Single Pipe Design for Integrated Community Energy Systems

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McMaster University – MASc Canddiate

A Unique Research Co-operative for a Unique Energy Landscape

- 17 Industry Partners joined with McMaster and Carleton Universities to form an Energy Research Consortium to tackle the problems facing the Canadian energy landscape with a **communities first approach.**
- Funded by NSERC and OCE to address with a goal to redesign how we interact with energy while increasing resiliency and efficacy of our existing cities from a holistic energy viewpoint.
- $2.7 million in funding was awarded to McMaster University to support leading energy system research for its **ICE-Harvest Systems Project**
- ICE-Harvest Systems promotes a VISION of a more sustainable community that produces, utilizes and manages its own energy systems

Potential Solution

MIES

Integrated Community Energy Systems – A Whole Systems Approach

Thermal Energy Generation

Electrical Generation

Thermal Energy Storage

Electrical Storage

THE VISION EMC Integrated Community Energy and Harvesting System

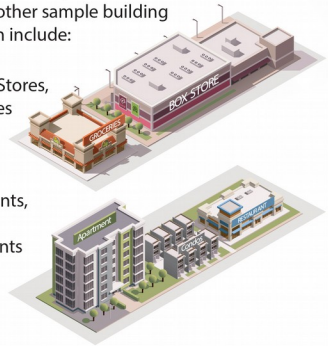
ENERGY MANAGEMENT CENTRE

McMaster University ENGINEERING

- Energy Transfer Station
- Community Buildings - Arena, Pool, Community Centre
- Electricity Generation
- Electricity Storage
- Thermal Energy Generation
- Thermal Energy Storage
- Underground Geothermal Seasonal Energy Storage

The EMC will plug into various components of the community. As well as those shown at right, other sample building types can include:

- Grocery Stores, Box Stores
- Apartments, Condos, Restaurants



- Electrical Flow
- Heated Fluid Return Flow
- Chilled Fluid Return Flow
- Thermal Energy Network

ARENA

Community POOL

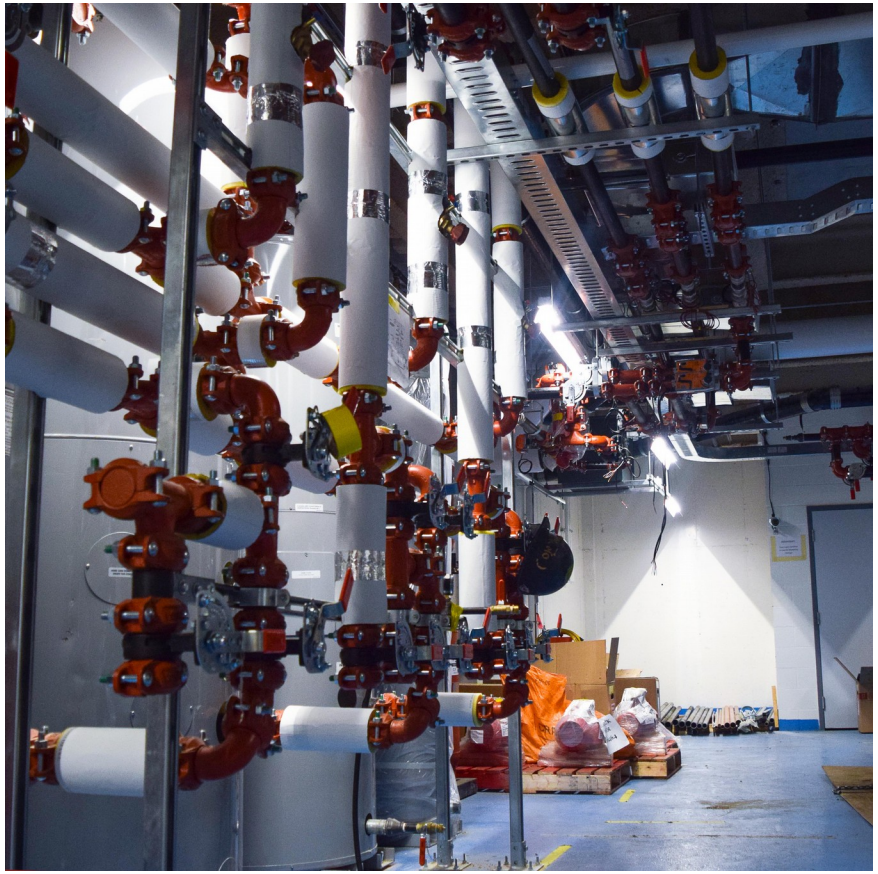
Community CENTRE

EMC ENERGY MANAGEMENT CENTRE

Harvested Waste Energy

ICE Harvest Facility

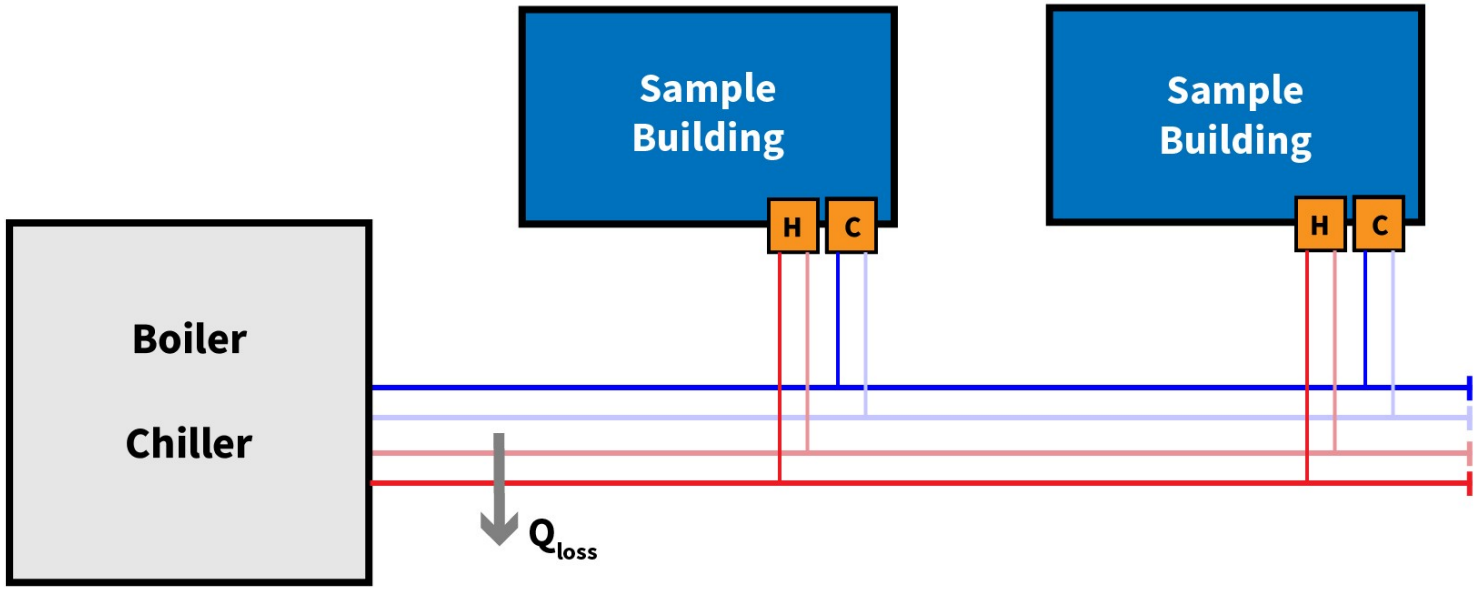
MIES

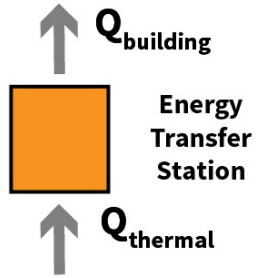


My Focus: Thermal Networks

MIES

Four Pipe Thermal Network

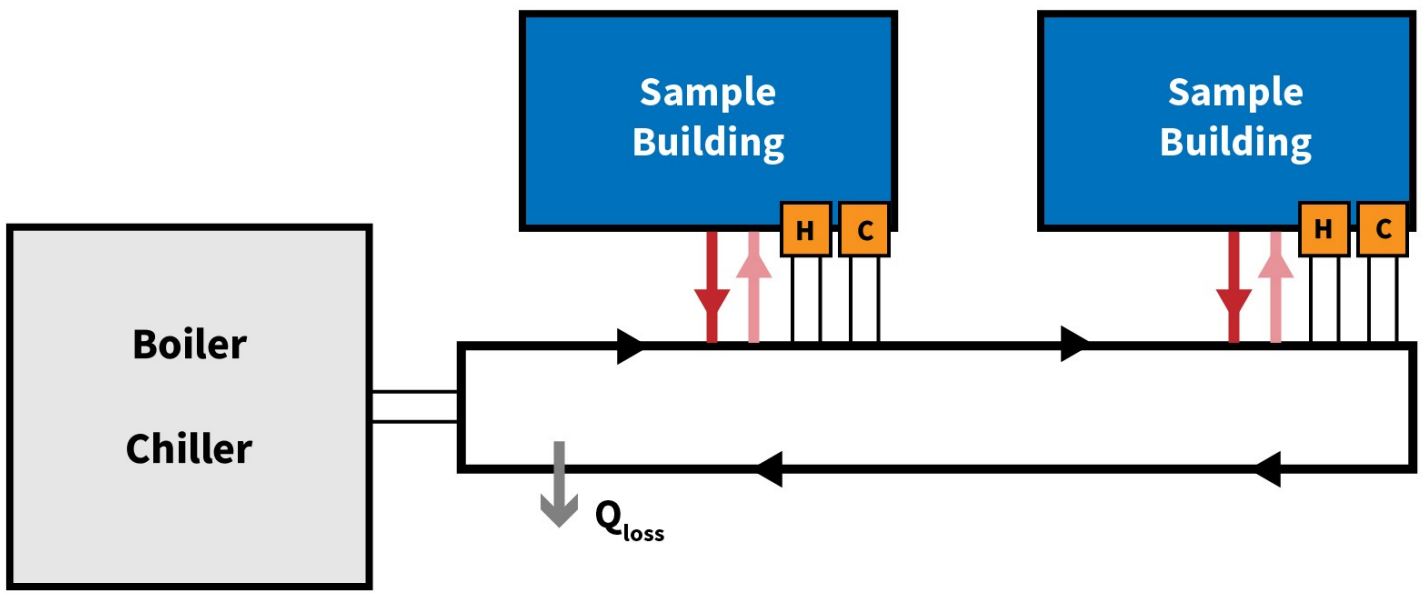


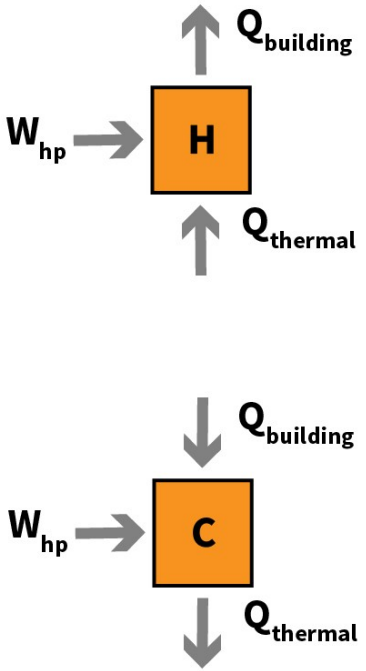


My Focus: Thermal Networks

MIES

One Pipe Thermal Network

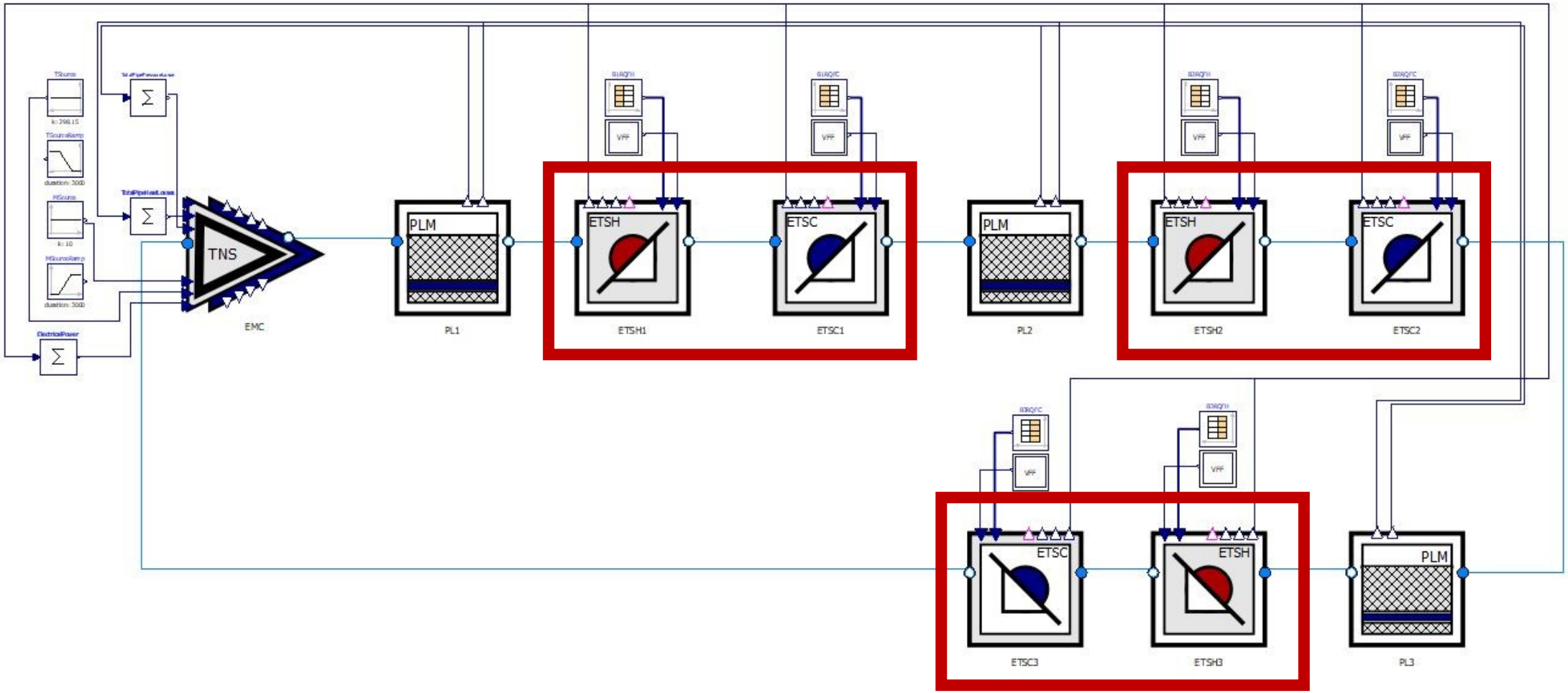




Modelica Models

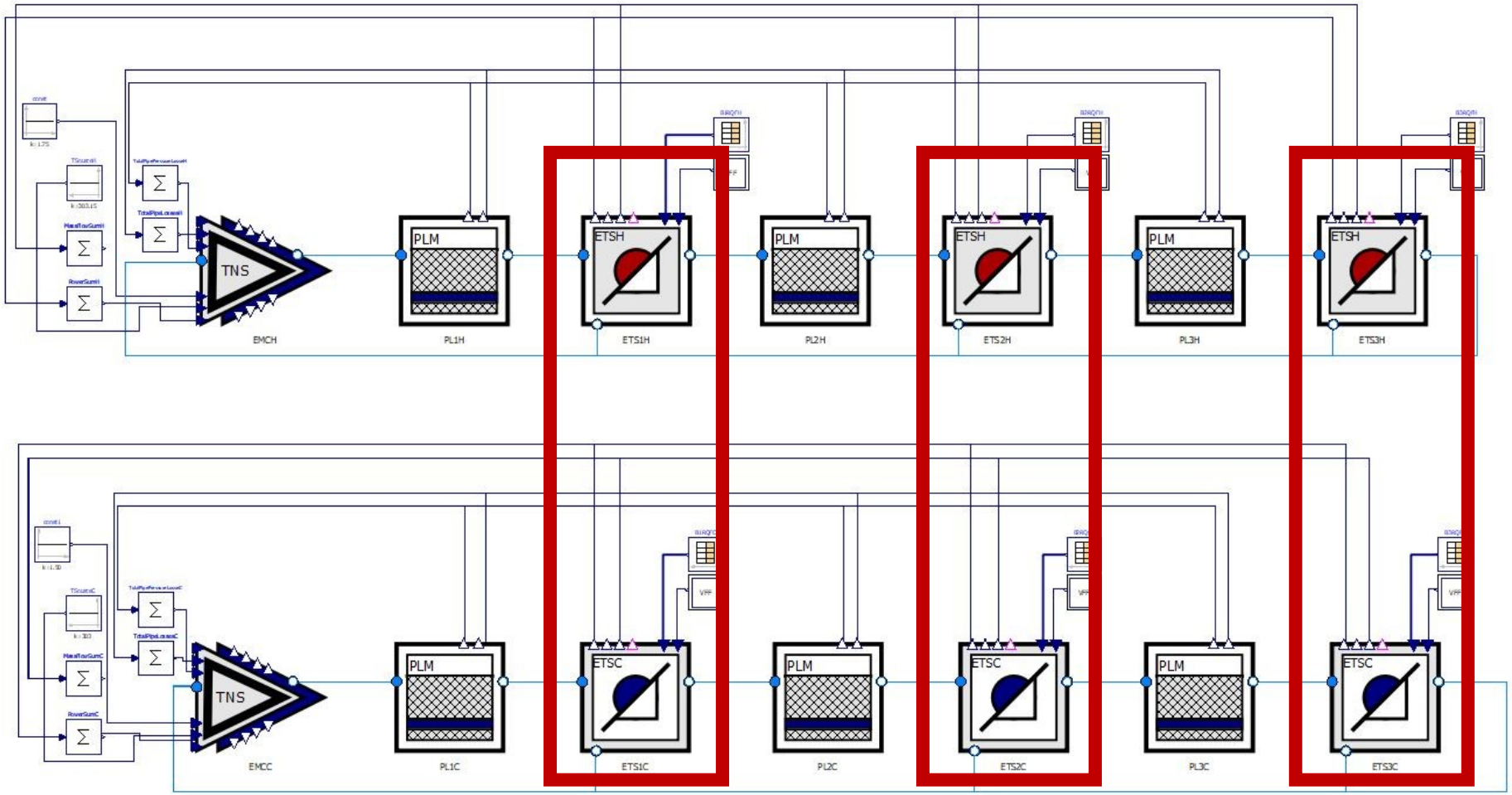
One Pipe Thermal Network

MIES



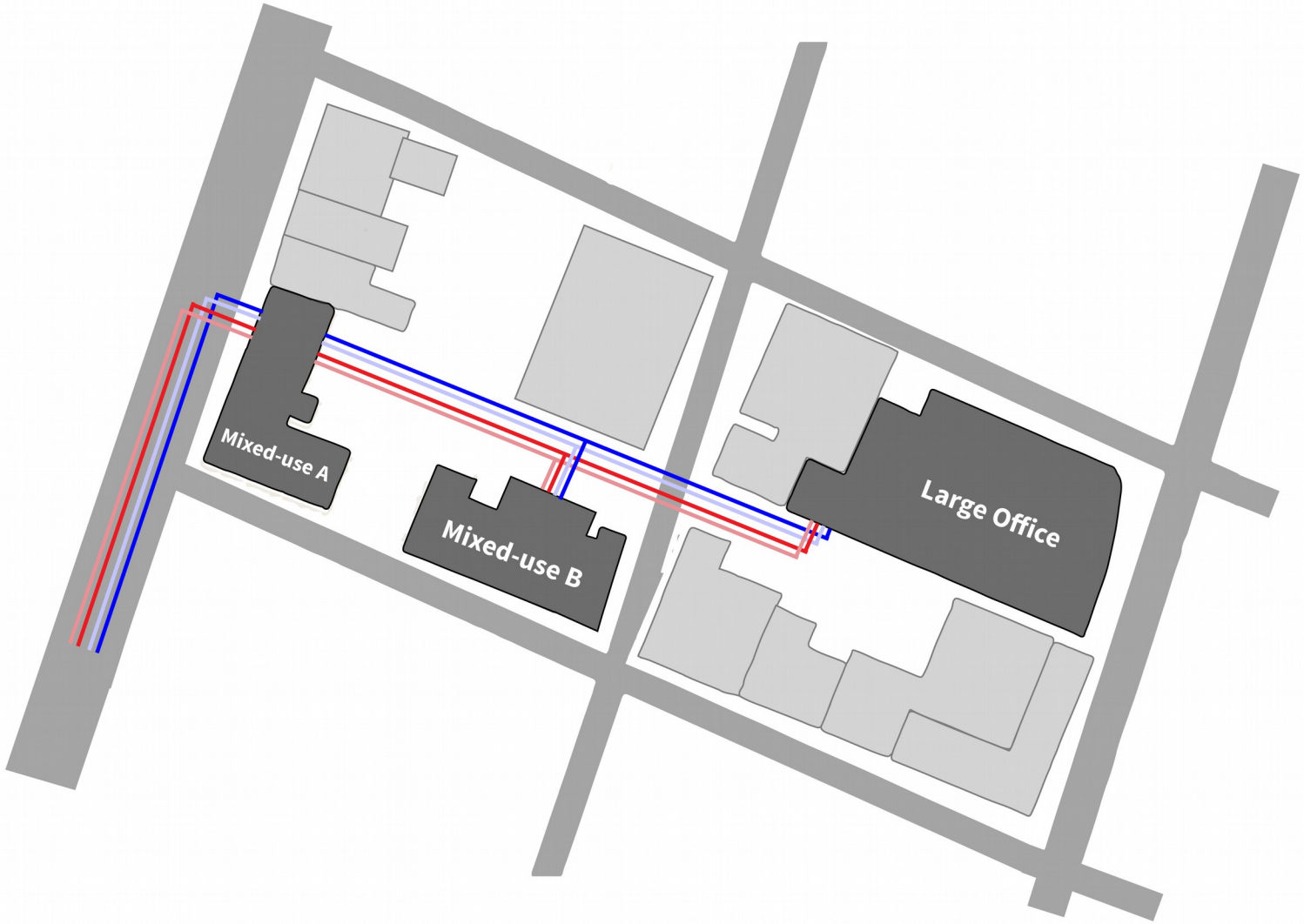
Four Pipe Thermal Network

MIES



Case Study

Case Study: 4PDH



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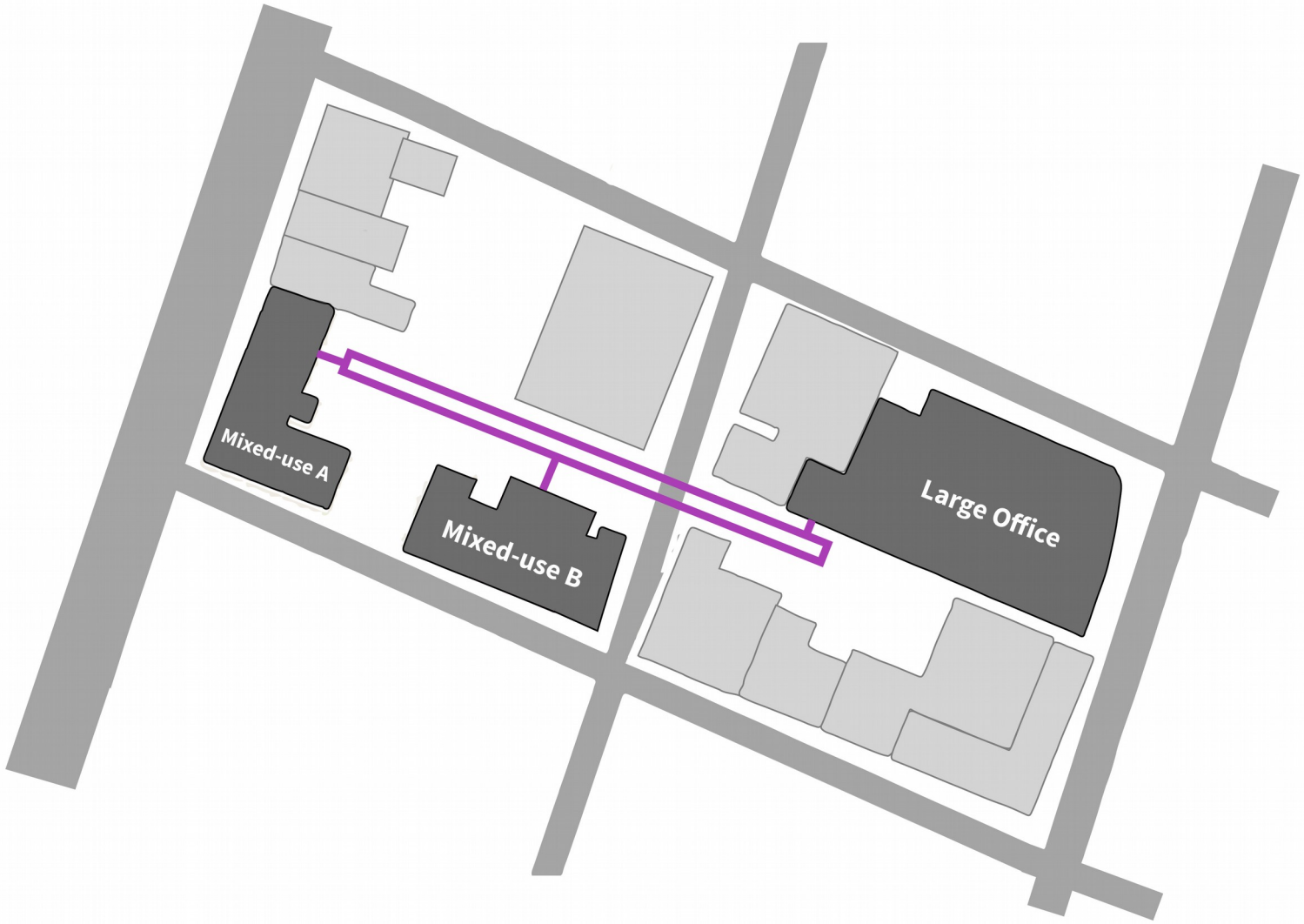
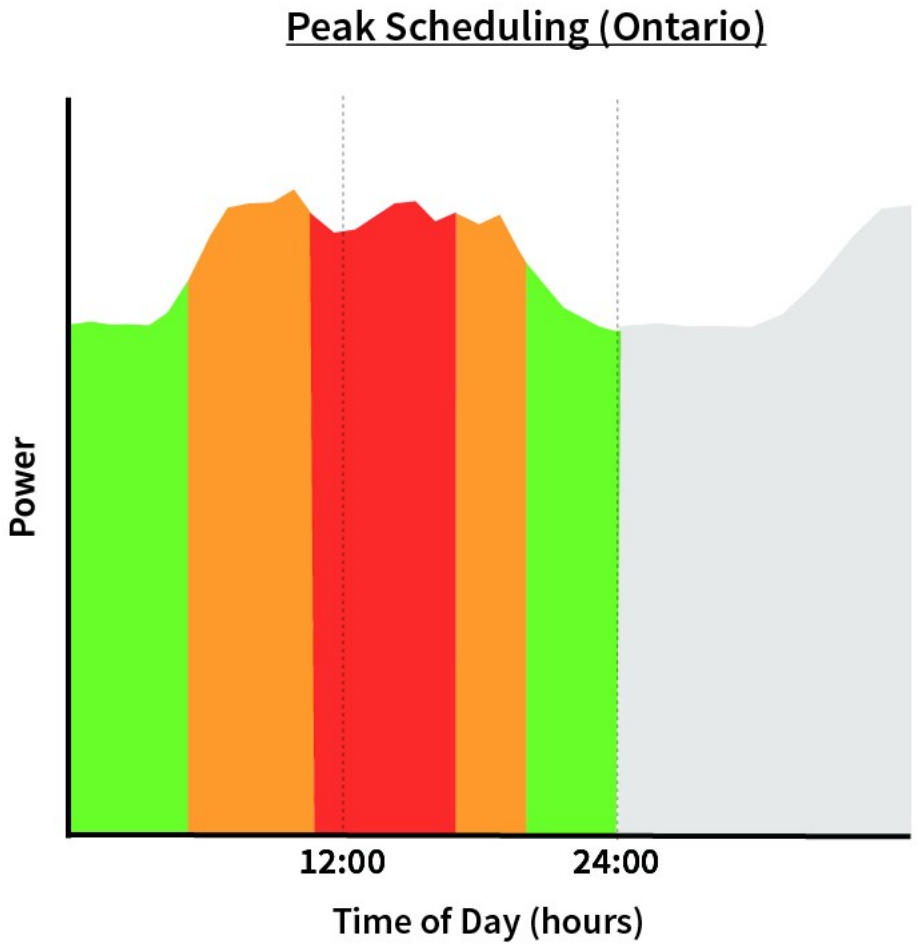


Energy Landscape



Time Of Use Pricing

Off Peak: 6.5¢ per kWh (0:00 – 7:00, 19:00 – 24:00)

Mid Peak: 9.4¢ per kWh (7:00 – 11:00, 17:00 – 19:00)

On Peak: 13.2¢ per kWh (11:00 – 17:00)

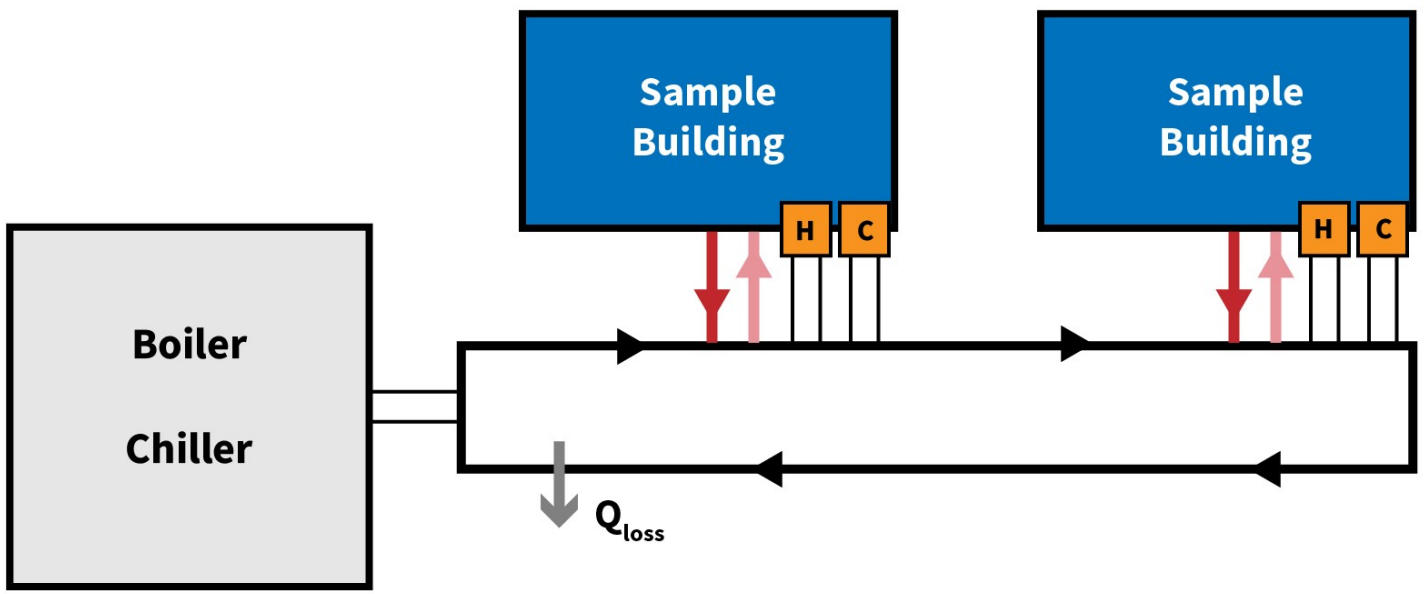
Gas Pricing

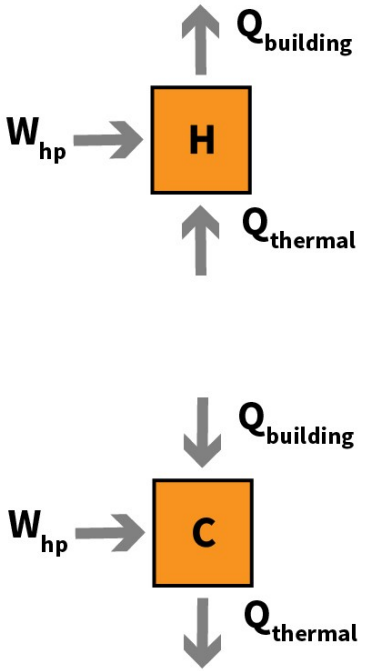
13.18¢ per m^3

Potential Problem

MIES

One Pipe Thermal Network





Solution 1:

CHP and Back Up Boiler

Heating Supply:
On Peak: CHP used to provide heat for thermal network and electricity for heat pumps

Off Peak: Boiler used to provide heat and grid used to provide electricity for heat pumps (grid pricing)

Cooling Supply: Electric Chiller

Solution 2:

CHP and Ground Source Heat Pump

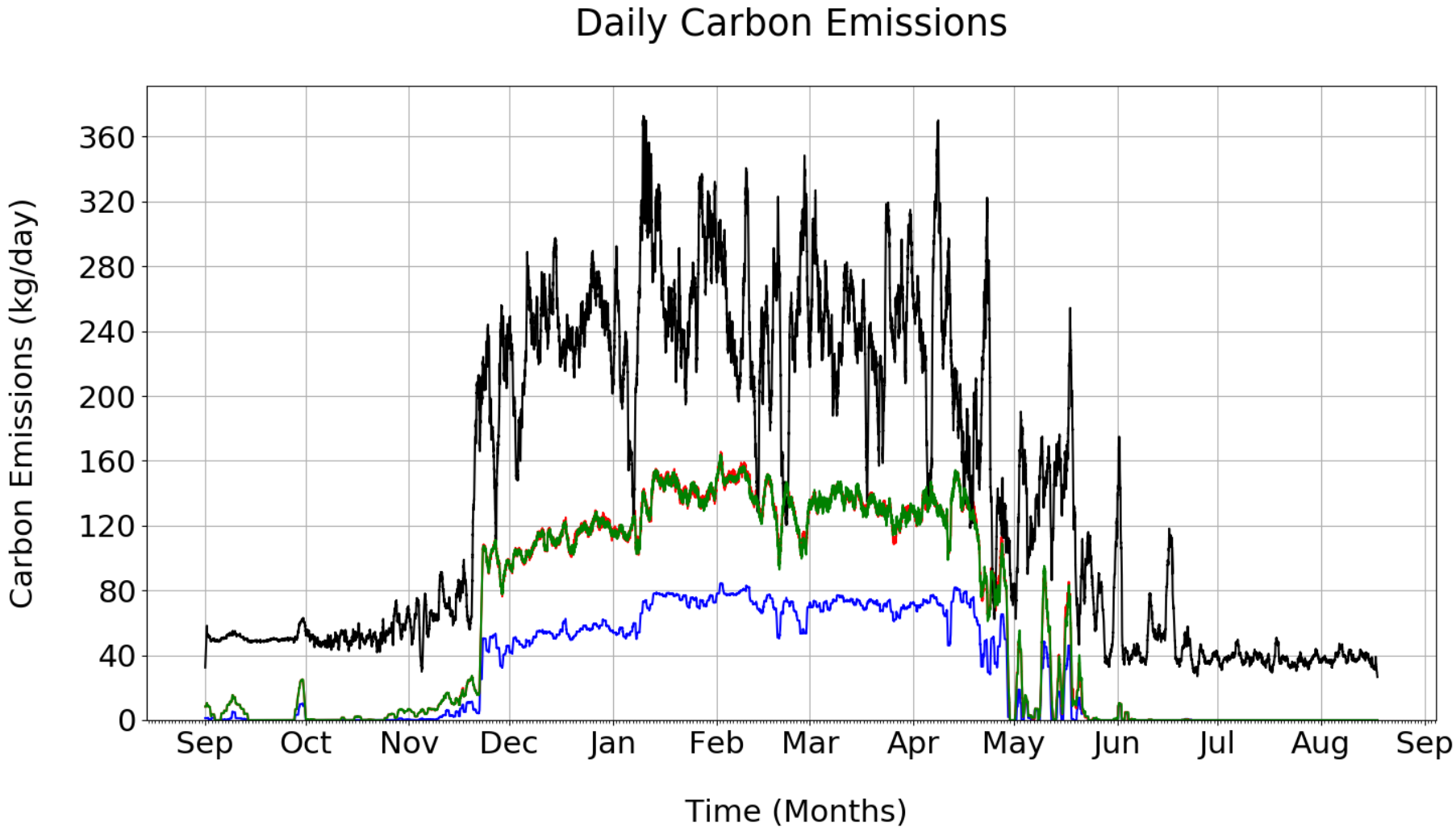
Heating Supply:
On Peak: CHP used to provide heat for thermal network and electricity for heat pumps

Off Peak: Ground Source Heat Pump used to provide heat and grid used to provide electricity for heat pumps

Cooling Supply: Electric Chiller

Results

Heating and Cooling

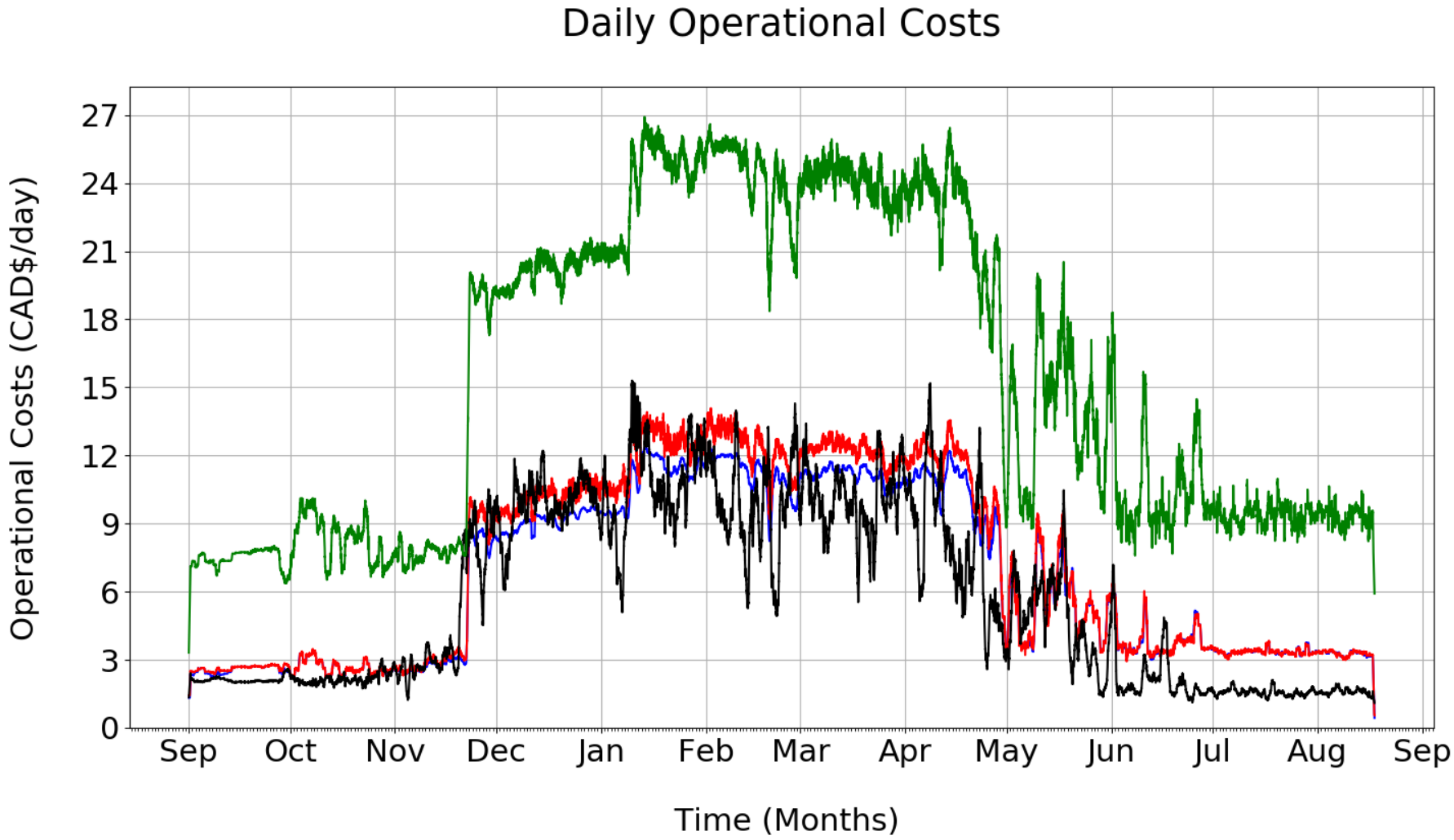


Black: Four Pipe Thermal Network

Green: One Pipe Thermal Network

Red: Solution 1: One Pipe Thermal Network (CHP and Boiler)

Blue: Solution 2: One Pipe Thermal Network (CHP and Heat Pump)



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Summary

MIES

One Pipe Thermal Networks

- Reduce carbon emissions by shifting heating load from boilers to heat pumps
- Cost more operationally, but can be made cost competitive by
  - changing the energy mix (local peaking power plant integration)
  - capturing waste energy (future area of research)
- Reduce the total energy demand by creating a shared energy loop that allows the cooling and heating demands to counteract each other.

Thank You For Listening

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