


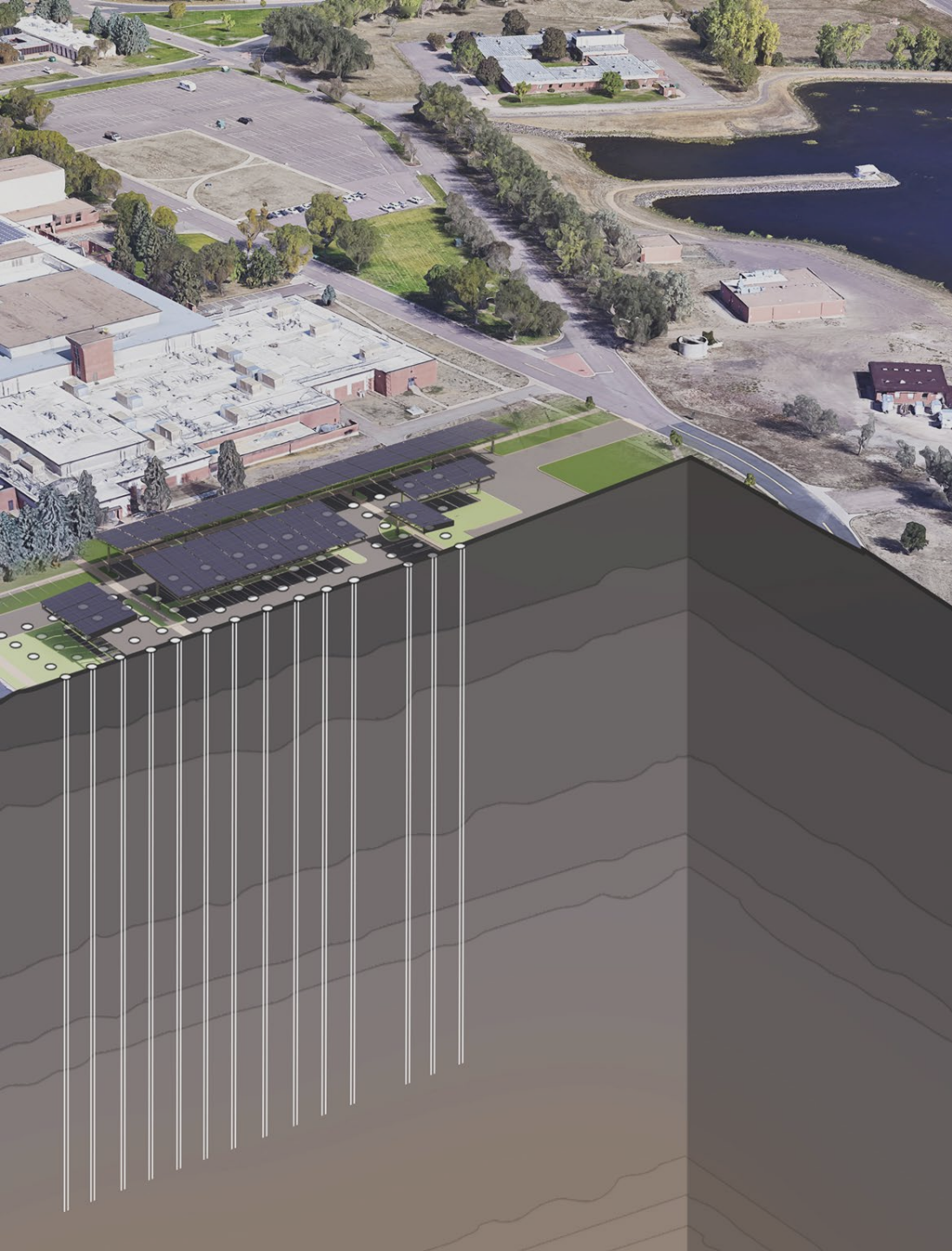
HEATING
OR
COOLING
OR
SIMULTANEOUS

THERMAL ENERGY NETWORK – AMBIENT LOOP



THERMAL ENERGY NETWORK – AMBIENT LOOP







NY - GEO 2025

APRIL 23-24, 2025 | SARATOGA SPRINGS, NY



Network Geothermal Modeling Tools

Presented by:

Brian Urlaub, Senior VP
Director of Geothermal Operations
E. brian.Urlaub@salasobrien.com

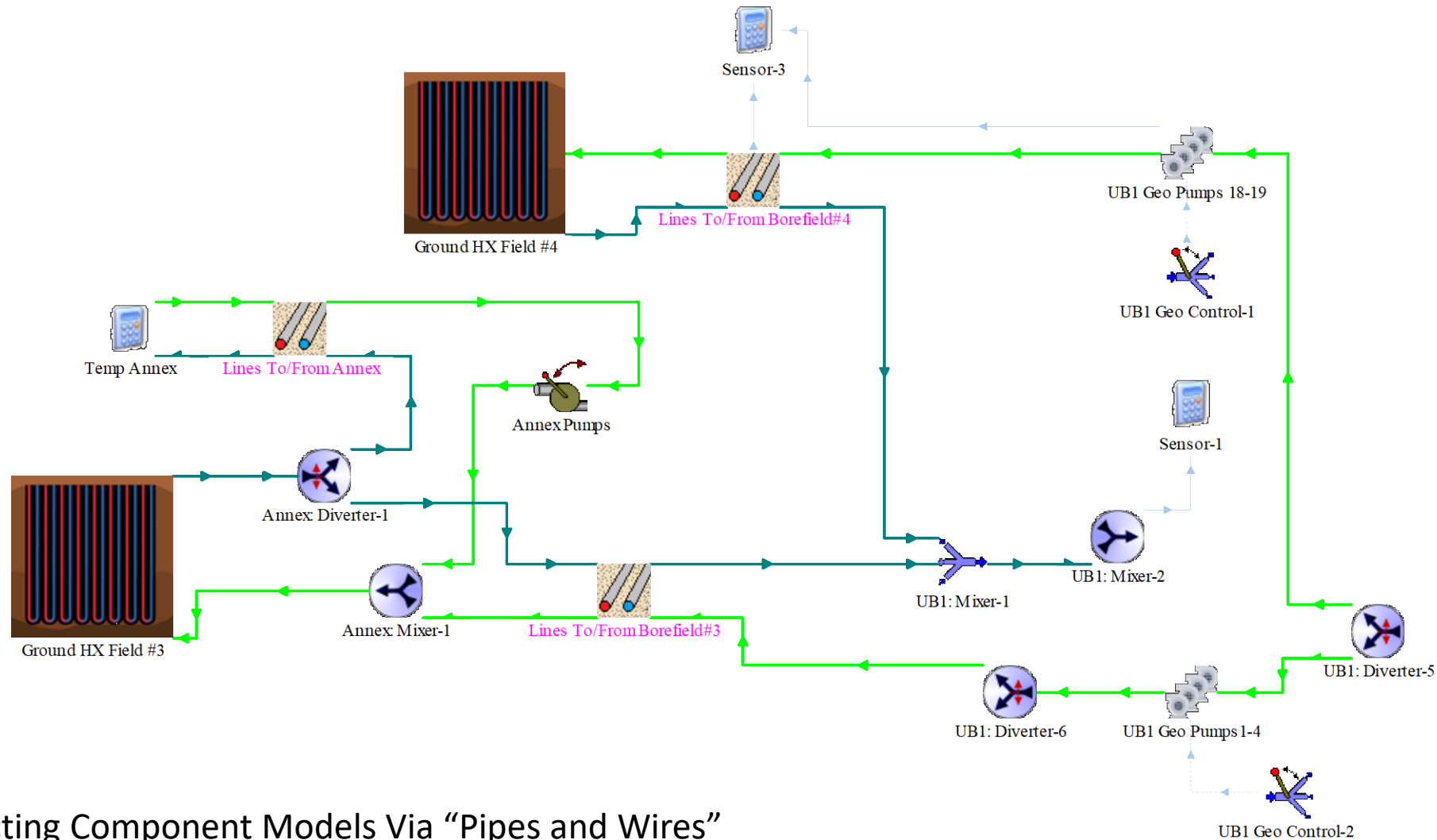
TRNSYS (Transient) Modeling

- Extremely Powerful & Flexible Modeling Tool
- Long History of Successful Projects
- Equation Solver Based on Black Box Component Concept
- Components = Pumps, Chillers, Pipes, Geo, Controllers etc.
- Parameters + Inputs → Outputs
- Output to Input Connections
- Very Easy to Add Content (New Models)
- Easily Coupled with Other Tools (Optimization, Loads, Output Processing, etc.)

TRNSYS Synopsis

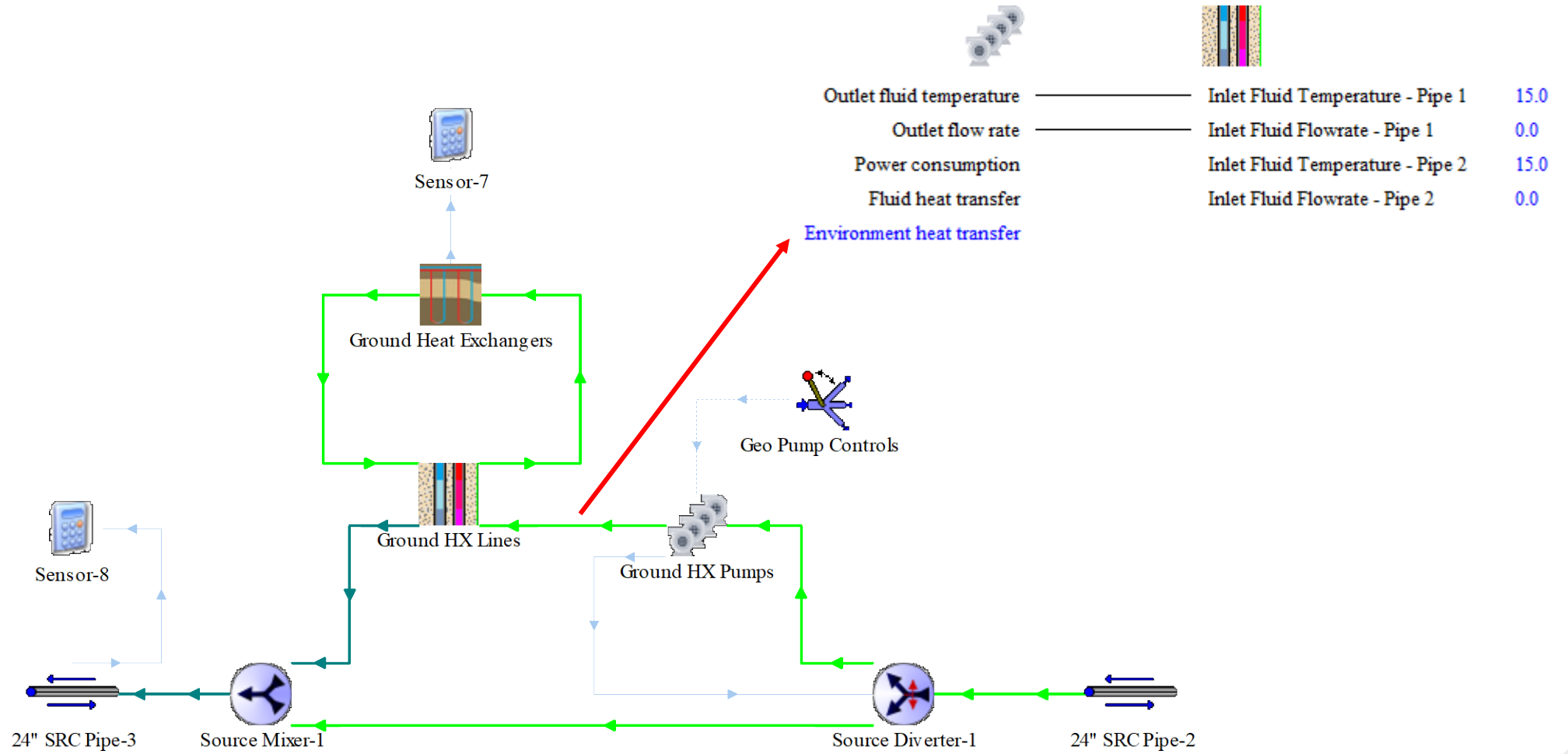
- Dynamic solution technique **reveals interconnected nature of complex system** and its components
- Utilizes an **extensive library of first principles-based component models which can be customized for each specific project**: i.e., boilers, combustion turbines, heat exchangers, pumps, pipes, storage tanks, chillers, heat pumps, cooling towers, energy recovery, ground heat exchangers, and renewable energy systems
- Custom projects are developed for **site-specific controls that can integrate multiple plants, energy sources, loads, or other system stresses**
- Planning / Design team can “watch” the modeled system run for greater insight related to asset dispatch, plant performance, and load optimization.

Building the TRNSYS Model



Connecting Component Models Via "Pipes and Wires"

Building the TRNSYS Model

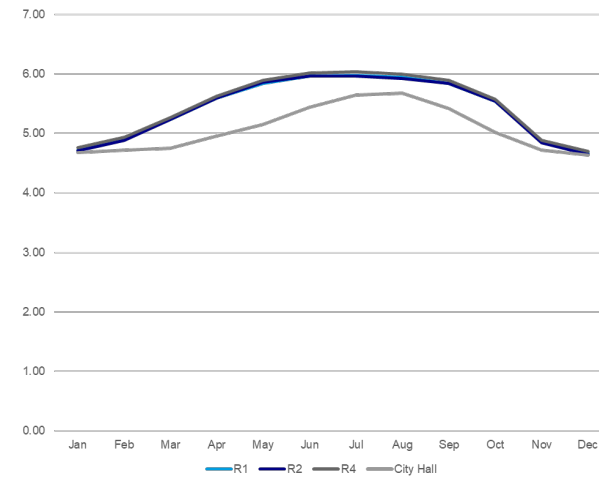


Connecting Component Models Via "Pipes and Wires"

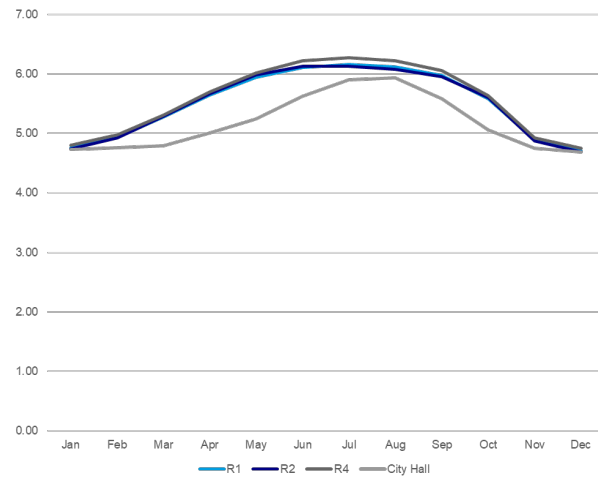
TRNSYS Outputs

- Every Temperature, Flow Rate, Power Consumption, Heat Transfer, Control Signal, etc. Can Be Output at Every 1-Minute Timestep - or Integrated and Reported Hourly, Daily, Monthly, and Annually
- Outputs Can be Displayed as the Simulations Run to Study System Behavior, Control Decision Impacts, etc.

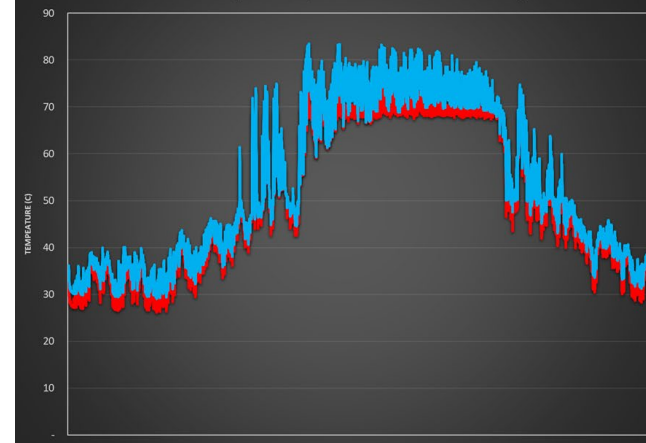
Monthly Average COP (5deg)



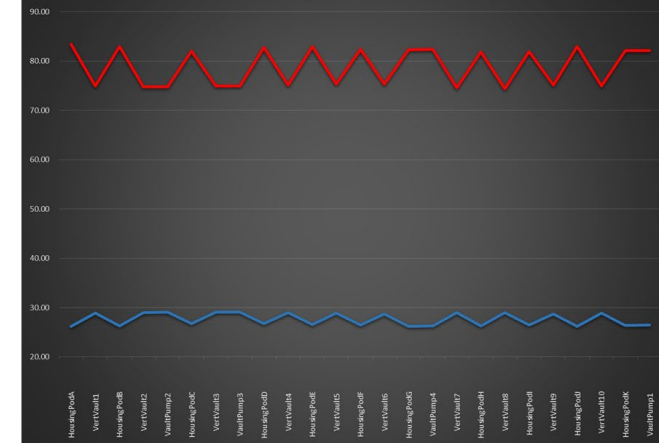
Monthly Average COP (12deg)



Year 10 Min/Max Temperatures in the Ambient Loop



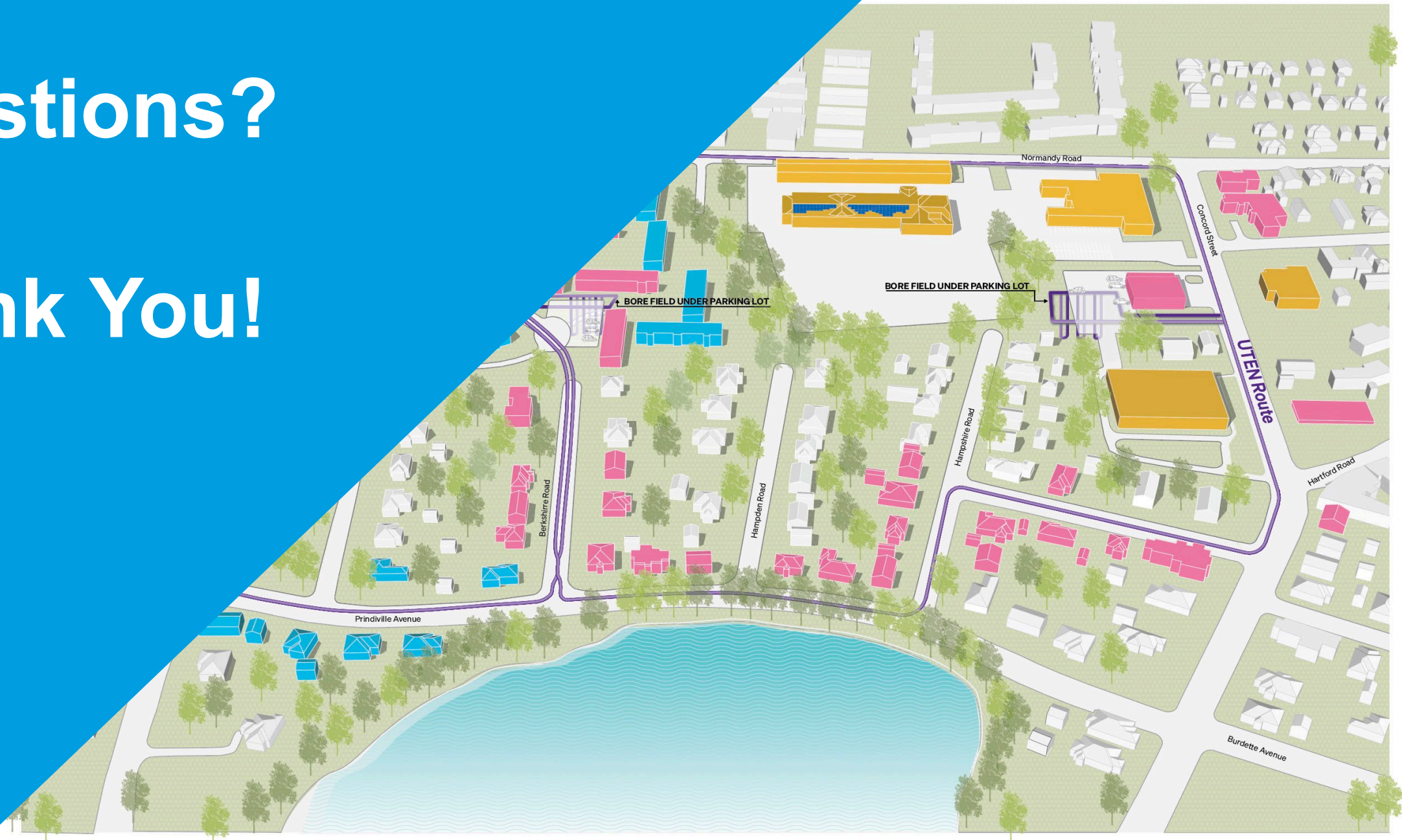
Max & Min Temperatures Around the Loop



Questions?

Thank You!

Phase 1  Phase 2  Potential Customers





NY - GEO 2025
APRIL 23-24, 2025 | SARATOGA SPRINGS, NY



Thermal Energy Network Modeling Tools

Moderator: Aeowyn Kendall / *Aztech Geothermal, LLC*

Panel: Brendan Hall / *CHA Solutions*

Jason Willeford / *Jacobs*

Victor Braciszewski / *SmithGroup*

Brian Urlaub / *Salas O'Brien*