Sidewalk Lab
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Quayside Energy Systems Analysis

Jianjun Hu
Michael Wetter

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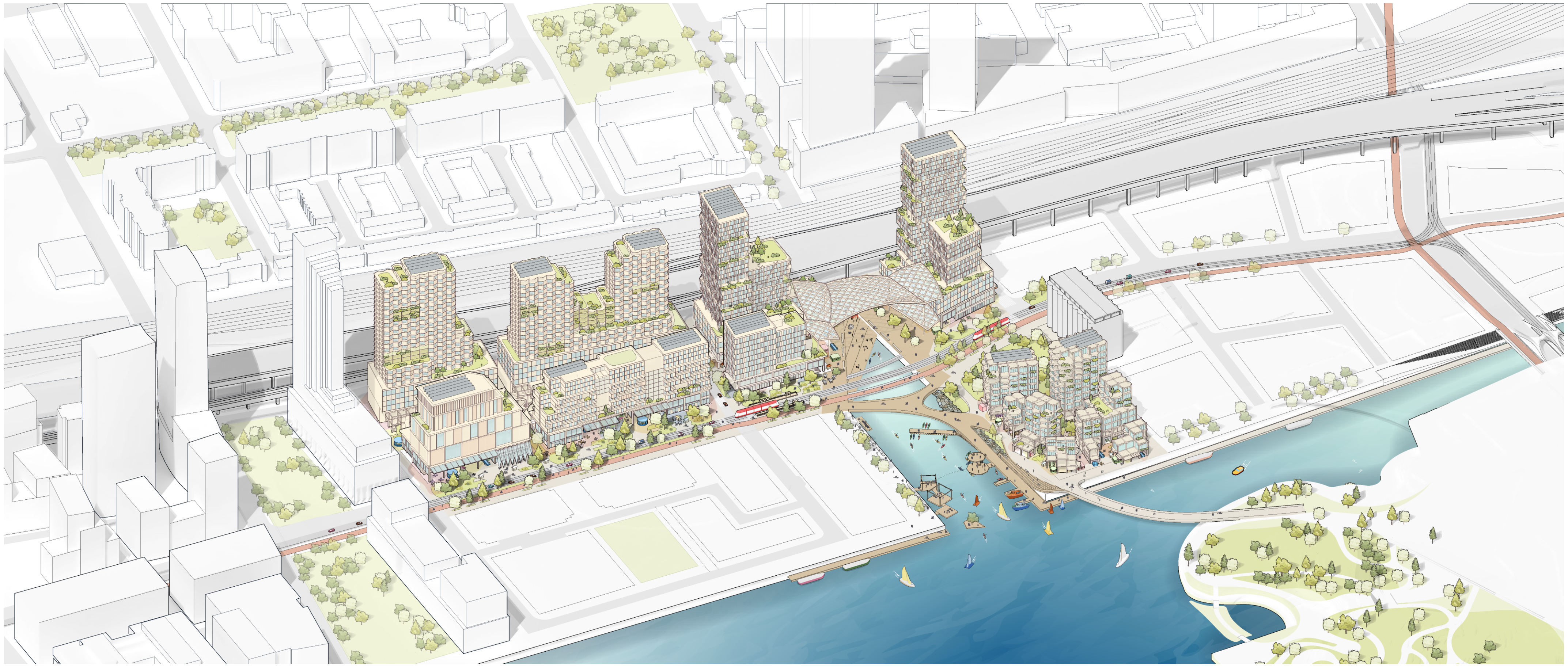
BERKELEY LAB
Lawrence Berkeley National Laboratory

Sidewalk Lab, Toronto Quayside development

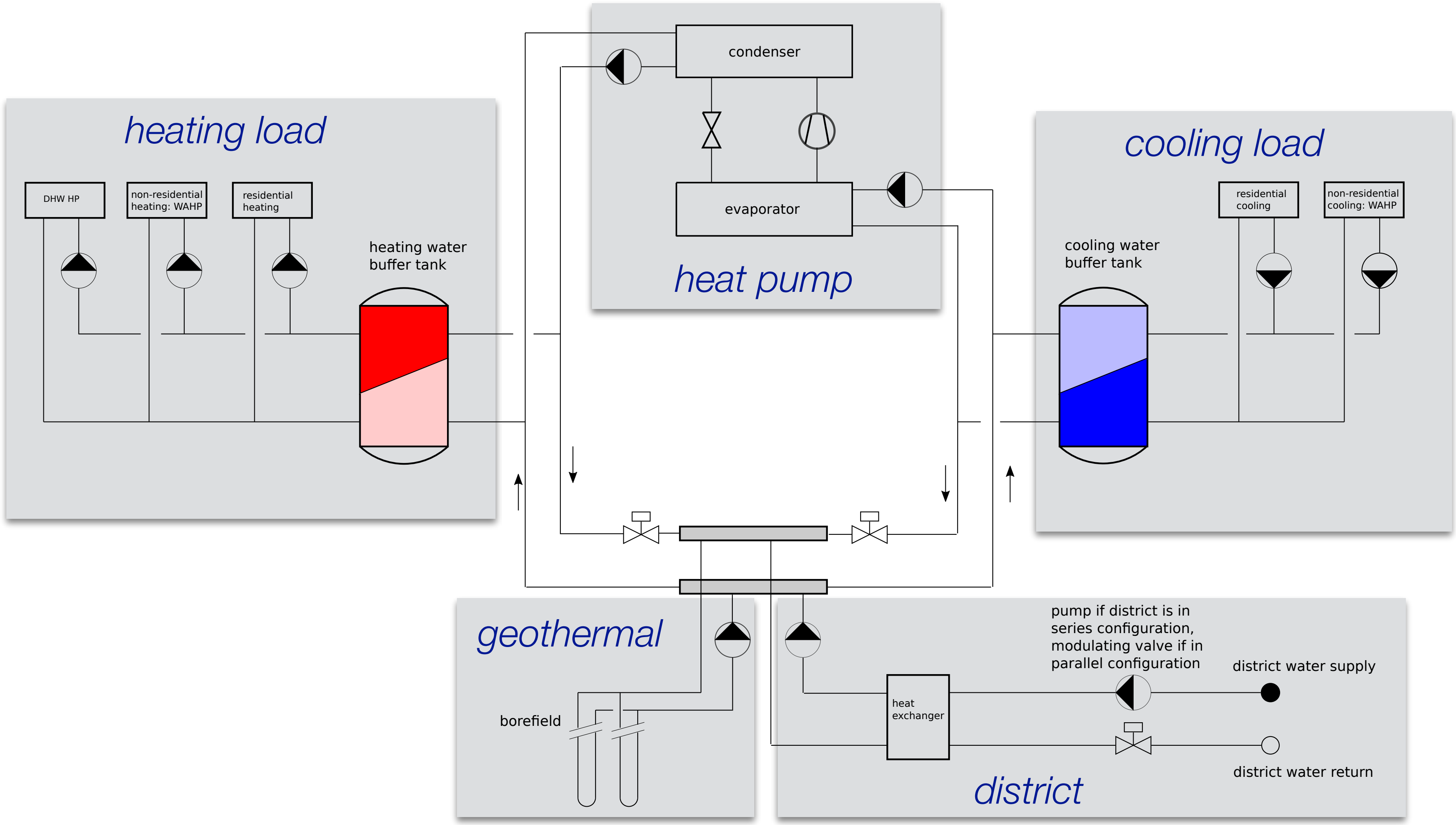
Mixed-use community with heating and cooling provided through district heating and cooling (DHC) system that integrates:

- industrial waste heat
- geothermal storage
- heat pumps



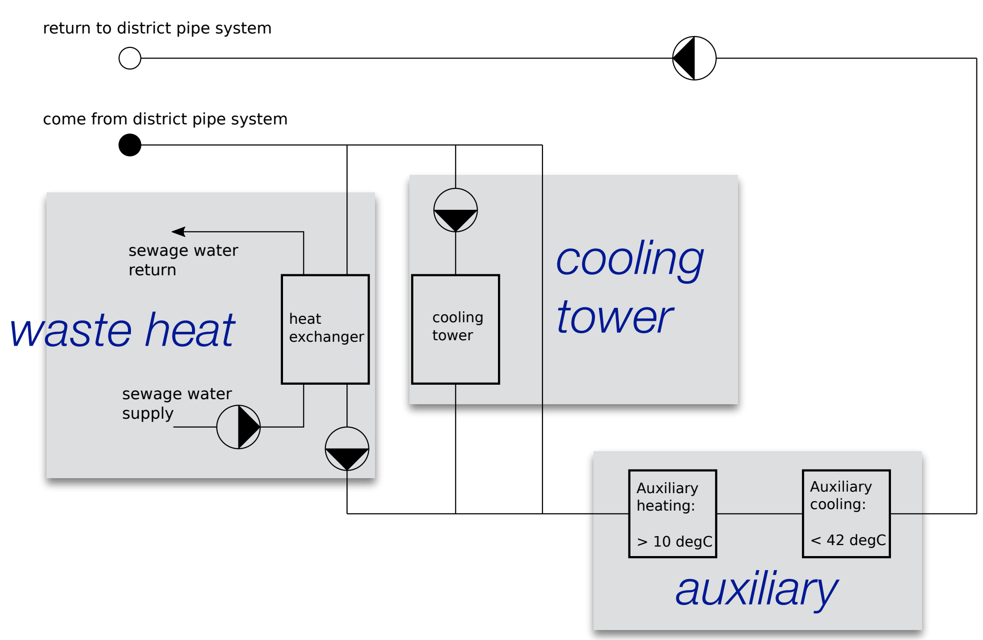
Goal: *flexible* and *expandable* system, being *climate positive*

Model description: substation, energy center



Substations:

- buffer tanks to ensure hydraulic stability
- heat pump allows direct heat recovery
- dual heating/cooling sources



Energy center:

- recover waste heat from sewage
- cooling tower to provide district cooling
- auxiliary sources as backup

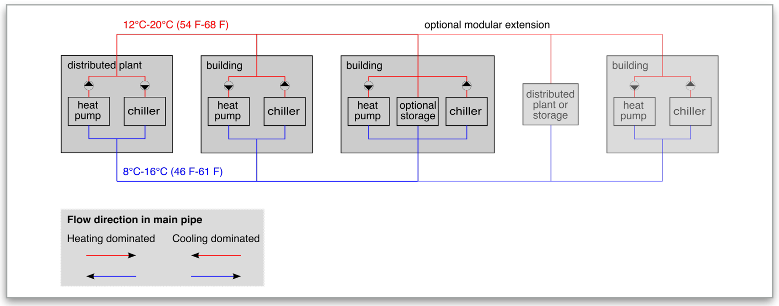
Simulation setup

Assembled component models from Modelica Buildings Library to form system models, including supervisory ***control sequences***.

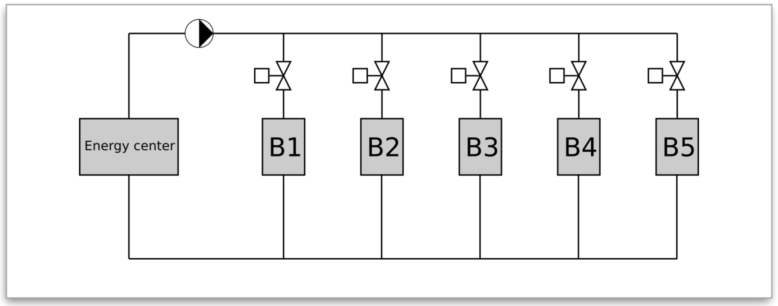
Investigated different designs, regarding:

- thermal ***network*** architectures
- geothermal system sizes
- design setpoint temperatures
- equipments effectiveness

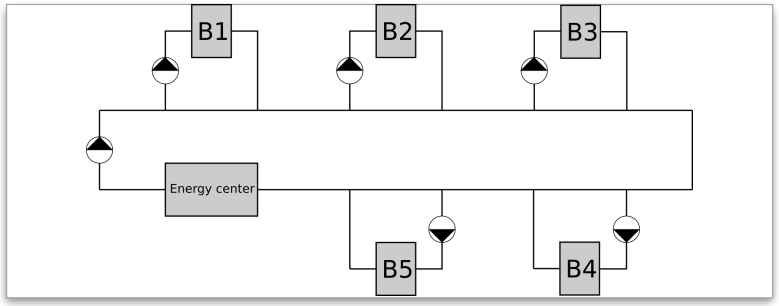
Bi-directional



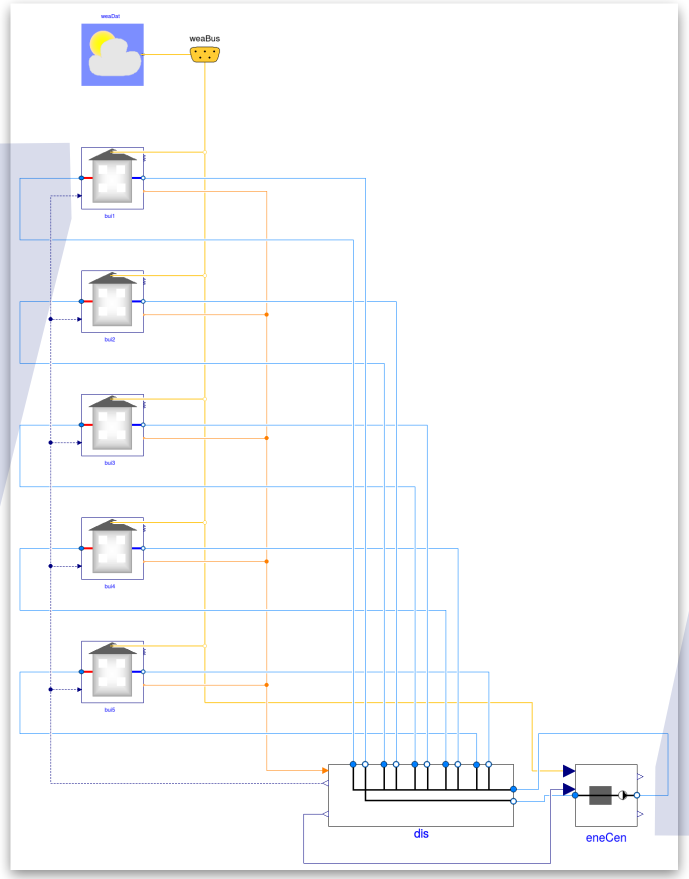
Uni-directional: parallel substations



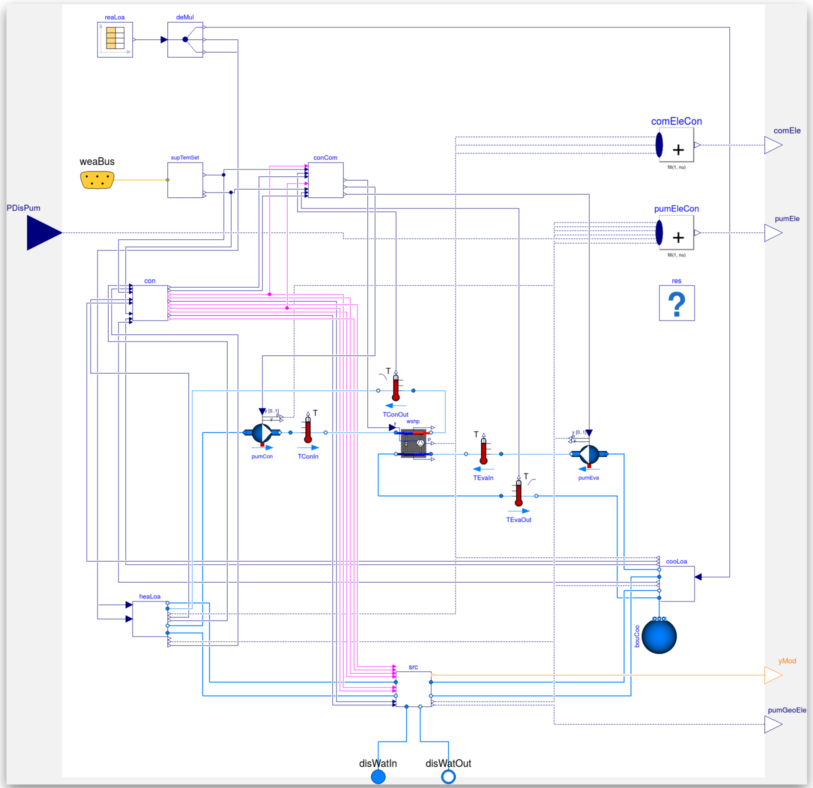
Uni-directional: series substations



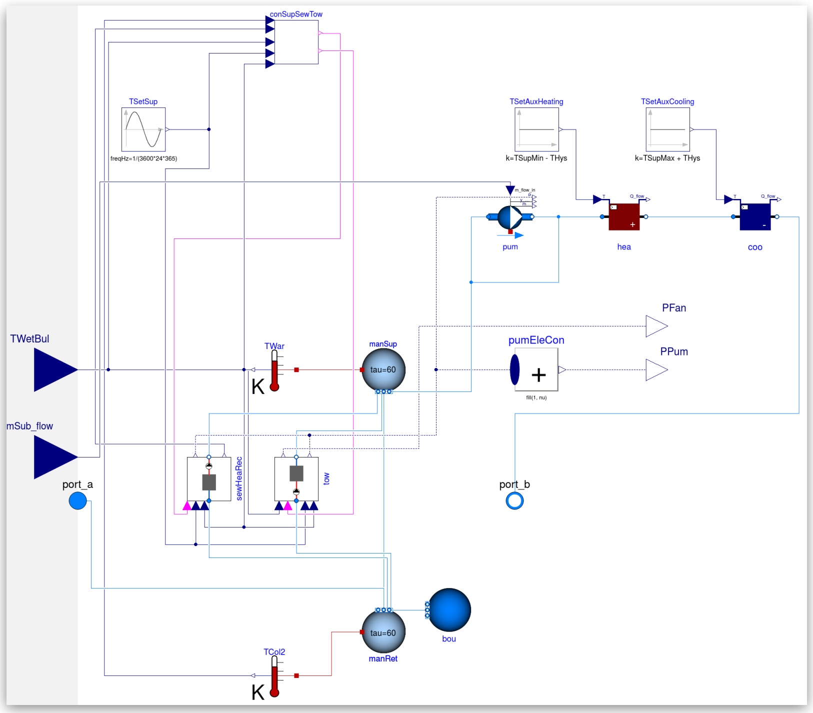
DHC system model



***Substation** model*



Energy source model



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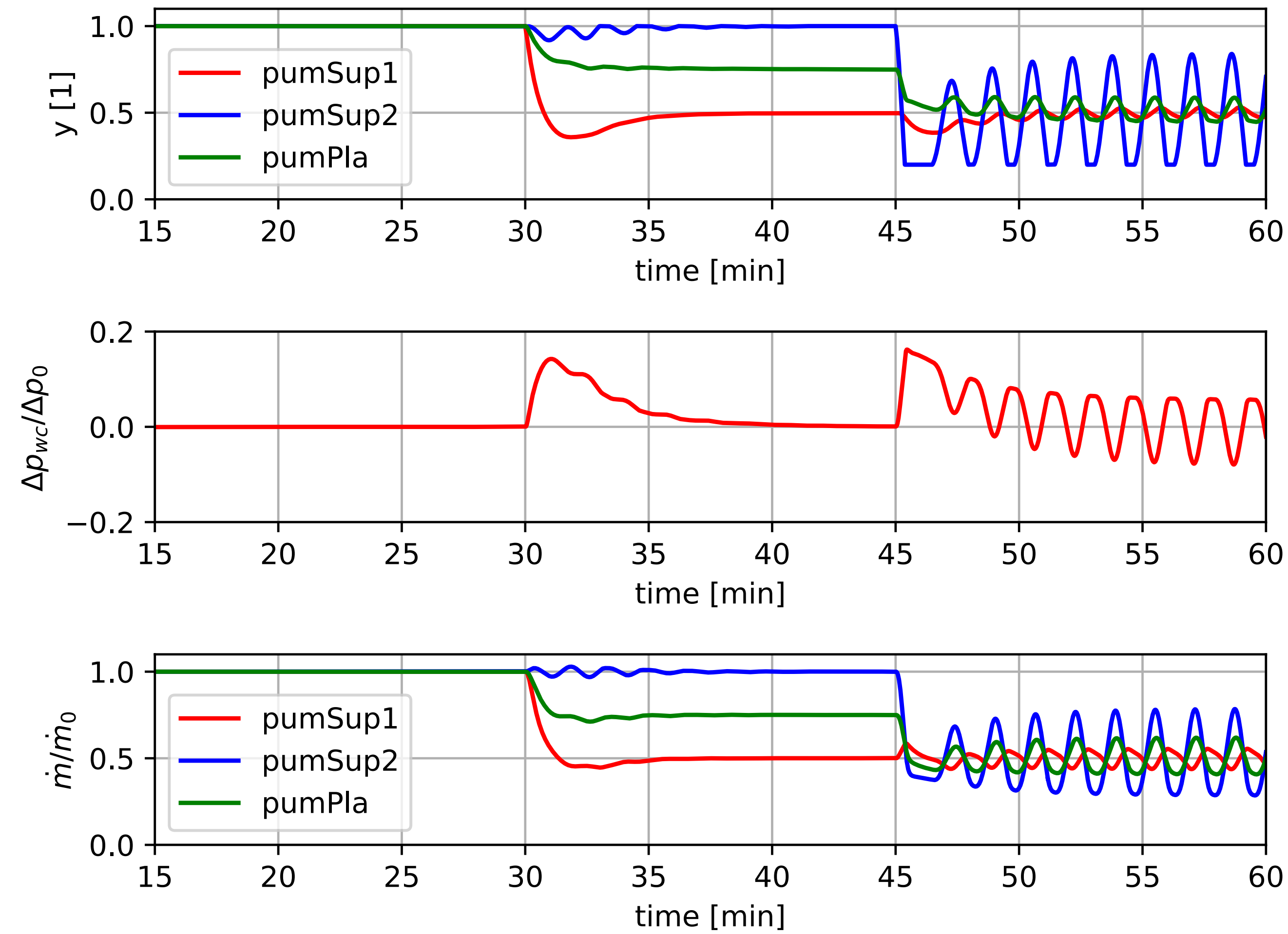
Conducted simulation based on hourly weather data and hourly load profiles for one year.

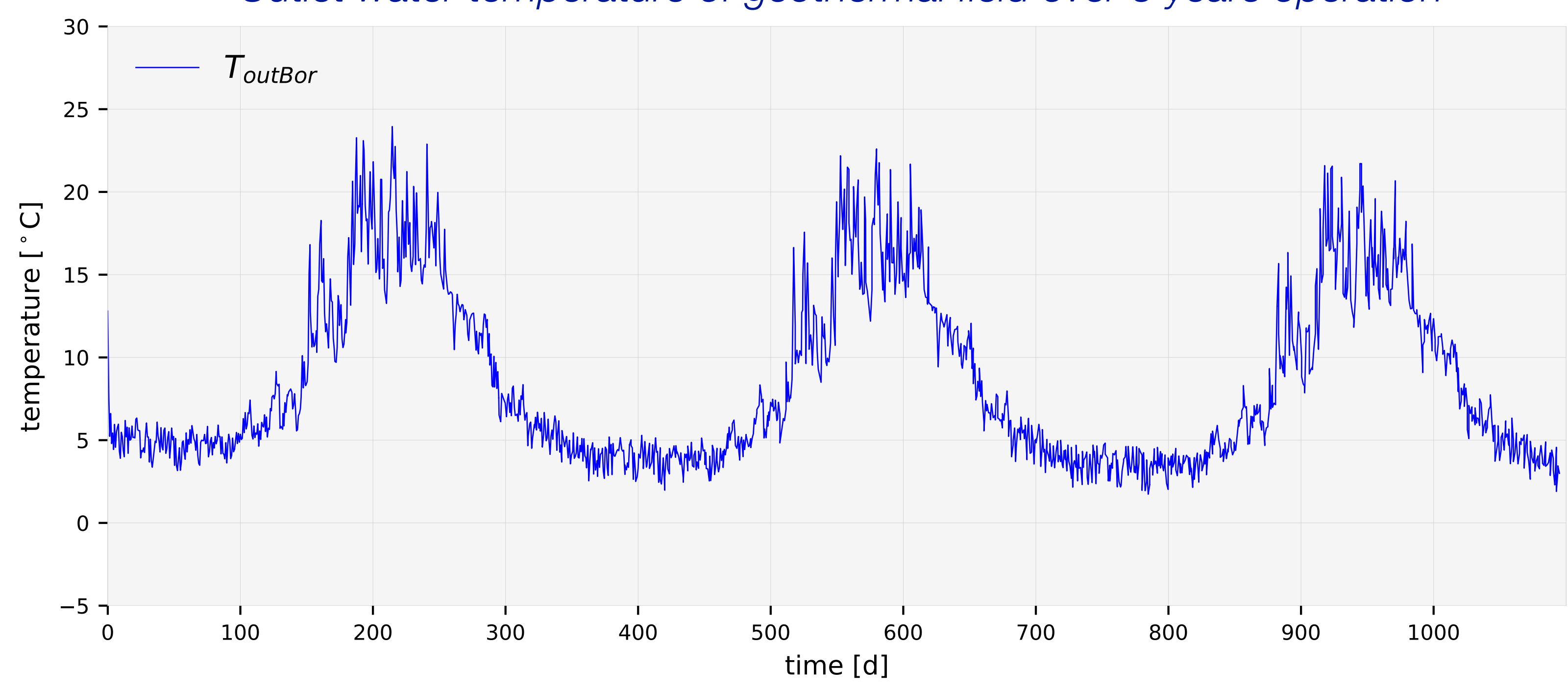
Evaluated the different designs, compared:

- energy consumption
- electricity usage
- electricity cost
- greenhouse gas emission
- hydraulic stability
- long-term borefield behavior

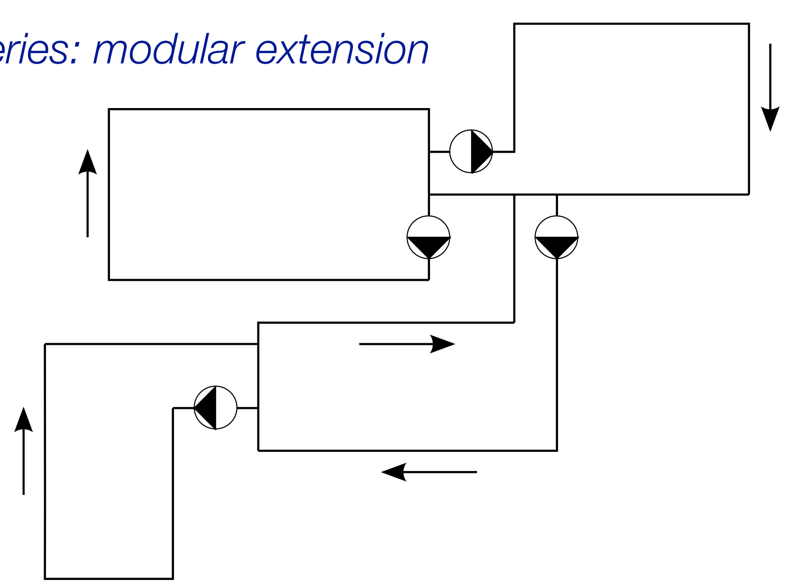
Early design showed to be too hard to control



Outlet water temperature of geothermal field over 3 years operation



Uni-series: modular extension



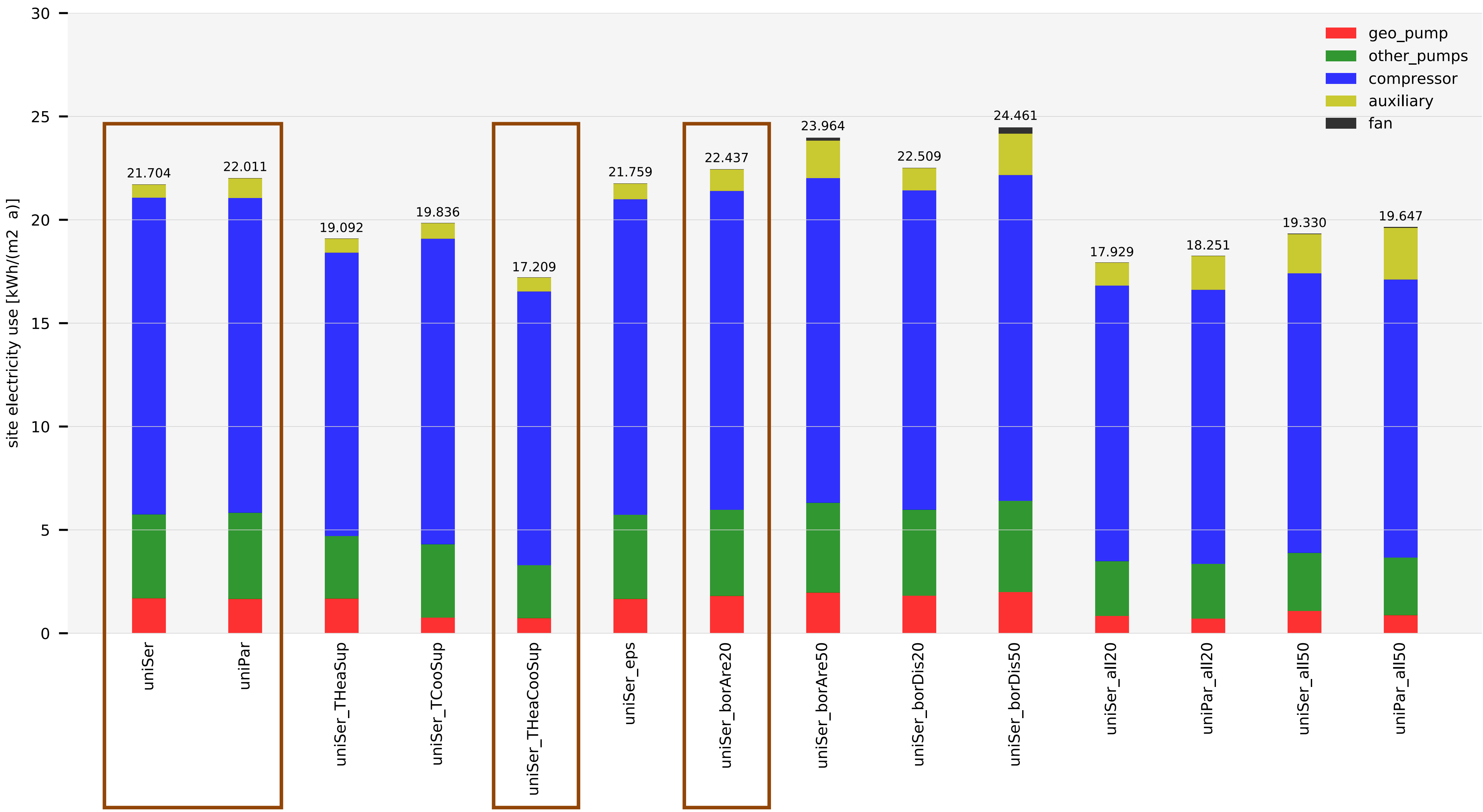
Simulated cases

Case	TheaSup (°C)	TheaRet (°C)	TCooSup (°C)	TCooRet (°C)	eps	geoLenSca	geoHDisSca
uniSer	41	30	4	15	0.71	1	1
uniPar	41	30	4	15	0.71	1	1
uniSer_THeaSup	30	25	4	15	0.71	1	1
uniSer_TCooSup	41	30	10	18	0.71	1	1
uniSer_THeaCooSup	30	25	10	18	0.71	1	1
uniSer_eps	41	30	4	15	0.9	1	1
uniSer_borAre20	41	30	4	15	0.71	0.8	1
uniSer_borAre50	41	30	4	15	0.71	0.5	1
uniSer_borDis20	41	30	4	15	0.71	1	$1/\sqrt{0.8}$
uniSer_borDis50	41	30	4	15	0.71	1	$1/\sqrt{0.5}$
uniSer_all20	30	25	10	18	0.9	0.8	1
uniPar_all20	30	25	10	18	0.9	0.8	1
uniSer_all50	30	25	10	18	0.9	0.5	1
uniPar_all50	30	25	10	18	0.9	0.5	1

- uniSer: series uni-directional system,
- uniPar: parallel uni-directional system,
- _THeaSup: changing design heating water temperature,
- _TCooSup: changing design cooling water temperature,
- _THeaCooSup: changing both design heating and cooling water temperature,
- _eps: changing design heat exchanger effectiveness,
- _borAre20 and _borAre50: shorten the geothermal field by 20% and 50% respectively,
- _borDis20 and _borDis50: reducing the borehole numbers by 20% and 50% respectively.

Main results

- Series configuration lead to 1.4% less energy use than the parallel configuration, and is easier to control.
- 21% reduction in annual energy by lowering design temperatures (cooling from 4… 15C to 10 ... 18C; heating 41C to 30C).
- Number of boreholes can be moderately reduced with <4% impact on energy.



Questions?

Jianjun Hu: jianjunhu@lbl.gov

Report link: https://buildings.lbl.gov/publications/quayside-energy-systems-analysis