The reservoir low temperature network:
A new topology for simultaneous heating and cooling

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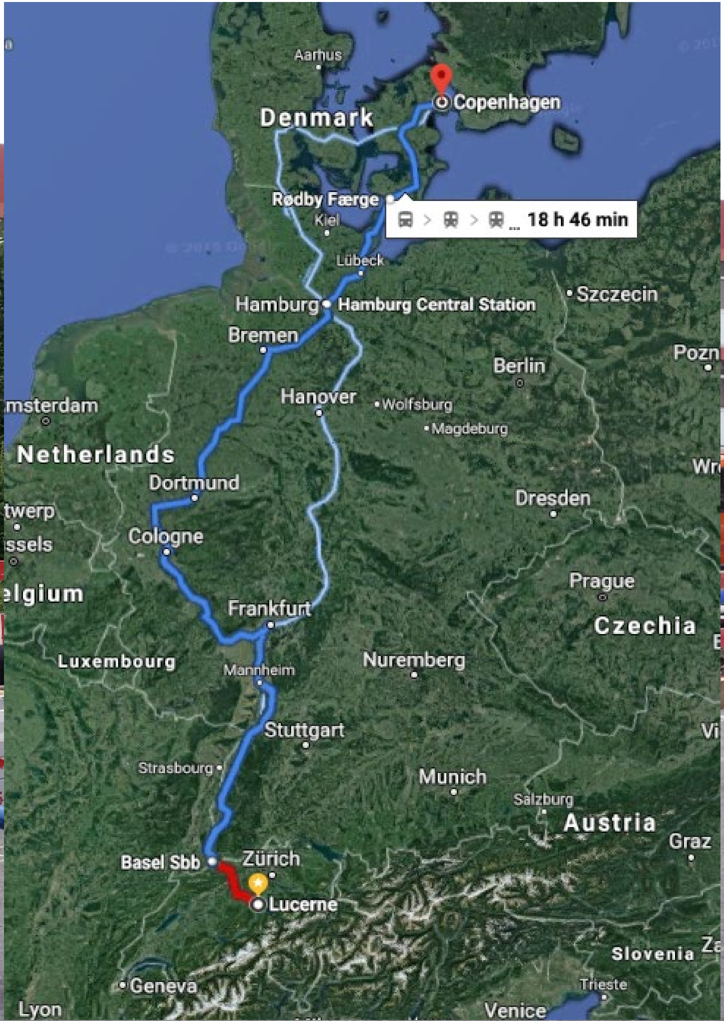
Hochschule Luzern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Rødby Færge
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Hamburg
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Hanover
Wolfsburg
Magdeburg
msterdam
Netherlands
Dortmund
Dresden
twerp
Cologne
ssels
elgium
Frankfurt
Prague
Czechia
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Salzburg
Austria
Graz
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Lyon
Venice


LÖTSCHER
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Lucerne

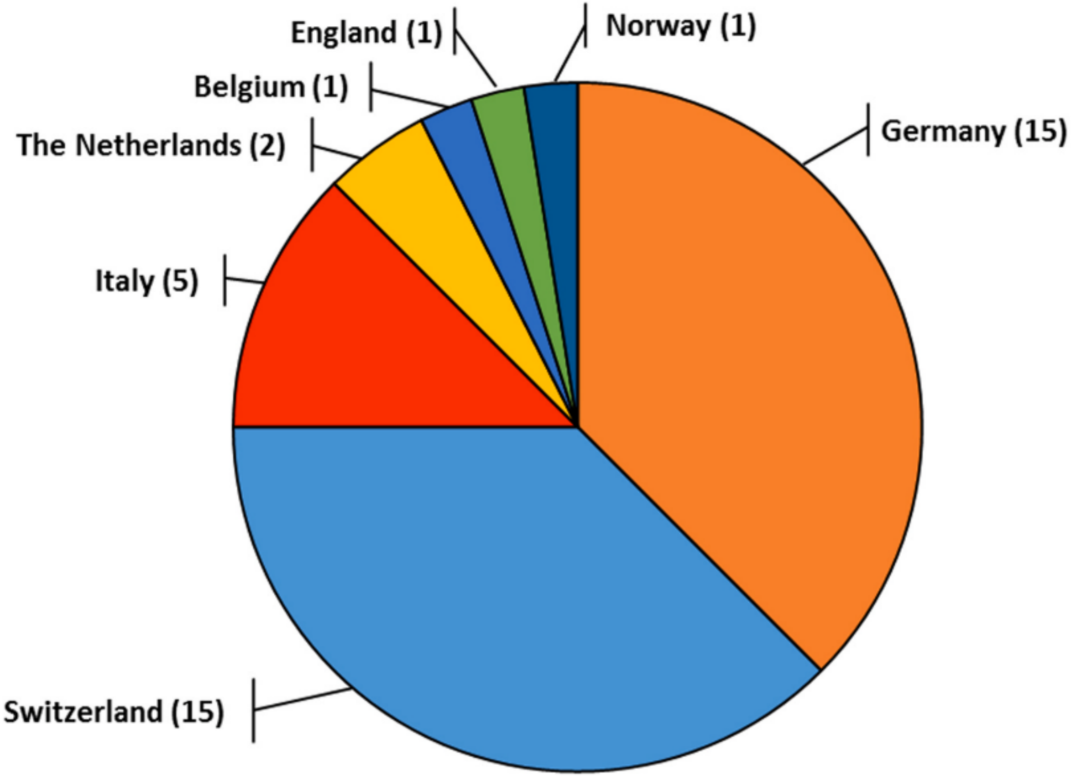
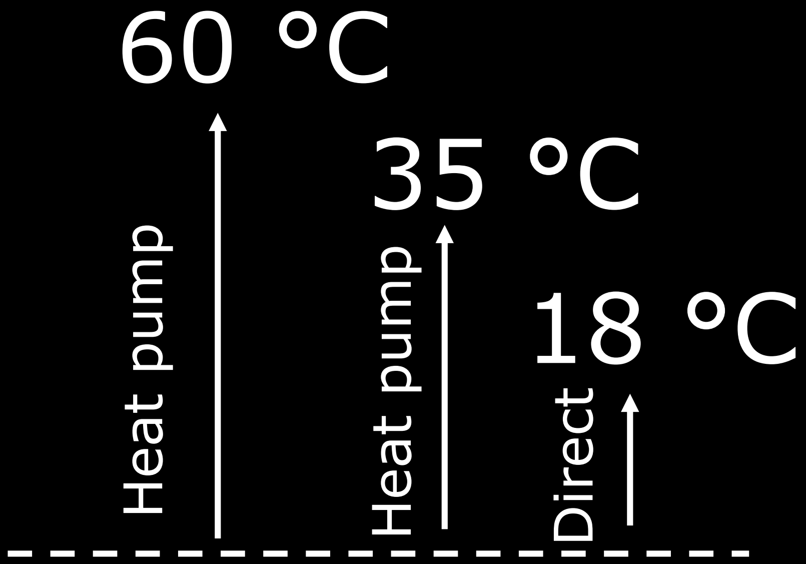


Fig. 1. Surveyed 5GDHC systems by country.

Buffa S, Cozzini M, D’Antoni M, Baratieri M and Fedrizzi R 2019 5th generation district heating and cooling systems: A review of existing cases in Europe *Renew. Sustain. Energy Rev.* **104** 504–22

Fossiles → Renewables



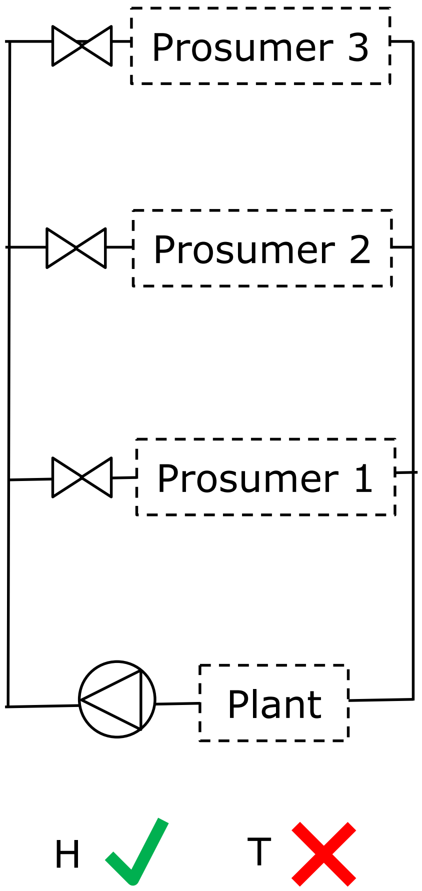
Warm water

Space heating

Cooling

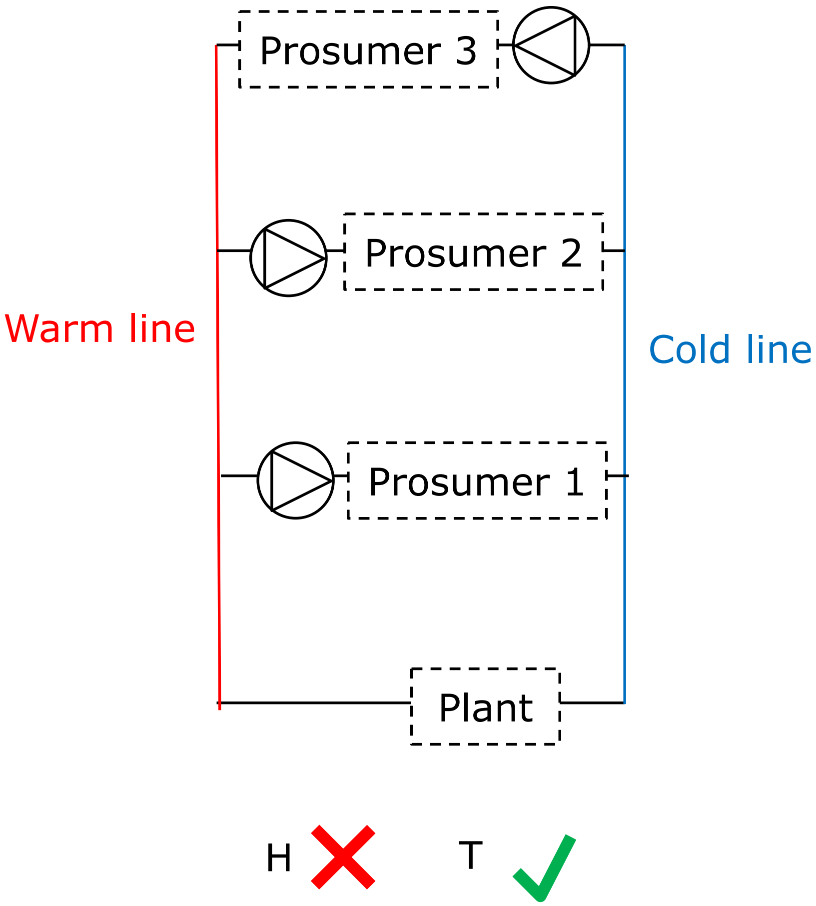
10°C Thermal grid

Type 1



Prosumer 3
Prosumer 2
Prosumer 1
Plant
H
T

Type 2



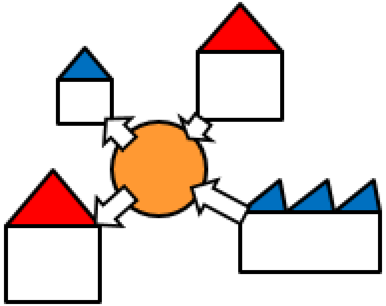
Prosumer 3
Prosumer 2
Warm line
Cold line
Prosumer 1
Plant
H
T

Simple and Robust

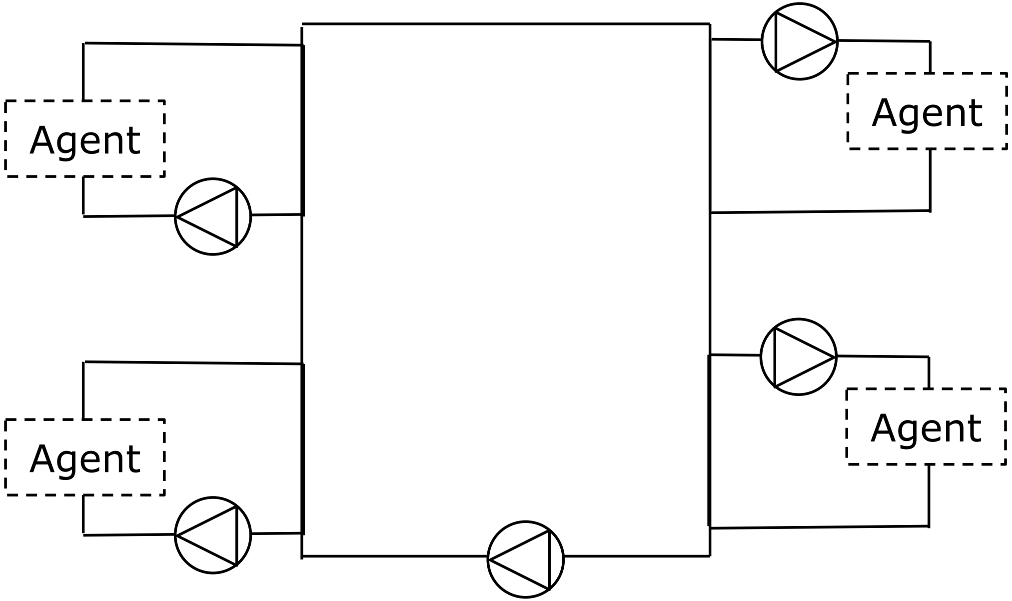
Efficient

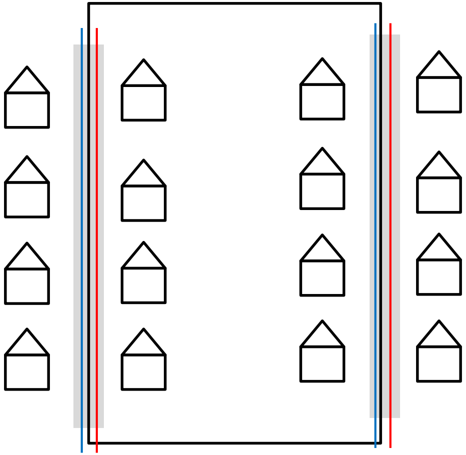
Flexible and Expandable

Cheap



Reservoir low temperature network (RLTN)





Simple and Robust

Efficient

Flexible and Expandable

Cheap

Simple and Robust

Hydraulic Coupling

Efficient

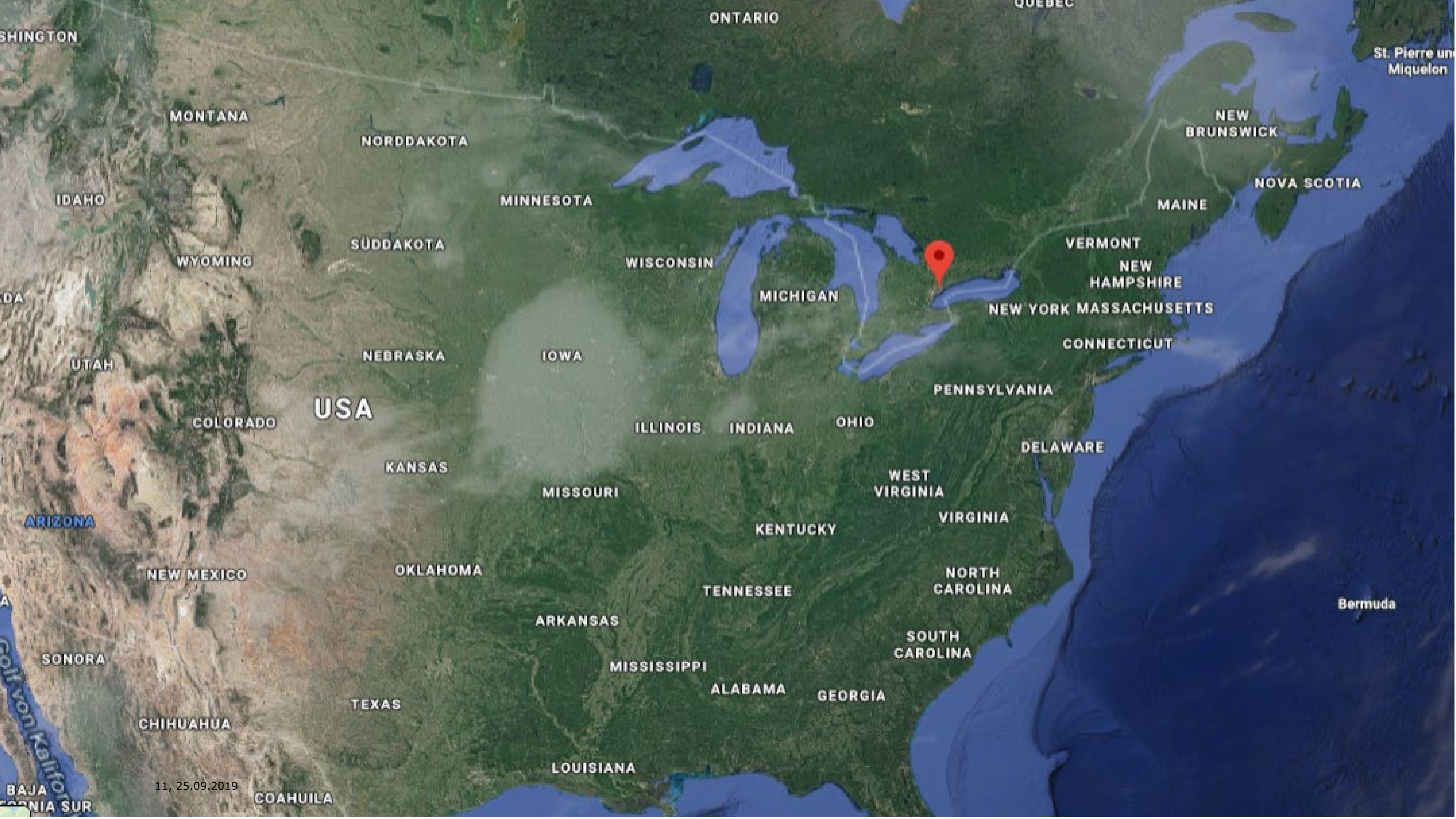
Main loop control

Modular structure

Flexible and Expandable

Online

Cheap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SÜDDAKOTA
WYOMING
WISCONSIN
VERMONT
NEW HAMPSHIRE
MICHIGAN
NEW YORK
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Georgina
Little Britain
Peterborough
Corners
Campbellford
New Tecumseth
Fraserville
Roseneath
Quinte West
Belleville
Shannonville
Uxbridge
Port Perry
Gores Landing
Newmarket
Mono
Aurora
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CONSECON
Prince Edward
Glenora
MILFORD
Cobourg
Oshawa
Vaughan
Ajax
Caledon
Erin
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Albion
Medina
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Williamson
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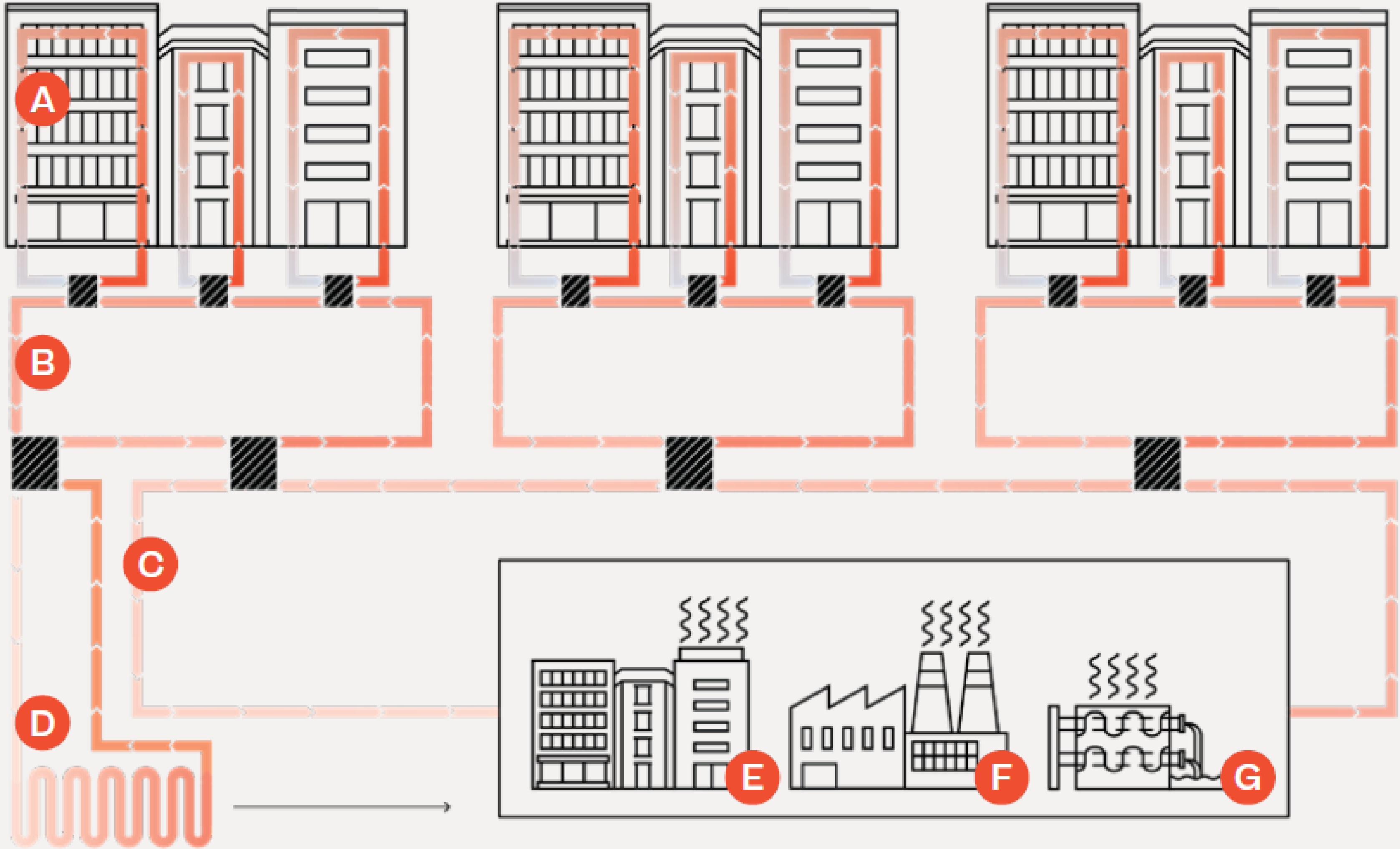
St. Catharines
Lockport
Rochester
Lincoln

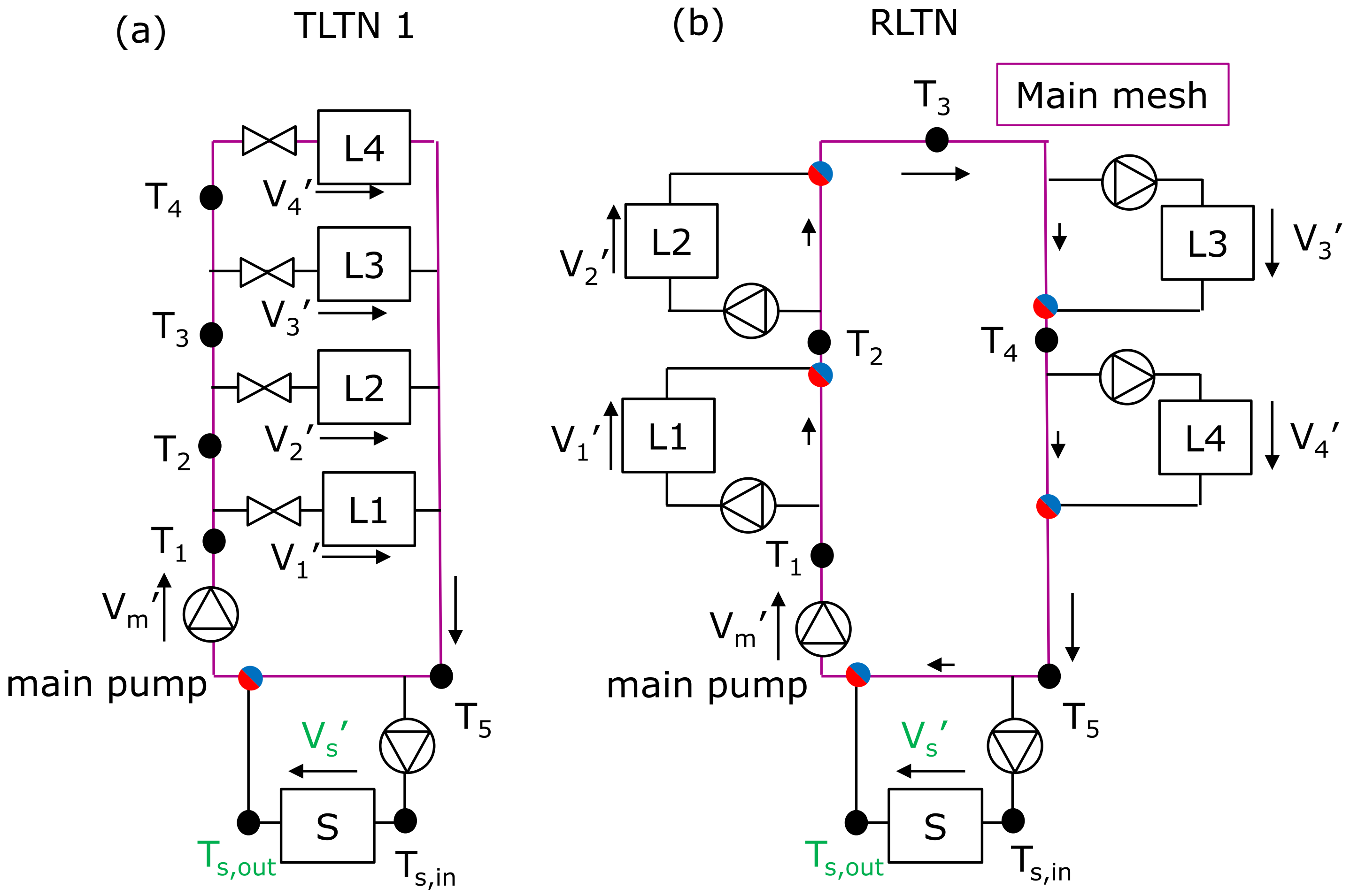
STUDIO DISTRICT
Ashbridges Bay Wastewater Treatment
Eastern Ave
Eastern Ave
CORKTOWN
Corktown Common
Don Valley Pkwy
Lake Shore Blvd E
Lake Shore Blvd E
Tommy Thompson Park
The Distillery Historic District
Commissioners St
Commissioners St
Gardiner Expy
PORT LANDS
T&T Supermarket
Cabana Pool Bar

https://www.sidewalktoronto.ca/



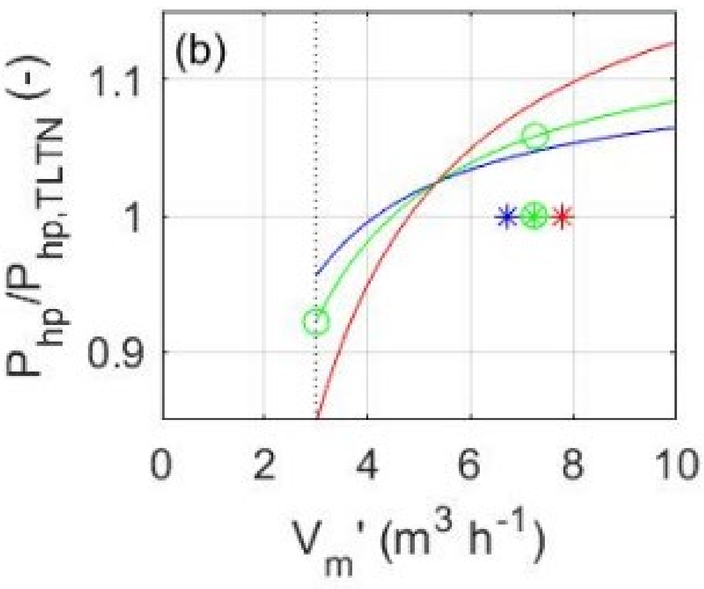
MIDP Sustainability (Sidewalk Labs)

Specific studies

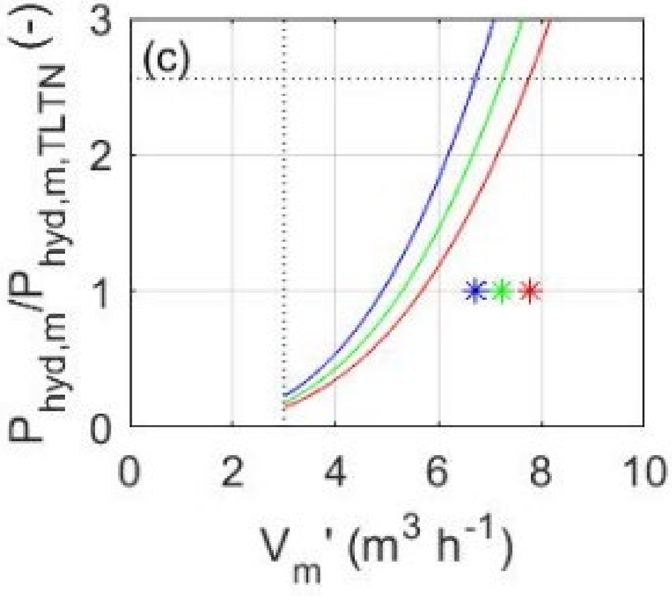


(a)
TLTN 1
L4
L3
L2
L1
T4
T3
T2
T1
V4'
V3'
V2'
V1'
Vm'
main pump
T5
Vs'
S
Ts,out
Ts,in
(b)
RLTN
Main mesh
T3
L2
L1
L3
L4
V2'
V1'
V3'
V4'
T2
T4
T1
Vm'
main pump
T5
Vs'
S
Ts,out
Ts,in

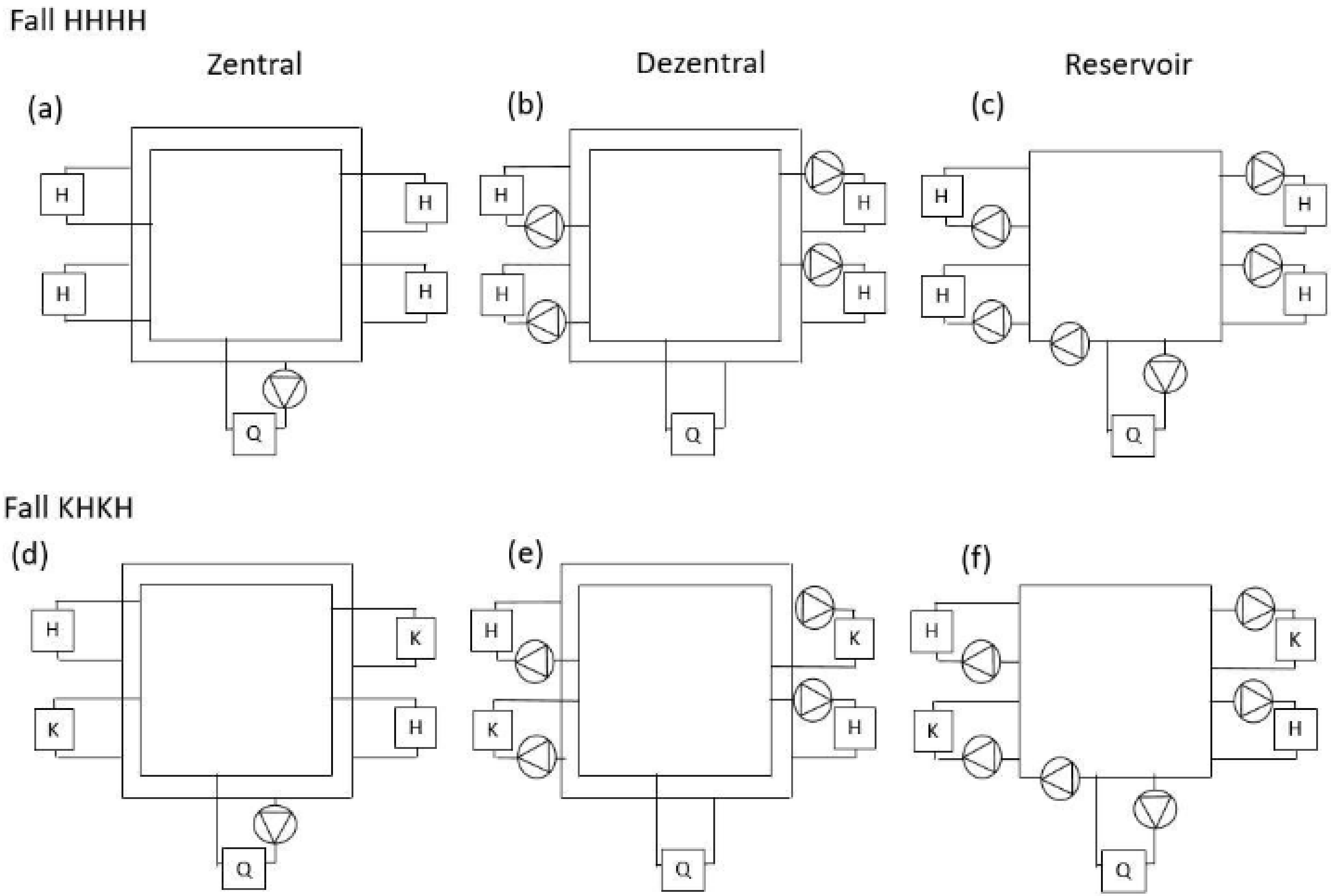
8 % reduction
in electricity consumption of heat pumps (green line)

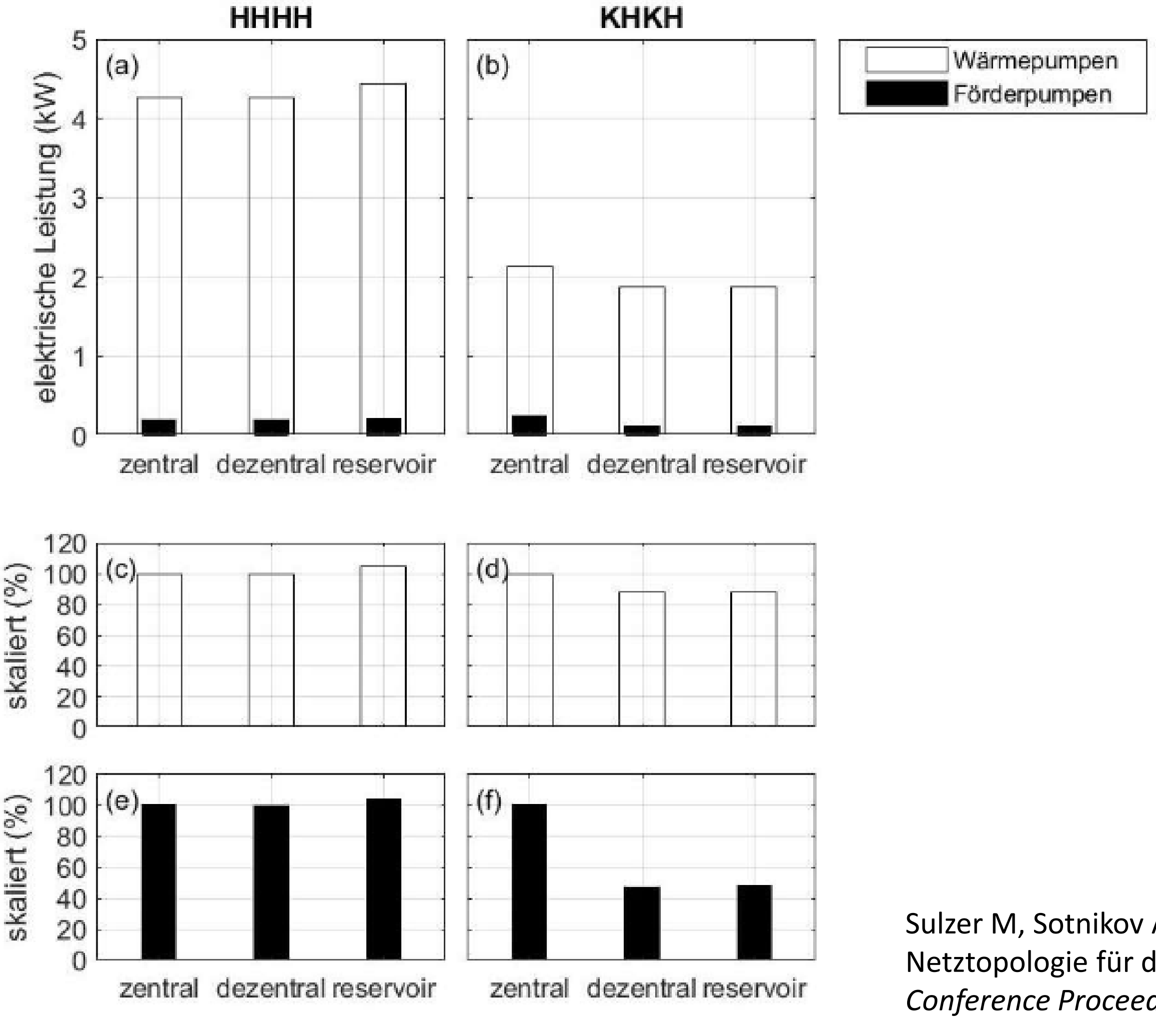


82 % reduction
in electricity consumption of heat pumps (green line)

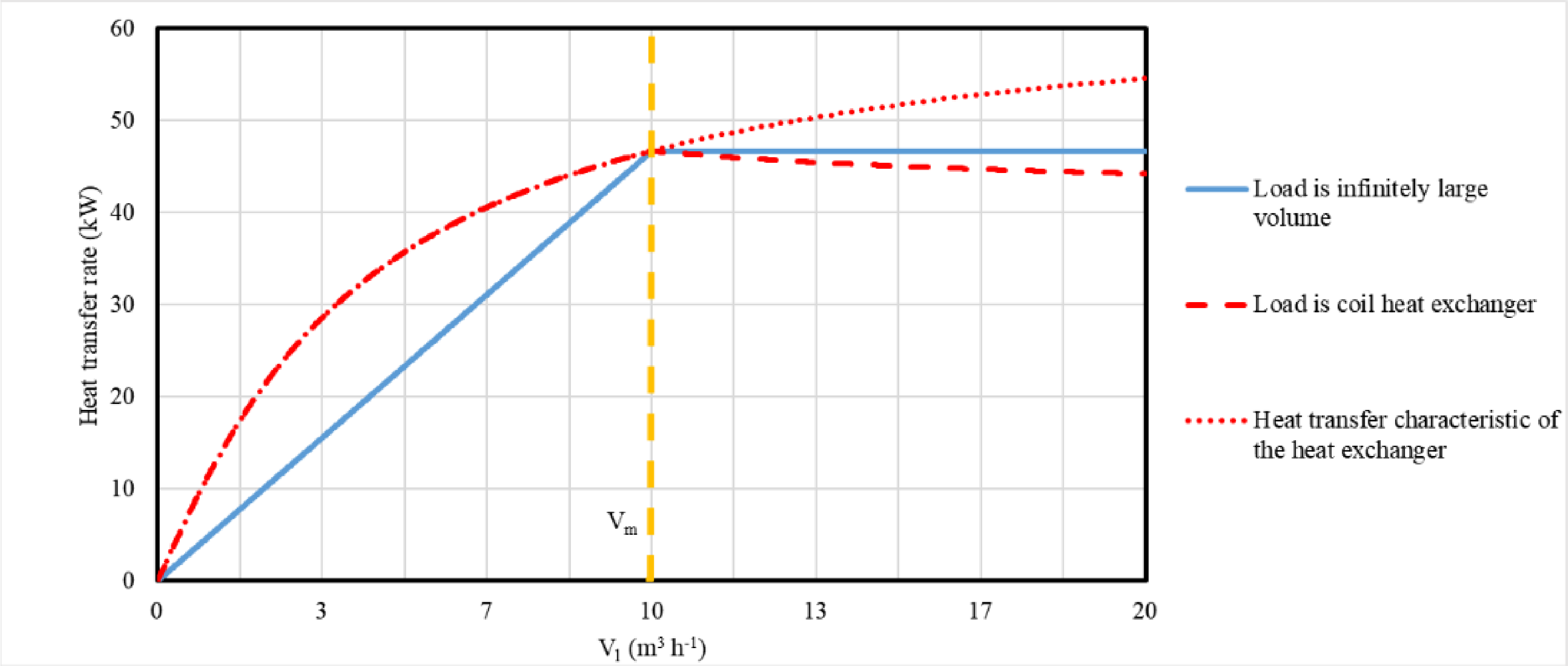


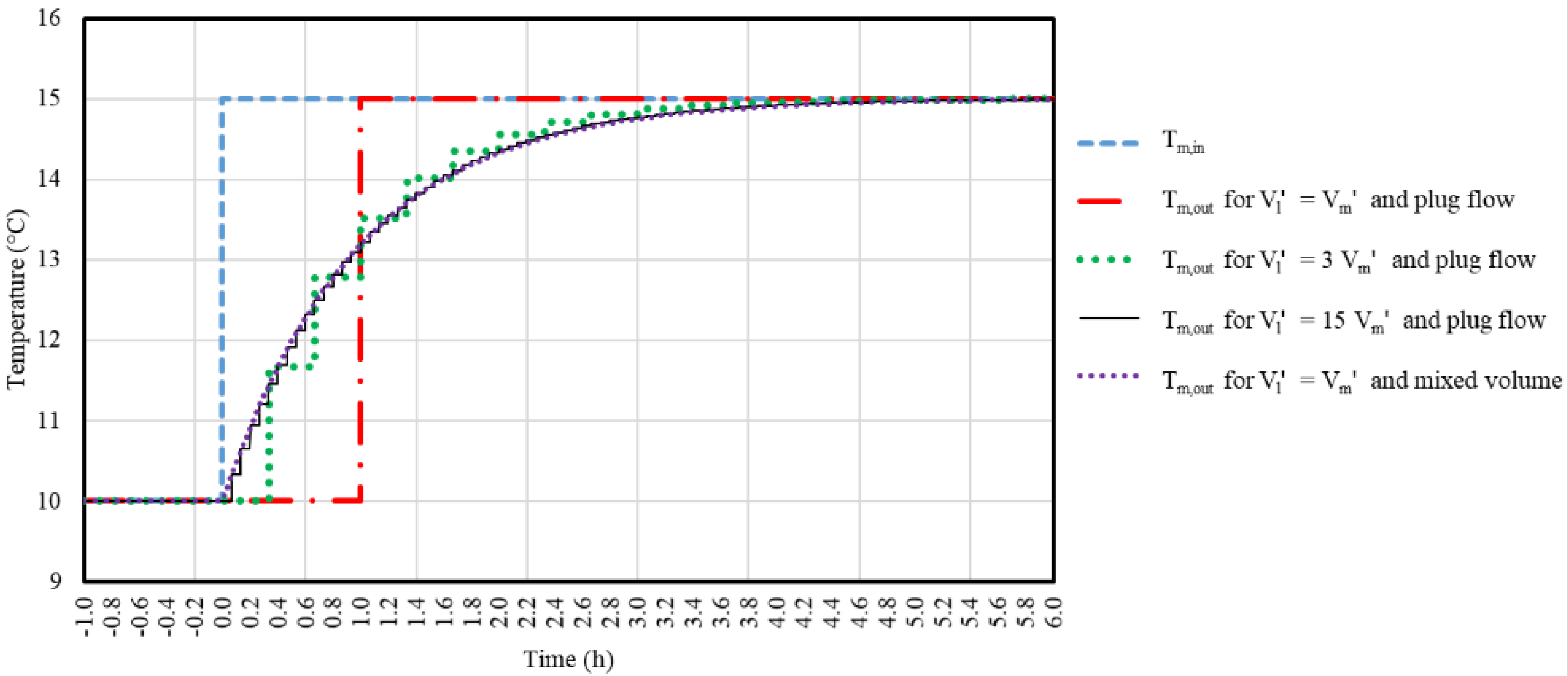
Sommer T, Sotnikov A, Sandmeier E, Stettler C, Mennel S and Sulzer M 2019 Optimization of low-temperature networks by new hydraulic concepts *Energy Procedia*


Fall HHHH
Zentral
Dezentral
Reservoir
(a)
H
H
H
H
Q
(b)
H
H
H
H
Q
(c)
H
H
H
H
Q
Fall KHKH
(d)
H
K
K
H
Q
(e)
H
K
K
H
Q
(f)
H
K
K
H
Q



Sulzer M, Sotnikov A and Sommer T 2018 Reservoir-Niedertemperatur Netztopologie für die Vermaschung von thermischen Netzen *brenet Conference Proceedings* (Zurich: BFE, Innosuisse) p 590


60
50
40
30
20
10
0
Heat transfer rate (kW)
0
3
7
10
13
17
20
V_1 (m^3 h^{-1})
V_m
Load is infinitely large volume
Load is coil heat exchanger
Heat transfer characteristic of the heat exchanger



Sotnikov A, Sandmeier E, Sulzer M, Sergi T, Mennel S and Sommer T 2019 Thermal stability and heat transfer in the reservoir low temperature network *Energy Procedia* submitted

District cooling becomes more and more important with increasing air temperatures due to climate change, in particular in urban areas. The waste heat generated by cooling is ideally recycled for heating and domestic hot water, either immediately or time delayed using seasonal storages. Here, we present a new network topology, the reservoir low temperature network, that provides optimal mutual benefit for simultaneous heating and cooling and is, at the same time, robust in operation, flexible toward network expansion and more cost effective compared to other low temperature network topologies. We define low temperature networks as networks below 20 °C. In such systems, heat pumps supply the warm water for heating, whereas heat exchangers supply direct cooling. In the reservoir low temperature network, water continuously circulates in a ring line, which represents the "reservoir". Clients withdraw water from this line, transfer heat and reinject the water into the same line. Clients can be residential buildings, industrial facilities, seasonal storages or even entire district heating or cooling networks.

In this work, we present a virtual, but realistic district with yearly heating and cooling demands and analyse three low temperature network topologies with respect to the energy consumption, investment costs and robustness in operation. We further present a general method to estimate savings at planning stage based on expected yearly demand profiles.

Buffa S, Cozzini M, D'Antoni M, Baratieri M and Fedrizzi R 2019 5th generation district heating and cooling systems: A review of existing cases in Europe *Renew. Sustain. Energy Rev.* **104** 504–22