ASHRAE®
Learning Institute

Welcome to the

Community Heat Pump Systems Webinar

A Series of 17 Webinars on Community Heat Pump Systems

Sponsored by NYSERDA

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

If you miss one of the webinars, register and view the recording at https://www.ashrae.org/CHPSWebinars.

Design for the Consumer Interconnection for District/Community Energy Systems

Presented by:

Steve Tredinnick, P.E., FASHRAE, CEM

Copyright

AIA/CES Registered Provider

ASHRAE is a Registered Provider with The American Institute of Architects Continuing Education Systems. Credit earned on completion of this program will be reported to CES Records for AIA members. Certificates of Attendance for non-AIA members are available on request.

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product. Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

1. Learn common district energy components and terms.
2. Distinguish the difference between Direct and Indirect Connections.
3. Understand impact to new and existing building HVAC design in connecting to district energy system.
4. Understand effect on heating unit capacity reducing entering water temperature.
5. Learn about available technology to assist with interconnections.
6. Design for more efficient building interconnection.

Instructors

Steve Tredinnick, P.E. FASHRAE, CEM
Burns & McDonnell
Chicago, IL

Gary Phetteplace, Ph.D, P.E. FASHRAE
GWA LLC
Lyme, NH

Outline/Agenda

1. Briefly cover some standard definitions and concepts.
2. Discuss supply temperatures available from different technologies.
3. Discussion on service connection types:
    a. Direct connections
    b. Indirect connections
4. Need for metering and technologies or solutions available.
5. Delivering Space Heat - Temperature Limitations of Available Methods (especially retrofit systems) regarding generation and terminal units.
6. Thoughts and difficulties on retrofitting existing HVAC systems (gas forced air furnaces, hydronic systems, and steam systems).

Community Heat Pump Systems

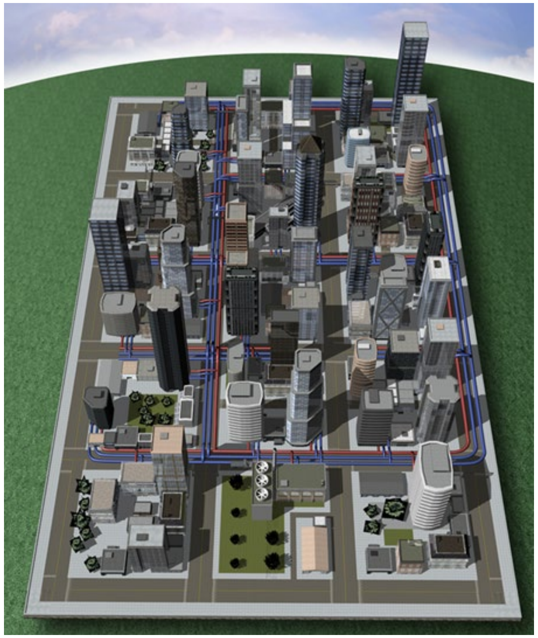
New York State Energy Research Development Authority's (NYSERDA) vision is a strategic network of distribution pipes serving multiple buildings:

- Meet the thermal needs within a building (HVAC and DHW) using renewable electricity
- Expand clean energy options for customers who have insufficient footprint space to serve their own needs
- Leverage economy of scale
- Use this approach to address New York State's nation-leading climate goals

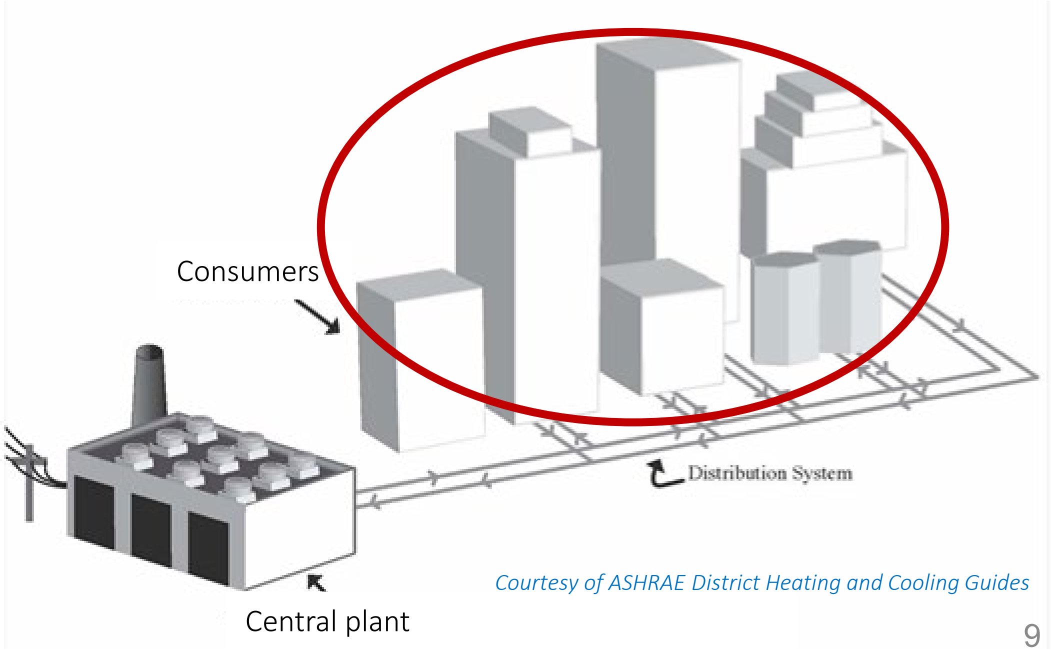
Standard Definitions and Concepts
District Heating and Cooling Systems

District Energy System Main Components:

- Central Plant or Generation Source
- Distribution Piping Network
- **Consumer Interconnection (Energy Transfer Stations)**



Courtesy of International District Energy Association



Courtesy of ASHRAE District Heating and Cooling Guides

Standard Definitions & Concepts DH Building Interconnection Terms

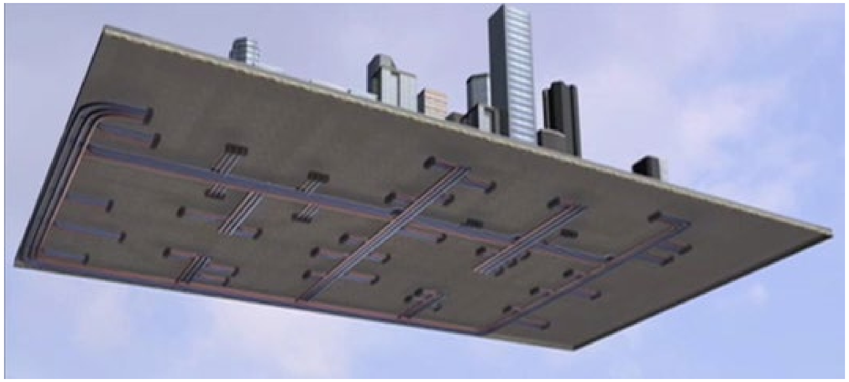
Commonly used Acronyms:

- **BPHE or BHE: Brazed Plate Heat Exchanger**
- **DEP: District Energy Provider**
- **DES: District Energy System**
- **DHS&R: District Heating Supply & Return**
- **ETS: Energy Transfer Stations**
- **EWT: Entering Water Temperature**
- **GPHE: Gasketed Plate Heat Exchanger (PHE)**
- **ULTDH: Ultra Low Temperature District Heating (5G)**

Standard Definitions & Concepts
DH Building Interconnection Terms

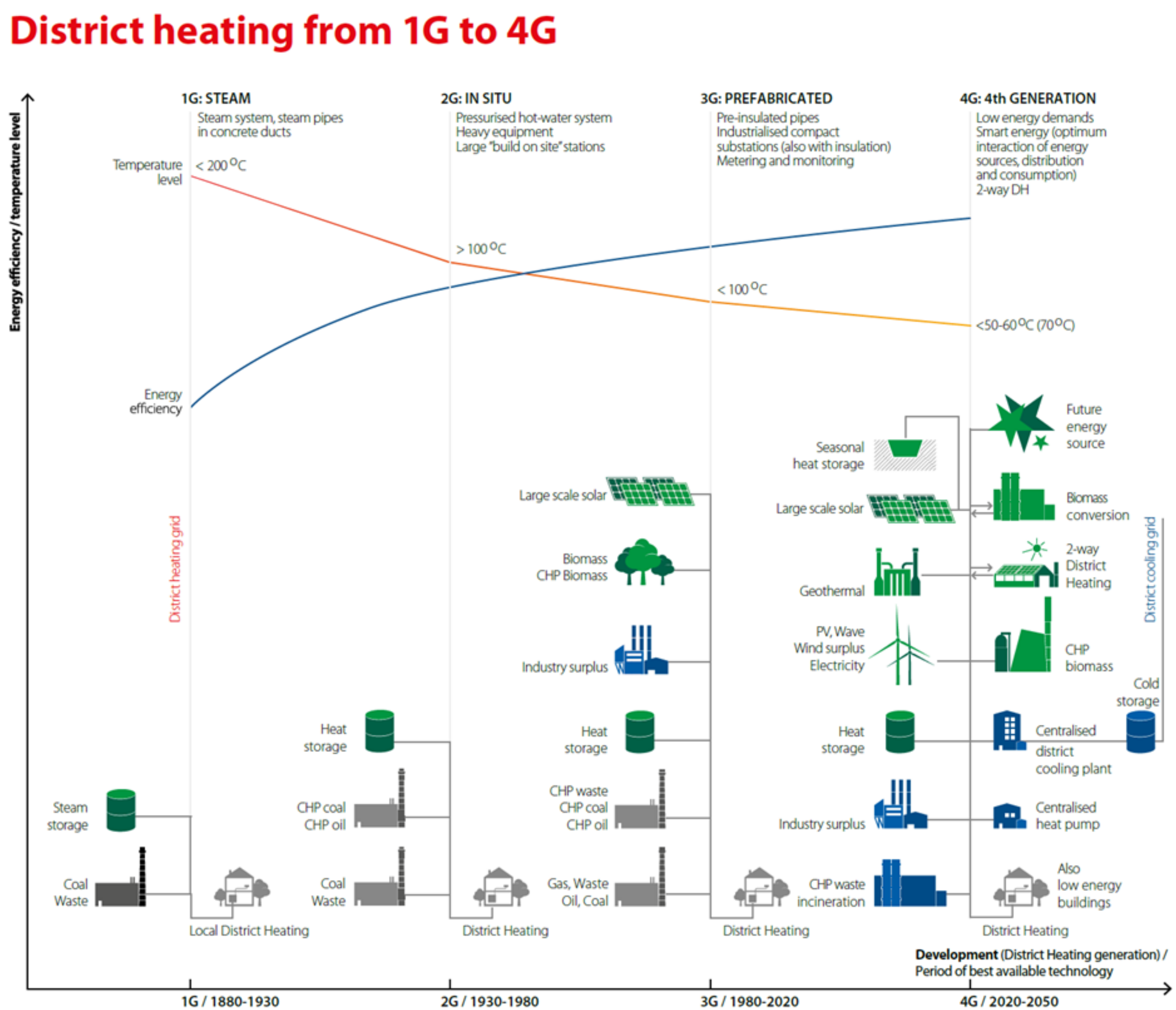
Known by many names or aliases:

- Building Interconnection Facilities (BIF)
- District Heating Substations (Swedes)
- District Heating Centrals (Swedes)
- Customer Centrals (Swedes)
- Connection Plants (Danes)
- Heat Interface Unit (Brits)
- **Energy Transfer Stations or ETS (US & Canada)**



Courtesy of International District Energy Association

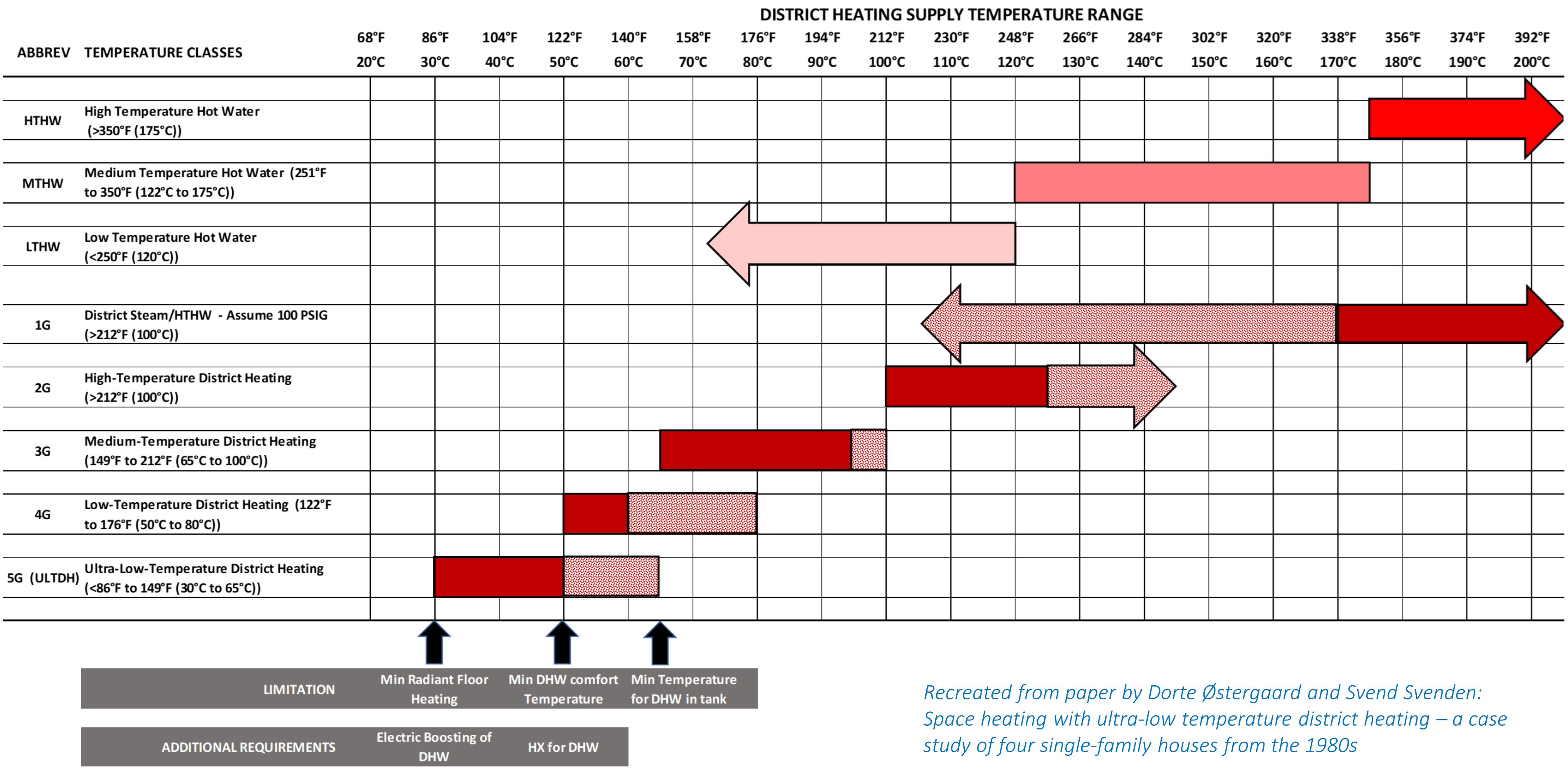
The Generations of District Heating



- 1st Generation (1G)
- 2nd Generation (2G)
- 3rd Generation (3G)
- 4th Generation (4G)
- 5th Generation (5G)
(not shown on this graph but on next page)

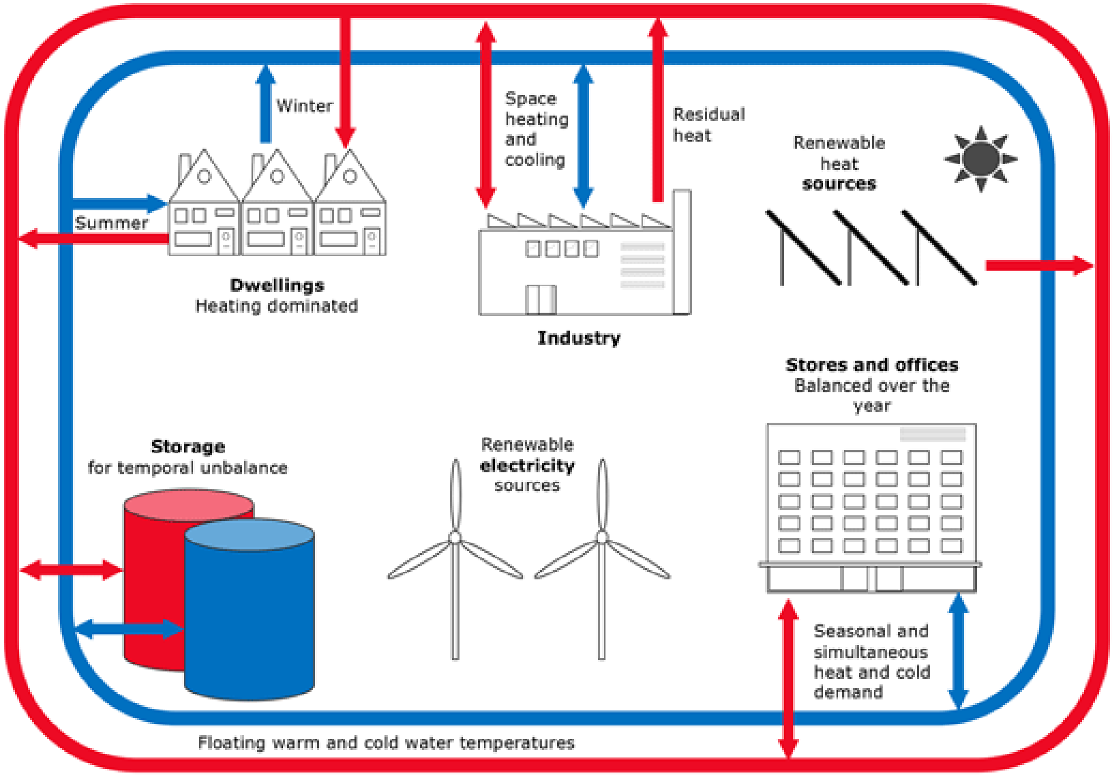
Courtesy of Danfoss 'District heating application handbook'

Generations of District Heating (cont.)



Recreated from paper by Dorte Østergaard and Svend Svenden: Space heating with ultra-low temperature district heating – a case study of four single-family houses from the 1980s

5th Generation District Energy Systems



- District heating and cooling approach using renewable resources
- District heating and cooling components may be decentralized.
- Systems may be bi-directional, close to ground temperature
- Seasonal storage
- All electric. Ideally, no CO_2 produced at sites
- Includes Community Heat Pump Systems

Boesten, S., Ivens, W., Dekker, S. C., and Eijdems, H.: 5th generation district heating and cooling systems as a solution for renewable urban thermal energy supply, Adv. Geosci., 49, 129–136, https://doi.org/10.5194/adgeo-49-129-2019, 2019.

ETS Standard Design Concepts
Understanding Your Load

- Know and understand the building load
  - Assists in Quantity and size of PHE and other equipment
  - ANSI/ASHRAE/ACCA Standard 183 Peak Cooling and Heating Load Calculations in Buildings Except Low-rise Residential Buildings and ASHRAE Load Calculation Manual
- How much of load is critical and needs to be on emergency power?
  - Hospitals, Data centers, Vivarium
  - Emergency CHW connections
  - Separate set of PHEs or even separate ETS Service Rooms
- The better you know the load the more confident you are in spending the Owner's money wisely

ETS Standard Design Concepts
Load Estimation – Old School Rule of Thumb

Typically, the District Heating Provider has their own metrics for the overall development or plant capacity, but there is some published rules of thumb data out there.

Heating Energy Load Factor (HELF) [Btu/ft^2-hr] calculation per IDHA District Heating Handbook 4th Edition (1983)

Building Type	Boston, MA	Chicago, IL	Denver, CO	Detroit, MI	Duluth, MN	Kansas City, MO	New York, NY	Portland, OR	Seattle, WA
Medium-Density Residential	33	37	37	34	45	34	30	25	24
High-Density Residential	30	33	33	31	40	31	27	23	22
Commercial/Institutional	18	21	21	19	26	19	16	13	13
Industrial	21	24	24	22	30	22	19	16	15

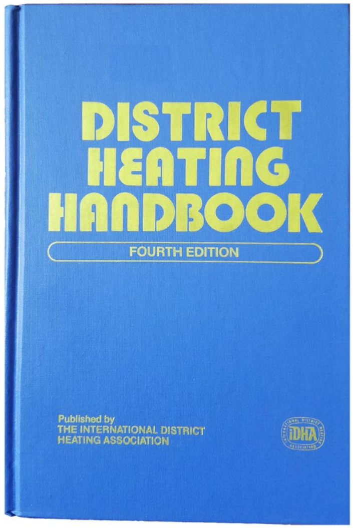


TABLE 2.2
SPACE AND WATER HEATING FACTORS

Building Type	Annual Space Heating Factor: ASHF (Btu/ft^2·HDD·yr)	Annual Water Heating Factor: AWHF (Btu/ft^2·yr)	Hourly Water Heating Factor: HWHF (Btu/ft^2·hr)
Medium-density residential	11.9	15,000	5.0
High-density residential	10.5	15,000	5.0
Commercial/institutional	7.37	3,300	0.9
Industrial	8.70	4,000	0.9

$$HELF = \frac{(65° - WDT)}{24}(ASHF) + HWHF$$

ETS Standard Design Concepts
Load Estimation – Newer School Rule of Thumb

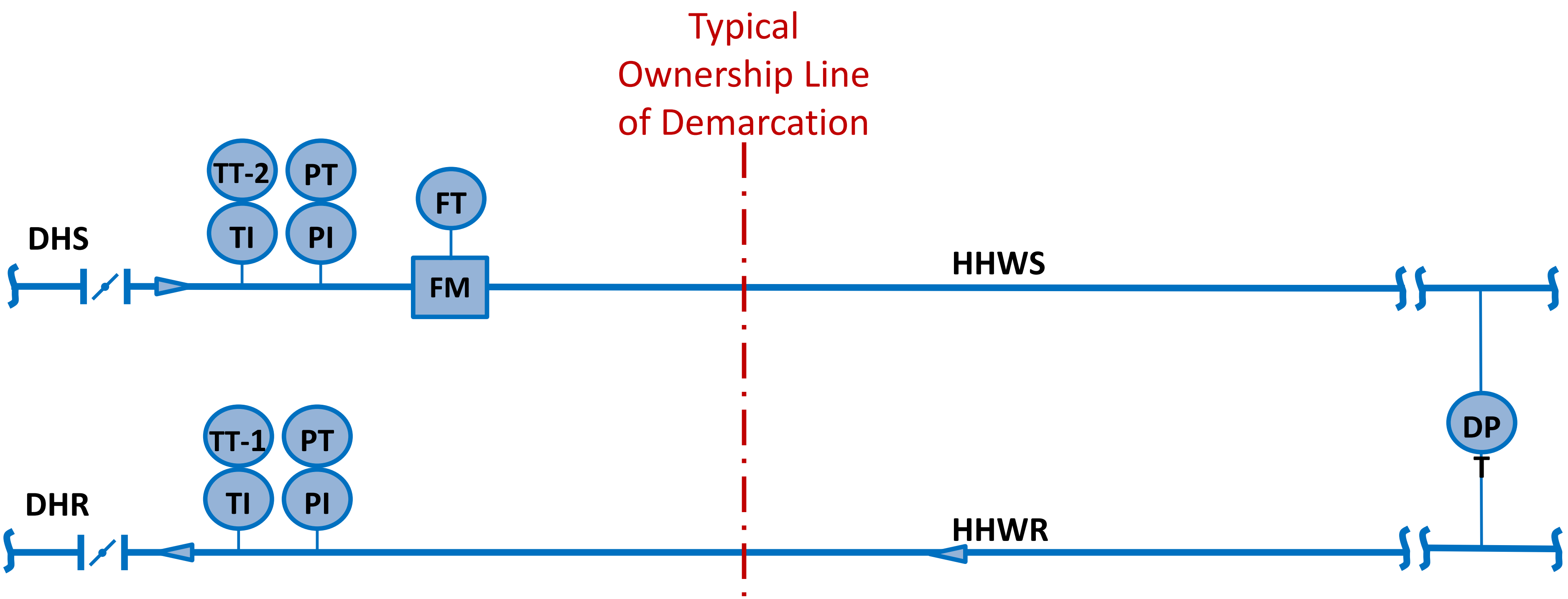
Building Type	St. Louis, MO (CZ4)			Portland, OR (CZ4)			Boston, MA (CZ5)			Duluth, MN (CZ7)		
	Base	High	Premier	Base	High	Premier	Base	High	Premier	Base	High	Premier
City Hall	24.7	10.9	9.0	17.4	7.7	6.3	22.0	9.5	7.8	30.3	12.6	10.4
Convention Center	44.3	16.0	13.5	31.3	11.3	9.5	40.4	14.4	12.1	57.3	20.0	16.9
Hotel	16.6	8.4	6.9	11.7	5.9	4.9	14.5	7.2	5.9	19.2	9.1	7.5
Multi-Family	31.5	24.6	16.1	21.9	17.0	11.0	29.6	22.7	14.8	44.1	34.1	22.2
Medium Density Office	22.0	12.0	11.0	22.0	10.0	8.0	22.0	11.0	10.0	26.0	14.0	12.0
High Density Office	24.0	16.0	13.0	24.0	11.0	9.0	24.0	14.0	11.0	32.0	18.5	15.4
High Density Retail	34.7	12.8	10.8	24.5	9.1	7.7	31.9	11.8	9.9	45.8	16.8	14.2
School	35.7	15.3	12.8	25.9	10.9	9.1	32.7	13.7	11.5	43.7	18.5	15.4

Information per 2008 EPA Research Project by Stephen P. Kavanaugh PhD from University of Alabama – all units in BTU/FT²-Hr

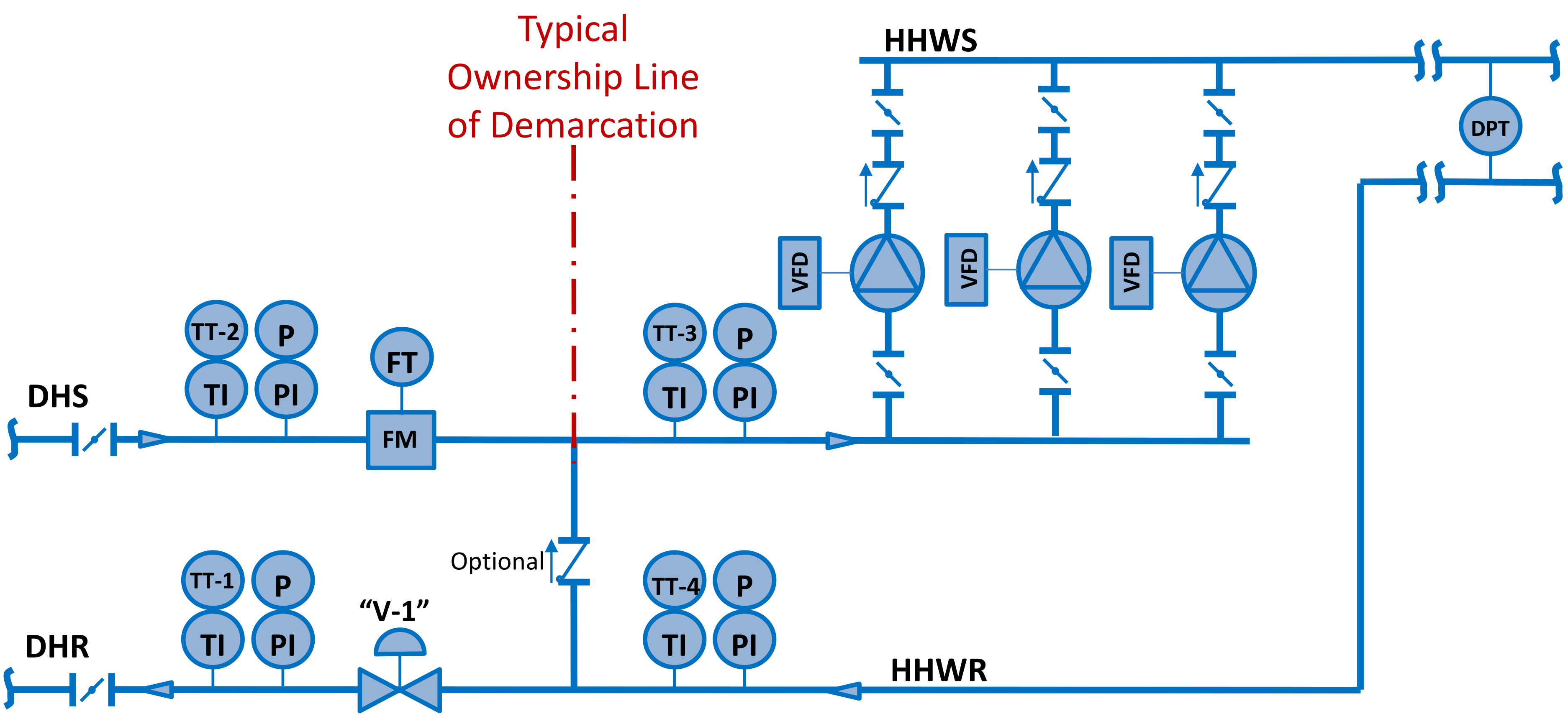
Standard Definitions & Concepts Configuration & Main ETS Components

- Connection Types:
  - Direct and Indirect
- Equipment/Components:
  - Heat Exchangers
    - Gasketed Plate or Brazed Plate Heat Exchanger
  - Piping
  - Controls
    - Metering and Sub-metering
    - Sensors
    - Control Valves

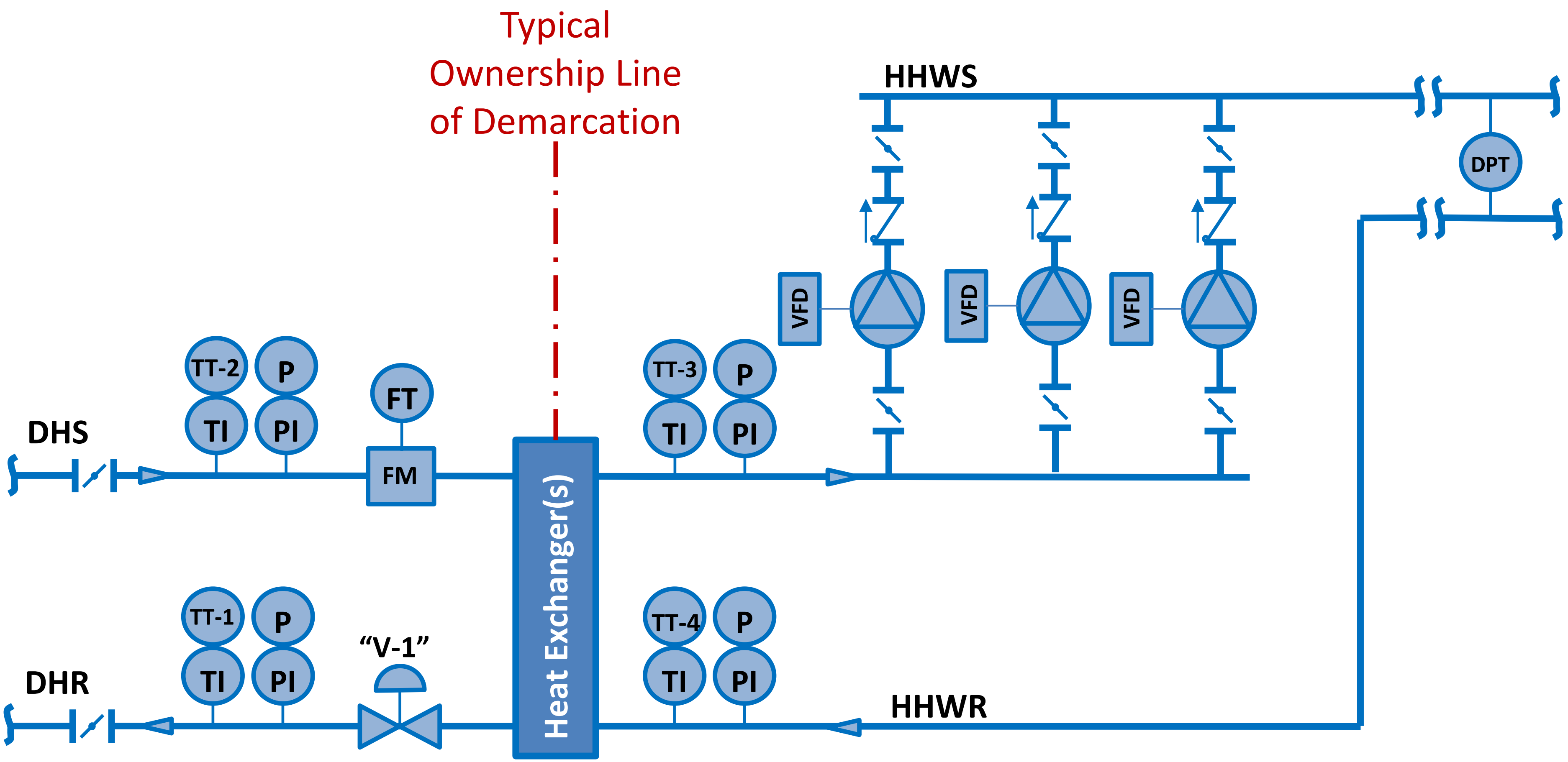
Standard Definitions & Concepts
Direct Connection – District Pumped



Standard Definitions & Concepts
Direct Connection – Building Pumped



Standard Definitions & Concepts
Indirect Connection



Standard Definitions & Concepts
Direct vs. Indirect Connection Comparison

Issue	Direct Connection	Indirect Connection
Water Quality	DH water is exposed to a building system which may have lower levels of treatment and filtering	Water quality of the DH water is isolated from building system and can be controlled
Water Consumption	Leakage and consumption of DH water within the building may be difficult to control and correct	Water leakage is within the control of the district heating utility
Contractual	Demarcation of consumer's building system may not be clear	Clear delineation between the consumer and district cooling utility equipment
Cost	Generally lower in overall cost due to the absence of a heat exchanger and possible deletion of building pumps and controls	Higher cost due to a heat exchanger and additional controls
Reliability	Failures within the building may cause problems or potentially even outages for the district system	The DCS is largely isolated of any problems in the building beyond the interconnection
Pressure Isolation	Building systems may need to be protected from higher pressure in a DH system or for tall buildings, a DCS may be subjected to higher pressures by the building system	The heat exchanger provides isolation from building system pressure and the DH System pressure so that each loop may operate at their preferred pressures without influence from the other
ΔT	Potential for greater ΔT due to absence of heat exchanger	Approach temperature in heat exchanger is a detriment to supply temperature and differential temperature (ΔT)
Space Requirements	Low space requirements	Additional space required for heat exchanger and controls

ETS Standard Design Concepts Layout & Enhancements

Design Concepts:

- Be Cognizant of Maintenance Clearances
- Number of PHEs based on capacity and redundancy requirements
  - 2@75%?
  - 2@100%?
  - 3@50%?

Enhancement:

- Add emergency connections

Standard Definitions & Concepts ETS Components – Flow Meters

- Main Building meter is the "Cash Register" of ETS Components, therefore, desire highly accurate and maintenance free technology
  - Typically, meters are flow tube magnetic "mag" or ultrasonic (strap-on or flow tube)
  - Follow MFR's straight diameter recommendations

Meter Type	Accuracy	Range of Control	Pressure Loss	Straight Piping Requirements (Length in Pipe Diameters)
Electromagnetic	**±0.15% to 1% rate**	**30:1 to 100:1**	**Low (<3 psi)**	**5 D to 10 D upstream; 3 D downstream**
Vortex	±0.5% to 1.25% rate	10:1 to 25:1	Medium (3 to 5 psi)	10 D to 40 D upstream; 2 D to 6 D downstream
Turbine	±0.15% to 0.5% rate	10:1 to 50:1	Medium (3 to 5 psi)	10 D to 40 D upstream; 2 D to 20 D downstream
Ultrasonic	±1% to 5% rate	>10:1 to 100:1	Low (<3 psi)	10 D to 40 D upstream; 2 D to 6 D downstream

Standard Definitions & Concepts
ETS Components – Flow Meters - Submetering

Need cost allocation method for multi-tenant buildings, either us a flow meter or another “equitable” method of cost allocation (SF)

Inside Insights

District Energy / Second Quarter 2013

How Much Is That Meter in the Window?

Table 1. Summary of Water Energy Meter Material Costs Based on Technology.

Type	Ultrasonic (In-Line)		Ultrasonic (Clamp-On)			Insertion Turbine		Insertion Magnetic		In-Line Magnetic (Chilled Water) (Hot Water)	
Accuracy	±2.0% of reading	±1.0% of reading	±1.0% of reading	±1.0% of reading	±0.5% to ±1.6% of reading	±1.0% of reading	±1.0% of full scale	±1. 0% of rate	±2.0% of reading	±0.40% of reading[1]	
Size Range	**MFR A**	**MFR B**	**MFR C**	**MFR D**	**MFR E**	**MFR F**	**MFR G**	**MFR H**	**MFR I**	**MFR J**	**MFR J**
½"	—	$1,260	$500	$4,200	$6,600	$745	—	—	—	$2,865	$3,265
¾"	$1,970	$1,350	$500	$4,200	$6,600	$745	—	—	—	$2,865	$3,265
1"	$2,010	$1,350	$500	$4,200	$6,600	$745	—	—	—	$2,640	$2,815
1-½"	$2,010	$1,825	$665	$4,200	$6,600	$1,565	$3,250	—	—	$3,055	$3,400
2"	$2,600	$2,325	$775	$4,200	$6,600	$1,565	$3,250	—	$4,200	$3,100	$3,420
2-½"	$3,700	$2,750	$1,025	$4,365	$6,600	$1,565	$3,360	—	$4,200	$3,245	$3,645
3"	$4,150	$3,150	$1,110	$4,365	$6,600	$1,565	$3,420	$3,050	$4,200	$3,400	$3,875
4"	$5,100	$3,730	$1,270	$4,365	$6,600	$1,865	$3,480	$3,050	$4,200	$3,510	$3,995
5"	—	—	$1,430	$4,365	$6,600	$1,865	$3,480	$3,050	—	$4,110	$4,705
6"	—	—	$1,555	$4,400	$6,600	$1,900	$3,480	$3,050	$4,200	$4,400	$5,045

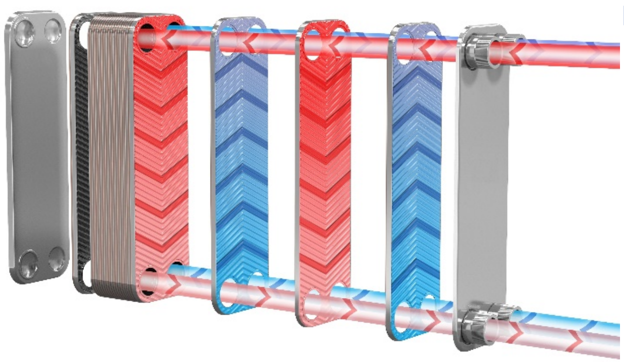
[1] ±0.4% of actual reading from 3.3 to 33 fps, ±0.75% of reading from 1.0 to 3.3 fps and ±0.0075 fps below 1.0 fps.

Source: Compiled by Steve Tredinnick.

Note: The author has made best efforts to get real-world, apples-to-apples comparisons for all costs including flow meter, Btu calculator, temperature sensors and communications module but cannot guarantee pricing for all vendors. Some temperature sensors were more accurate than others. Costs do not include installation, power and communications connections or programming. A rough value of $1,200 to $1,500 per meter can be assumed for budgetary purposes. Most vendors will offer discounted prices (more than 20 percent reductions) for volume purchases of meters. It is suggested that readers contact their local vendor for more project-specific pricing.

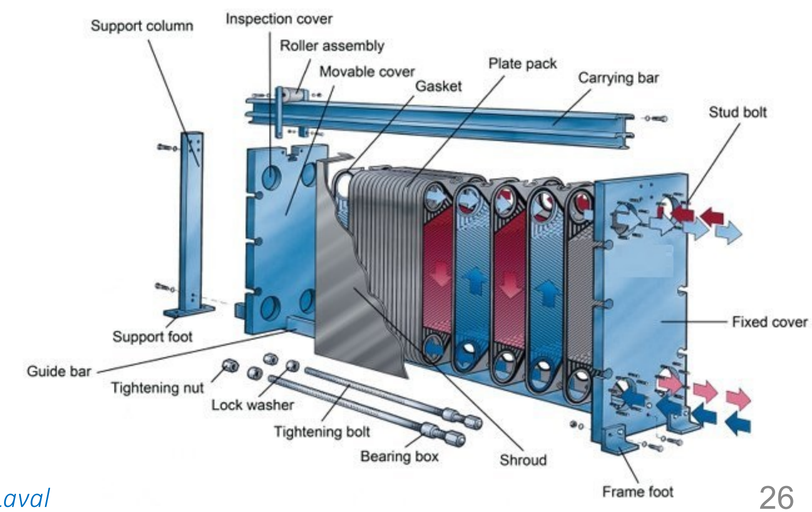
Standard Definitions & Concepts
Heat Exchangers

Brazed Plate Heat Exchangers (BPHE)
Single & Double Wall



- **Counterflow Design**
- **PHEs up to 5X more efficient than Shell & Tube Heat Exchangers (HX)**
- **As close as a 1°F approach temperature**
- **~1/5th floor space requirements**

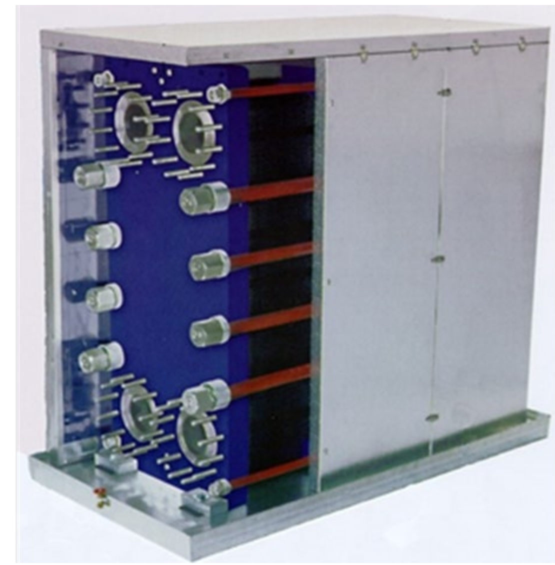
Gasketed Plate Heat Exchangers (GPHE)
Single & Double Wall



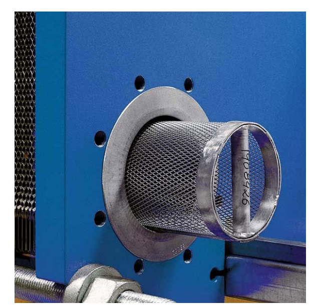
Images courtesy of Alfa Laval

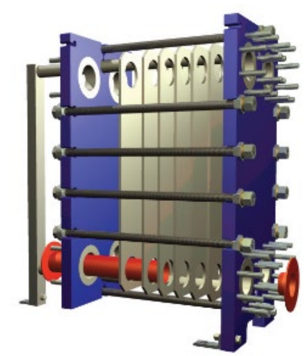
Standard Definitions & Concepts
Heat Exchanger Best Practices – What to Specify

- Understand the load minimums and maximums
- Minimum Plate Thickness = 0.4mm
- Gasket material – one piece snap-in
- AHRI certified
- Fouling factors based on water quality
- Pressure drop
- ASME Section VIII Division 1 (U-Stamp)
- Frame is typically oversized for 20% additional plates
- Accessories:
    - Insulated cabinets/shroud
    - Provide Wye or Port strainers (1/16” openings)



Images courtesy of Alfa Laval





Standard Definitions & Concepts
Controller & Instrumentation

- Controller
  - The “brains” of the ETS components
  - Control of all devices
  - Communications back to DCP
  - UPS Power to panel
- Instrumentation
  - Industrial grade preferred due to accuracy and robustness
    - Commercial grade acceptable if is accurate
  - Resistance Temperature Detectors (RTD)
    - 4-wire, 100-ohm, platinum, matched and calibrated pair of sensors and transmitters
    - Digital/Analog Accuracy: +/- 0.02% of span
    - Stability: +/- 0.1% of reading or 0.1°C, whichever is greater
  - Differential Pressure Transmitters (DPT)
    - Accuracy: +/-0.2% of span
    - Repeatability: +/- .01% of span

Standard Definitions & Concepts
Control Valves

- Avoid butterfly throttling valves
- High Turndown
- Depending on configuration and location in system, may need to "eat" a great deal of pressure
  - Characterized rotary ball valves
  - Eccentric disc valves
- Tight and close off pressure (bubble tight) Class VI per ANSI/FCI 70-2-199
- Fail closed, slow acting
- Two-way configuration
- Electric actuation with manual overrides
- Valve positioners
- Could have multiple valves based on load turndown or phased in growth

Standard Definitions & Concepts
Pipe Sizing and Design

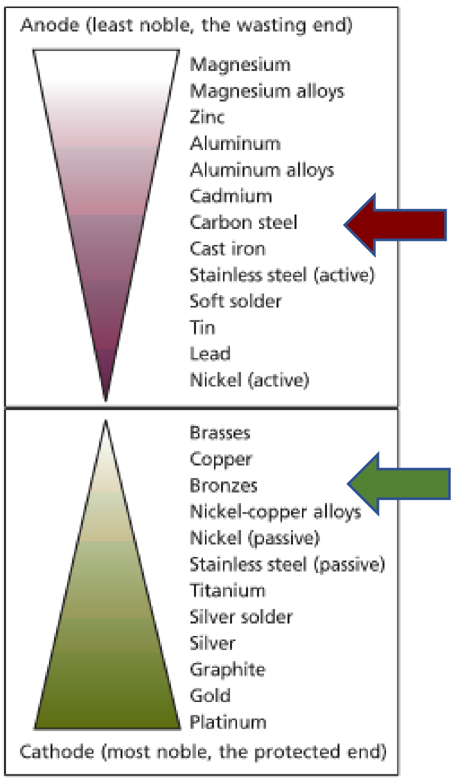
TABLE 6.5.4.6 Piping System Design Maximum Flow Rate in GPM

Operating Hours/Year	≤2000 Hours/Year		>2000 and ≤4400 Hours/Year		>4400 Hours/Year	
Nominal Pipe Size, in.	Other	Variable Flow/ Variable Speed	Other	Variable Flow/ Variable Speed	Other	Variable Flow/ Variable Speed
2 1/2	120	180	85	130	68	110
3	180	270	140	210	110	170
4	350	530	260	400	210	320
5	410	620	310	470	250	370
6	740	1100	570	860	440	680
8	1200	1800	900	1400	700	1100
10	1800	2700	1300	2000	1000	1600
12	2500	3800	1900	2900	1500	2300
Maximum velocity for pipes over 14–24 in. in size	8.5 ft/s	13.0 ft/s	6.5 ft/s	9.5 ft/s	5.0 ft/s	7.5 ft/s

Size piping per ASHRAE Standard 90.1 Table 6.5.4.6

Standard Definitions & Concepts
Galvanic Corrosion – Need for Dielectric Fittings

Dielectric Fittings – Use between dissimilar metals and similar metals that have age disparity



Source: Piping Handbook, Sixth Edition, Mohinder L. Nayyar, McGraw-Hill, 1992.

Corrosion that developed between carbon steel and bronze fitting in less than 2-years

ETS Components:
Who Typically Provides What?

- Typically, the DEP will have their own design manual with interconnection standards
- The process is a constant communication between the DEP and their consultants, building owner (customer) and their consultants
  - Location of ETS room
  - Routing of District Piping
  - Controls
- ETS room needs to house all equipment, have adequate access for maintenance, have lighting and convenience power, ventilated and have restricted access

ETS Components: Who Typically Provides What?

District Energy Provider Responsibilities:

- Design, Installs, Operates & Maintains the Primary Side of ETS:
  - Piping from distribution to ETS (dielectric)
  - Plate Heat Exchangers
  - Strainers (both sides)
  - Instrumentation
    - Energy Meters
    - Temperature transmitters & thermowells (both sides)
    - Pressure gauges & thermowell
    - Temperature gauge & thermowell
    - Manual Isolation & Control Valves
  - Control Panel
    - Secondary side monitoring and control of pumps and DHW
- Power to all devices
- Chemical Treatment and Makeup Water
- Commissioning of all DES equipment

Customer/Consumer Responsibilities:

- Design, Install, Operates and Maintains the Secondary Side of ETS:
  - Piping to building system
  - Circulation Pumps
  - Suitable Space for ETS Room
    - Ventilated, drains, water, receptacles
  - Penetration in building foundation wall for DH piping and communications conduit
  - Chemical Treatment and Makeup Water
    - DEP may require certified water treatment analysis prior to energizing
  - 2-way control valves at terminal units
- Building Side Controls
- Commissioning of Bldg HVAC Systems

For more info, refer to ASHRAE District Heating and Cooling Guides

System Supply Temperature Requirements

• Traditional commercial HW heating temperatures –	180°F to 160°F
• Typical chiller leaving condenser water temperatures –	85°F to 100°F
• Heat Pump HW outlet temperatures –	95°F to ~170°F
• Scroll or Screw compressor chiller –	up to 140°F
• Typical heat recovery chiller –	100°F to 110°F
• Drying process for food industry –	>266°F
• Spa and wellness resort –	>158°F
• Greenhouse air heating –	140°F
• Greenhouse with floor heating -	>104°F

Most reheat and building heat applications do not need 130 to 140°F to perform satisfactorily – lower temperatures change from 1 row to 2 row reheat coil, lower than that, required larger duct mounted coil

Typical HW System Supply Temperatures

• Radiant Floor Heating:	85°F to 125°F
• Baseboard Radiators:	100°F to +180°F
• Domestic Water Heater:	120°F to **140°F***
• Condensing boilers:	<80°F to +160°F**
• Radiator wall panels:	120°F to +190°F
• Air Handler Preheat coils:	+140°F
• Ducted Reheat coils:	100°F to 120°F
• Snow Melt:	95°F to 120°F

** Typical temperature to mitigate bacteria (legionella) growth*

*** Needs maximum 130°F return water temperature to be in condensing mode*

Ease of Retrofits – Conversion Suitability

System Type	Low	Medium	High
Steam Equipment			
One Pipe Cast Iron Radiator	X		
Two Pipe Cast Iron Radiator & FTR		X	
AHU Coils		X	
Hot Water Equipment			
Radiators & Convectors			X
Radiant Panels and Floors			X
AHU Coils (Reheat & Preheat)			X
Solar Hot Water			X
Gas/Oil Fired Equipment	X		
Electric Equipment	X		

Modified Table 14 from 2020 ASHRAE Handbook – HVAC Systems & Equipment Chapter 12 District Heating & Cooling

Delivering space Heat Baseboard Limitations

Inside
Insights

District Energy / First Quarter 2009

When Is Too Much Delta T Too Much?

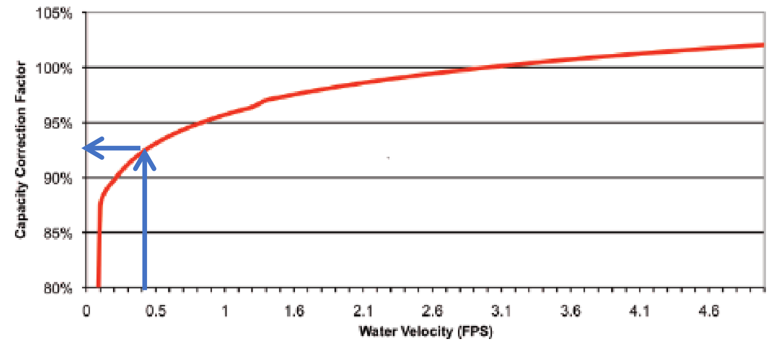
Avoiding the low-flow-hydronic-heating blues

- Impact of Lower Temperatures
- Temperature Limitations of Available Methods
- Retrofit issues

Table 1. Load Summary Space (Btuh).

Wall Load	Window Load	Roof Load	Ventilation Load	Infiltration Load	Total Heat Loss
550	3,325	480	2,770	3,000	10,125

Figure 2. Baseboard Radiation Heat Output Based on Water Velocity.



Source: 2008 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 35.

Table 1. Sample Finned Tube Selection Data for .75" Copper Tubing.

Case	Entering Water Temp (°F)	Leaving Water Temp (°F)	Average Water Temp (°F)	ΔT (°F)	Listed Capacity at 3 fps (Btu/hr/ft)	Actual Water Velocity (fps)	Corrected Capacity at Actual Velocity (Btu/hr/ft)	Length of Element Required (ft)
A1	200	180	190	20	848	0.45	786	8.8
A2	200	170	185	30	797	0.30	726	9.5
A3	200	160	180	40	745	0.22	671	10.2
A4	180	160	170	20	658	0.45	610	11.3
A5	180	150	165	30	615	0.30	561	12.3
A6	180	140	160	40	572	0.22	515	13.3
A7	160	140	150	20	486	0.45	450	15.3
A8	160	130	145	30	459	0.30	418	16.4
A9	160	120	140	40	432	0.22	389	17.7
A10	140	120	130	20	356	0.45	330	20.9
A11	140	110	125	30	319	0.30	290	23.7
A12	140	100	120	40	281	0.22	253	27.2
A13	120	100	110	20	216	0.45	200	34.3

Table 2. Sample Finned Tube Selection Data for 1.25" Copper Tubing.

B1	200	180	190	20	803	0.18	717.5	9.58
B2	200	170	185	30	757	0.12	665.5	10.33
B3	200	160	180	40	711	0.09	618.0	11.13
B4	180	160	170	20	628	0.18	561.2	12.25
B5	180	150	165	30	587	0.12	516.1	13.32
B6	180	140	160	40	546	0.09	474.5	14.49
B7	160	140	150	20	464	0.18	414.6	16.58
B8	160	130	145	30	438	0.12	385.1	17.85
B9	160	120	140	40	412	0.09	358.1	19.20
B10	140	120	130	20	340	0.18	303.8	22.63
B11	140	110	125	30	304	0.12	267.3	25.72
B12	140	100	120	40	268	0.09	232.9	29.52
B13	120	100	110	20	206	0.18	184.1	37.35

Source: Slant/Fin Commercial Finned Tube Selection Guide.

Delivering space Heat
Baseboard Radiation Impact of Lower EWT

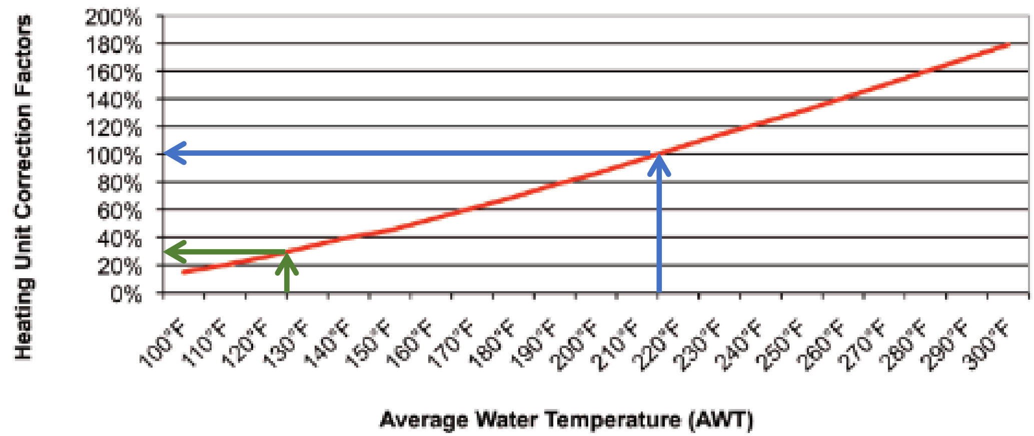
Table 2

Calculating BTUH Output for Different Water Temperatures

Please note: The BTUH outputs listed in this catalog are based on 180°F water. The following chart may be used for calculating the BTUH outputs for different water temperatures.

Water Temperature:	Multiply listed BTUH by:
120°	.38
130°	.48
140°	.57
150°	.67
160°	.78
170°	.89
180°	1
190°	1.13

Figure 1. Baseboard Radiation Heat Output Based on Average Water Temperature.



Source: 2008 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 35.

- Lower temperatures require more heat transfer area
- Temperature Limitations of Available Methods
- Retrofit issues
- Terminal Units
- Laminar flow

Reheat Coil Capacity Impact from Reduced EWT

Table 2. Reheat Coil Selection Samples.

Item	Height (inch)	Length (inch)	Oversizing	LAT (°F)	Load (MBH)	EWT (°F)	LFT (°F)	Flow (GPM)	Rows	FPI
1	9	8	0%	90.9	11.8	180	156.6	1.0	2	8
2	9	8	0%	90.5	11.6	180	145.5	0.7	2	8
3	9	8	0%	87.5	10.7	180	137.7	0.5	2	8
4	9	8	0%	90.7	11.7	170	146.9	1.0	2	8
5	9	8	0%	87.4	10.6	170	138.5	0.7	2	8
6	9	8	0%	88.0	10.8	170	127.1	0.5	2	10
7	9	8	0%	86.6	10.4	160	139.7	1.0	2	8
8	9	8	0%	88.0	10.8	160	128.0	0.7	2	10
9	9	8	0%	87.3	10.6	160	118.0	0.5	2	12
10	9	8	0%	87.2	10.6	150	129.4	1.0	2	10
11	9	12	50%	86.4	10.3	150	119.4	0.7	2	8
12	9	12	50%	87.0	10.5	150	108.5	0.5	2	10
13	9	12	50%	89.2	11.2	140	118.0	1.0	2	10
14	9	12	50%	86.3	10.3	140	109.6	0.7	2	10
15	9	12	50%	87.6	10.7	140	97.7	0.5	2	12
16	9	14	75%	87.0	10.5	130	109.5	1.0	2	10
17	12	14	133%	86.5	10.3	130	99.7	0.7	2	10
18	12	14	133%	86.6	10.4	130	88.9	0.5	2	12
19	12	14	133%	85.7	10.1	120	100.3	1.0	2	10
20	12	14	133%	71.4	**5.4**	120	104.0	0.7	2	12
21	12	14	133%	68.8	**4.3**	120	102.0	0.5	2	14
22	12	14	133%	72.9	**5.9**	110	98.5	1.0	2	14
23	12	14	133%	69.0	**4.6**	110	96.5	0.7	2	14
24	12	14	133%	66.5	**3.8**	110	95.2	0.5	2	14

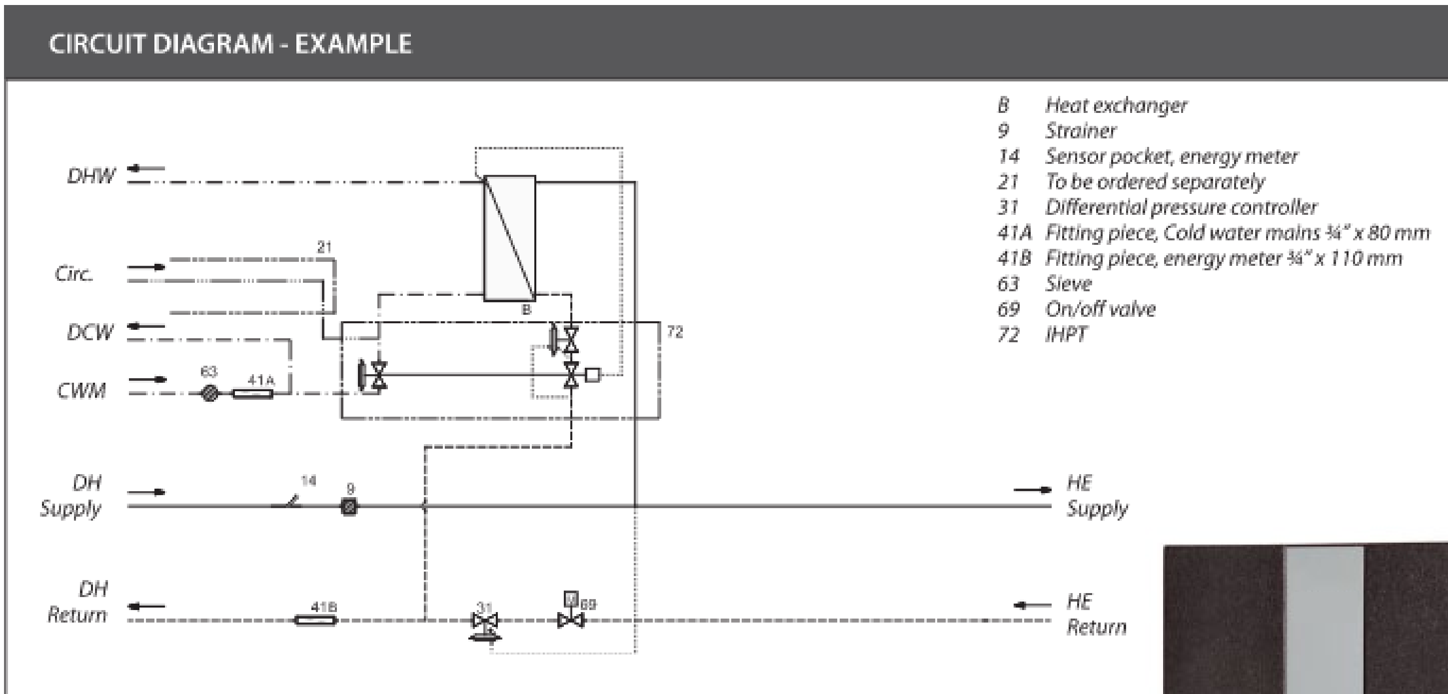
Inside Insights

When Is Too Much Delta T Too Much?
Part 2 - Getting real about reheat
District Energy / Second Quarter 2009

Difficulties in Retrofitting Existing HVAC Systems

- Gas forced air furnaces
  - For District heating, add HW coil, new fan
  - Typically, no vertical space above residential furnace
  - Need to replace furnace/AHU due to higher static, etc.
- Hydronic systems
  - Lower supply temperatures mean larger coils to obtain the same capacity
- Steam systems
  - Possible to reuse radiators, but they will be derated
  - Possible, but very difficult due to condensate piping is smaller than steam piping

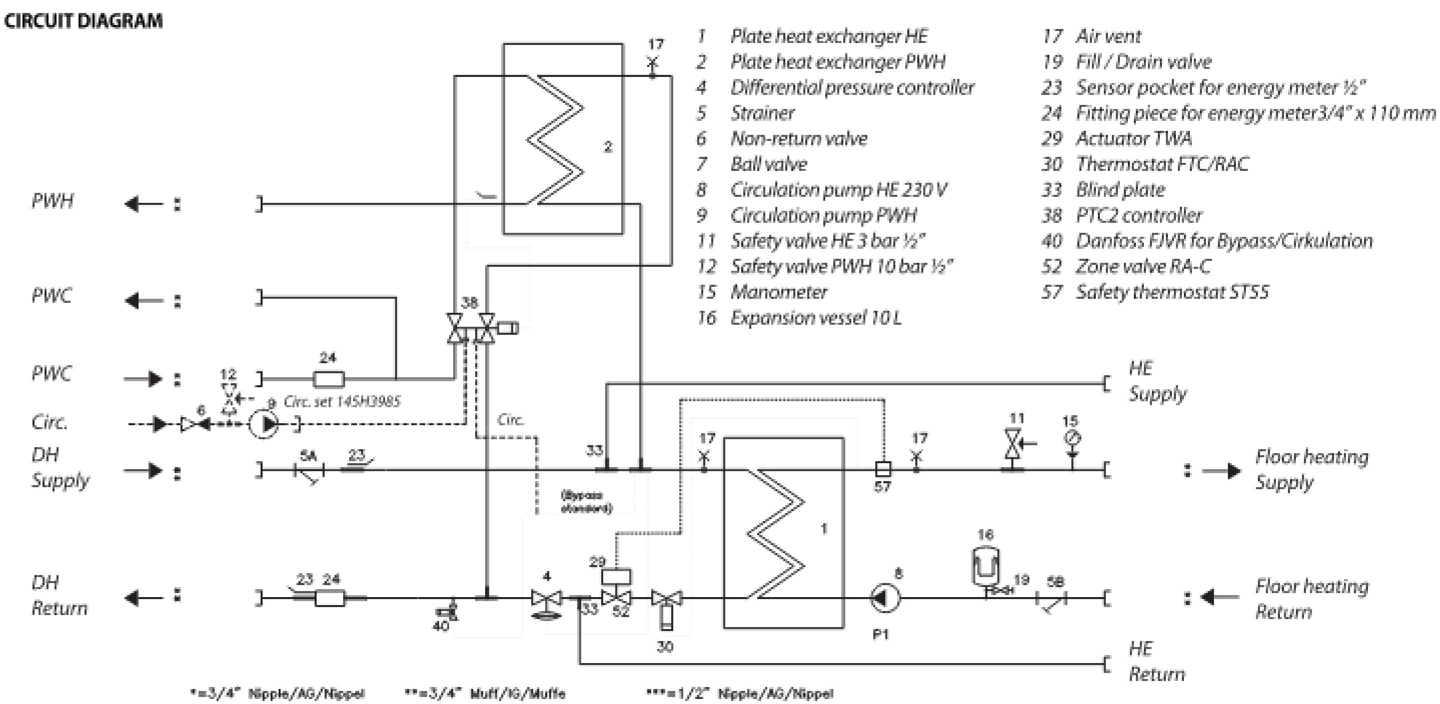
Pre-manufactured Substations / ETS
~125 MBH Direct/Indirect (Heating & DHW)



Images courtesy of Danfoss

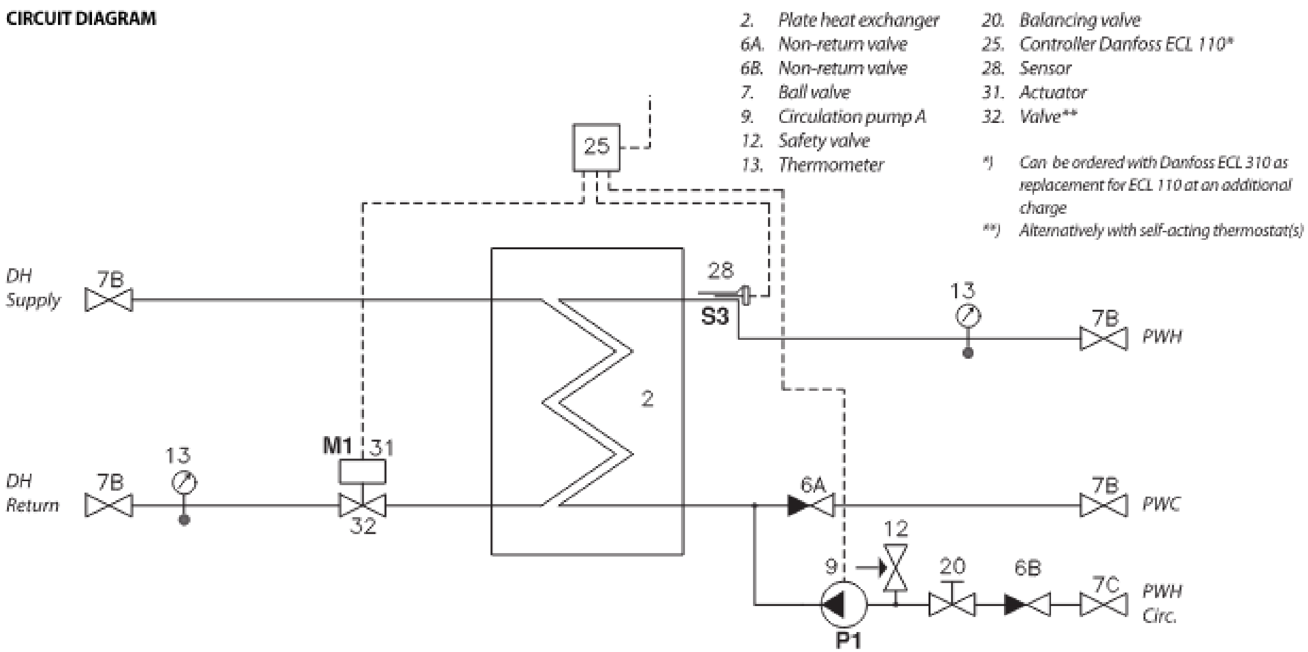
- Thank goodness for the Europeans!

Pre-manufactured Substations / ETS ~125 MBH Indirect (Heating & DHW)



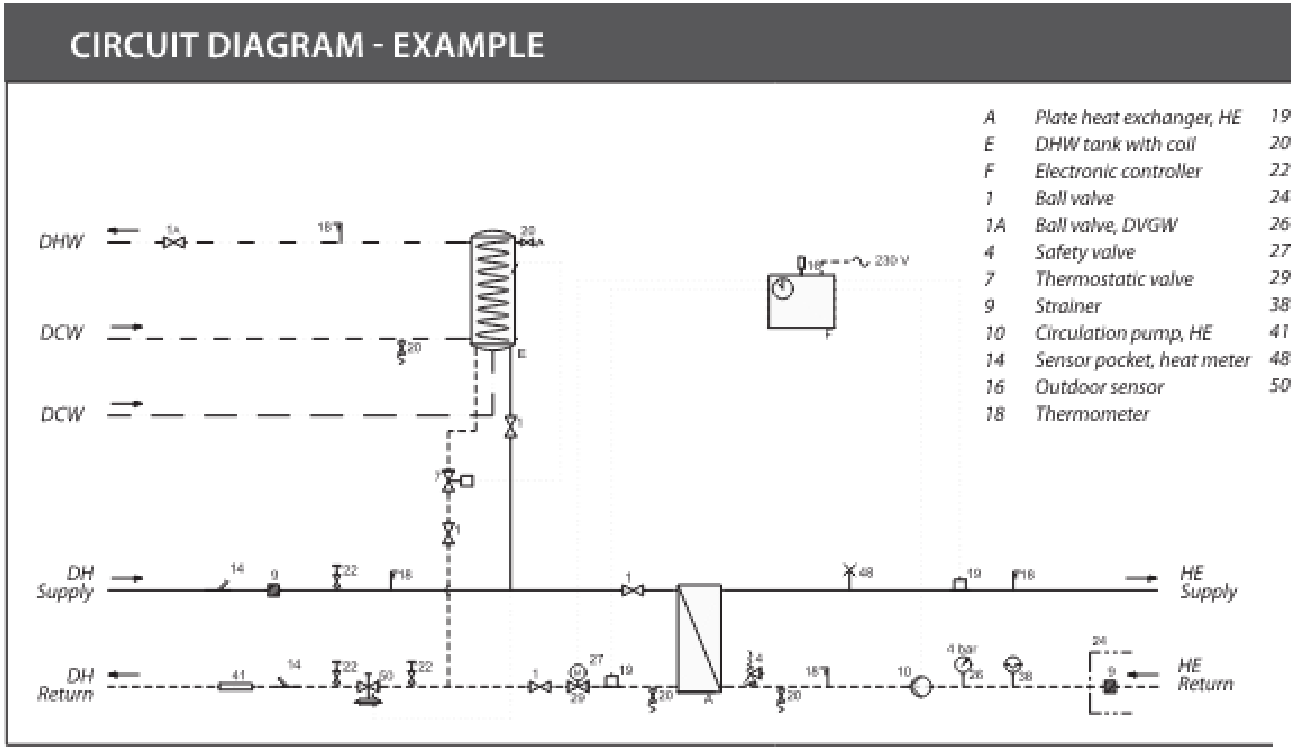
Images courtesy of Danfoss

Pre-manufactured Substations / ETS ~460 MBH Indirect (Heating Only)



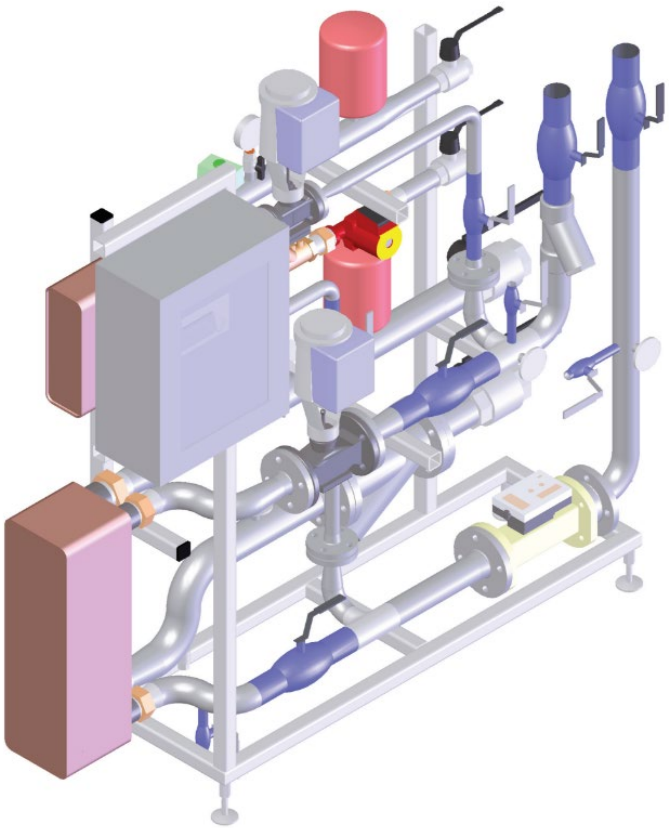
Images courtesy of Danfoss

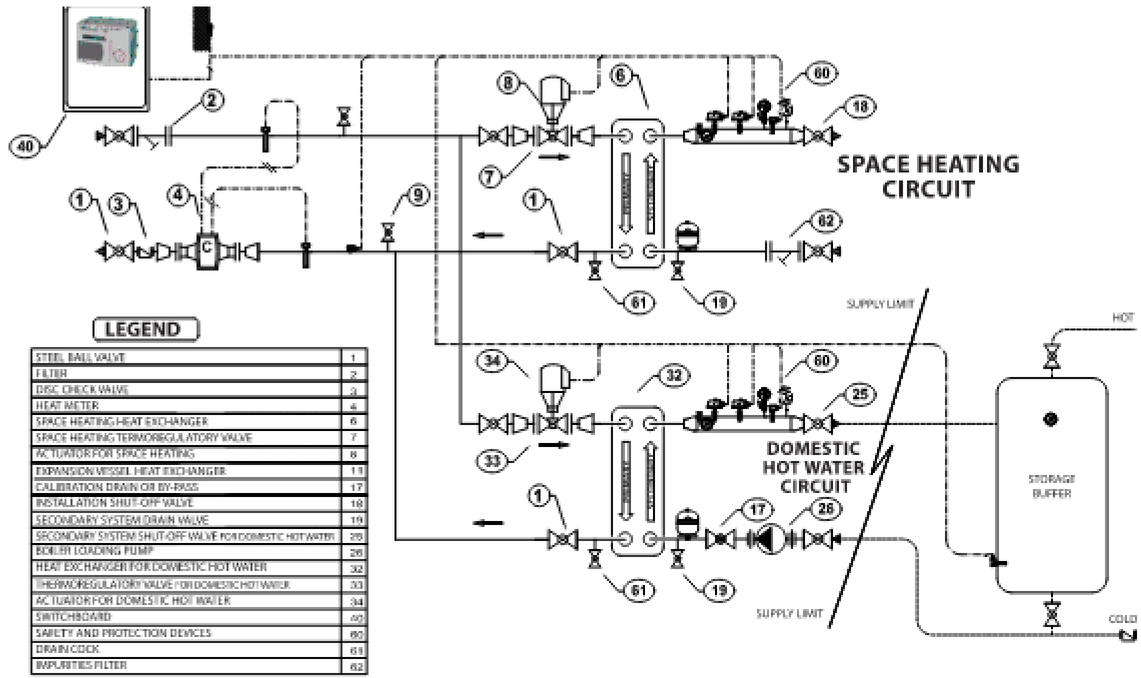
Pre-manufactured Substations / ETS
Small Apartment Bldgs (340 to 500 MBH)



Images courtesy of Danfoss

Pre-manufactured Substations / ETS Larger installation (up to 5,000 MBH)





STEEL BALL VALVE	1
FILTER	2
DISC CHECK VALVE	3
HEAT METER	4
SPACE HEATING HEAT EXCHANGER	6
SPACE HEATING TERMOREGULATORY VALVE	7
ACTUATOR FOR SPACE HEATING	8
EXPANSION VESSEL HEAT EXCHANGER	11
CALIBRATION DRAIN OR BY-PASS	17
INSTALLATION SHUT-OFF VALVE	18
SECONDARY SYSTEM DRAIN VALVE	19
SECONDARY SYSTEM SHUT-OFF VALVE FOR DOMESTIC HOT WATER	25
BOILER LOADING PUMP	26
HEAT EXCHANGER FOR DOMESTIC HOT WATER	32
THERMOREGULATORY VALVE FOR DOMESTIC HOT WATER	33
ACTUATOR FOR DOMESTIC HOT WATER	34
SWITCHBOARD	40
SAFETY AND PROTECTION DEVICES	60
DRAIN COCK	61
IMPURITIES FILTER	62

Images courtesy of Stea S.p.A

Field Erected Energy Transfer Stations Larger installation (>5,000 MBH)

- May be able to get pre-manufactured units, but for retrofit must fit through standard door opening, therefore, typically field erected or “stick built”
- Example of District Heating Thermal and Domestic HW BPHE
- Not shown: pump, meters, instrumentation

Delivering Domestic Hot Water Efficiently

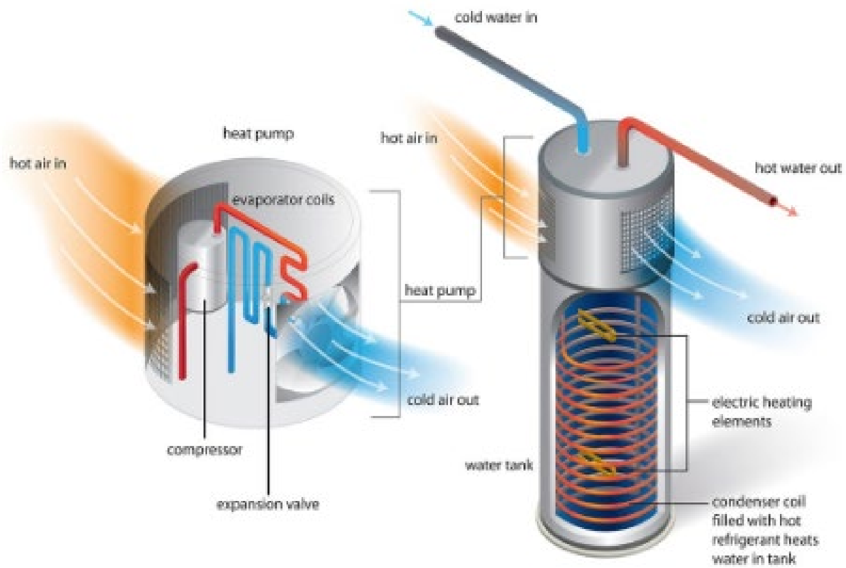


Image courtesy EPA Energy Star®

Compare:

High-Efficiency Hybrid Electric Heat Pump Tank Water Heaters:

Standard Electric Tank Water Heaters:

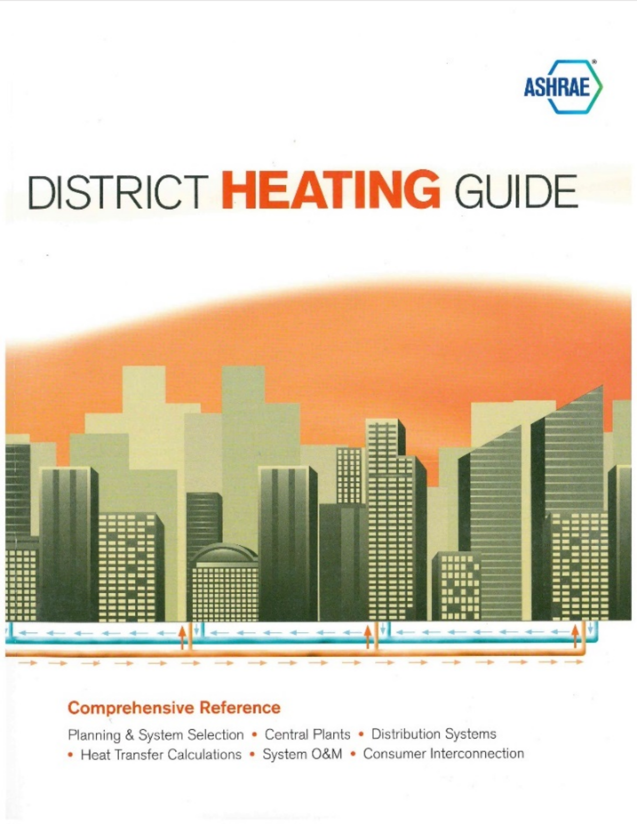
ENT-50

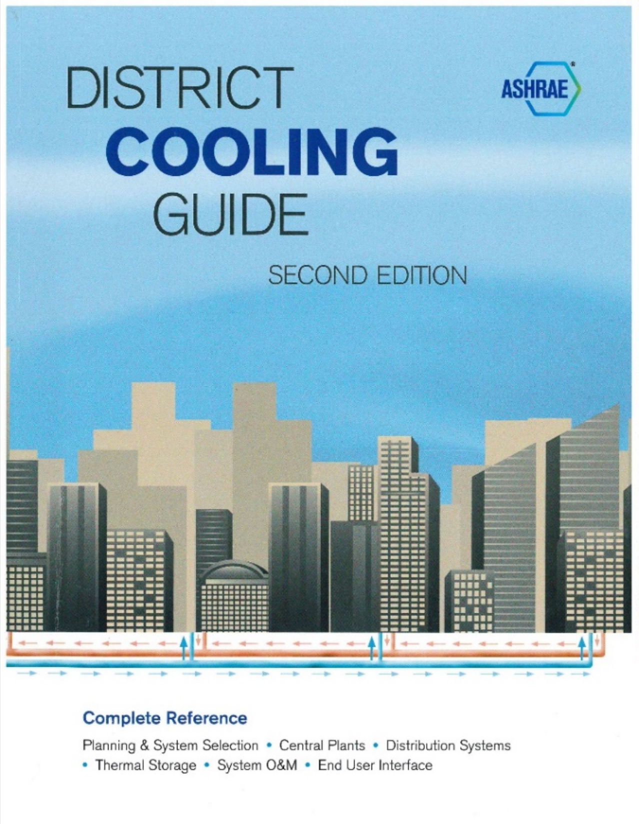
	PROLINE® XE BEST	PROLINE® GOOD
Single Shower Length	33 minutes	27 minutes
Back-to-Back Showers	4.2 showers	3.4 showers
Showers at the Same Time	2.9 showers	2.9 showers
Maximum Tub Size	85 gallons	75 gallons
ENERGY STAR® Certified	✓	
UEF	3.45	0.92
Warranty	6 - 10 Years	6 Years

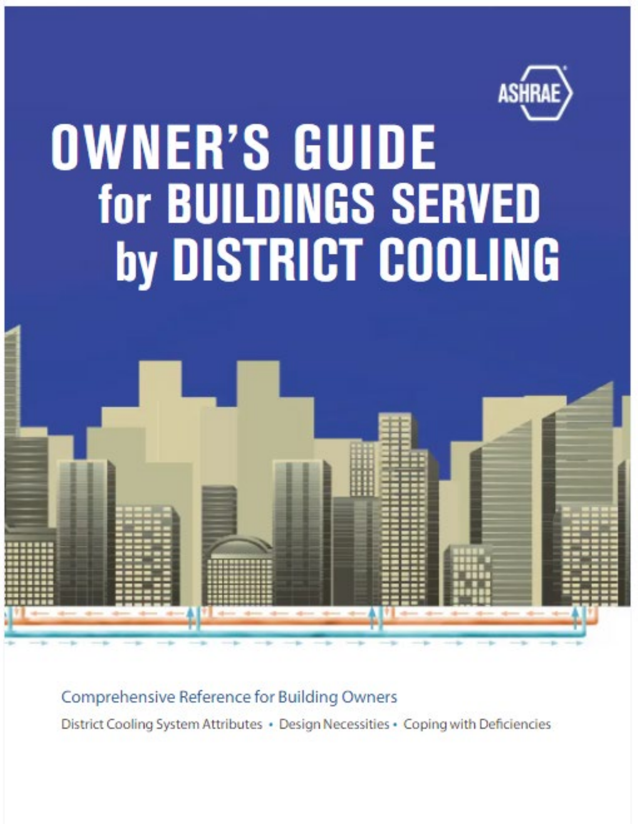
Images courtesy of A.O Smith

- How to get to 140°F Efficiently for larger volumes
- Hybrid Electric Heat Pump Tank Water Heaters

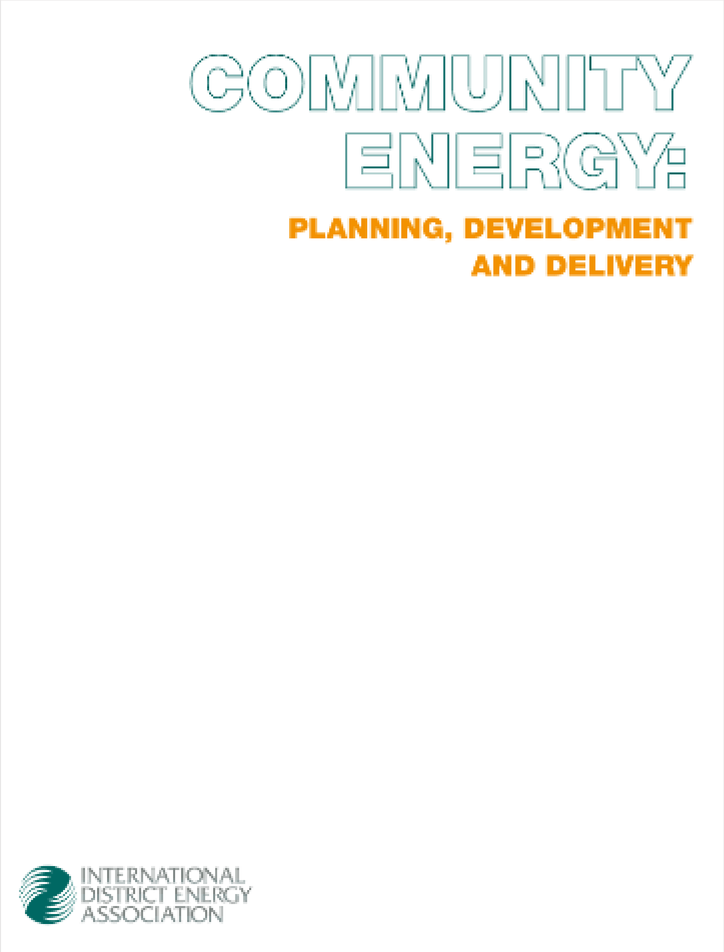
Community Heat Pump Energy Planning Resources







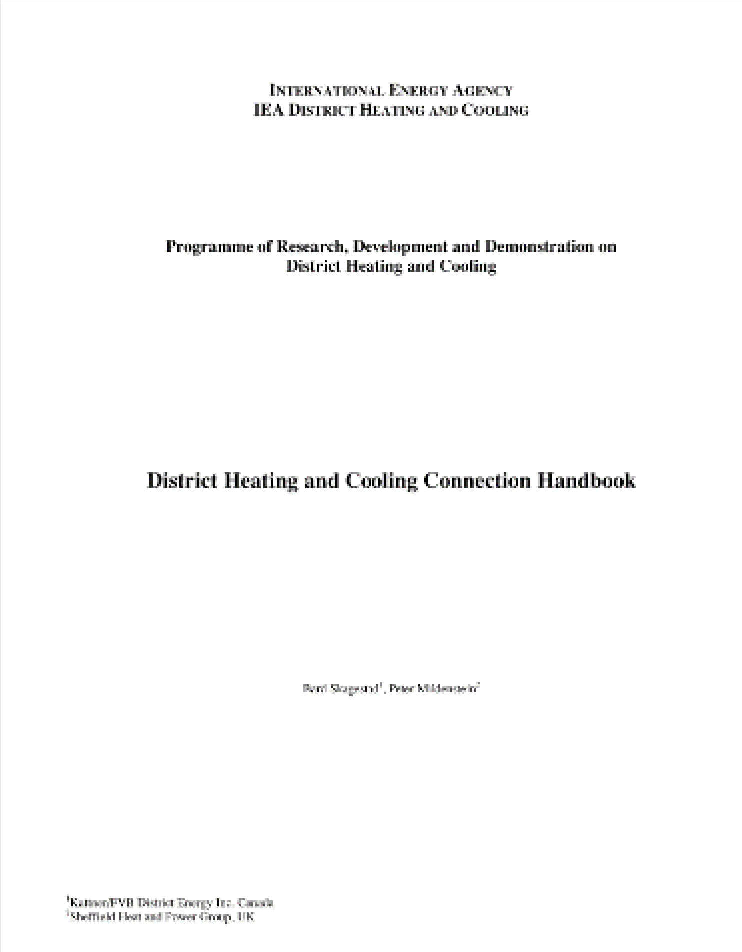
Community Heat Pump Energy Planning Resources (Cont.)



COMMUNITY ENERGY:

PLANNING, DEVELOPMENT AND DELIVERY

INTERNATIONAL DISTRICT ENERGY ASSOCIATION



INTERNATIONAL ENERGY AGENCY
IEA DISTRICT HEATING AND COOLING

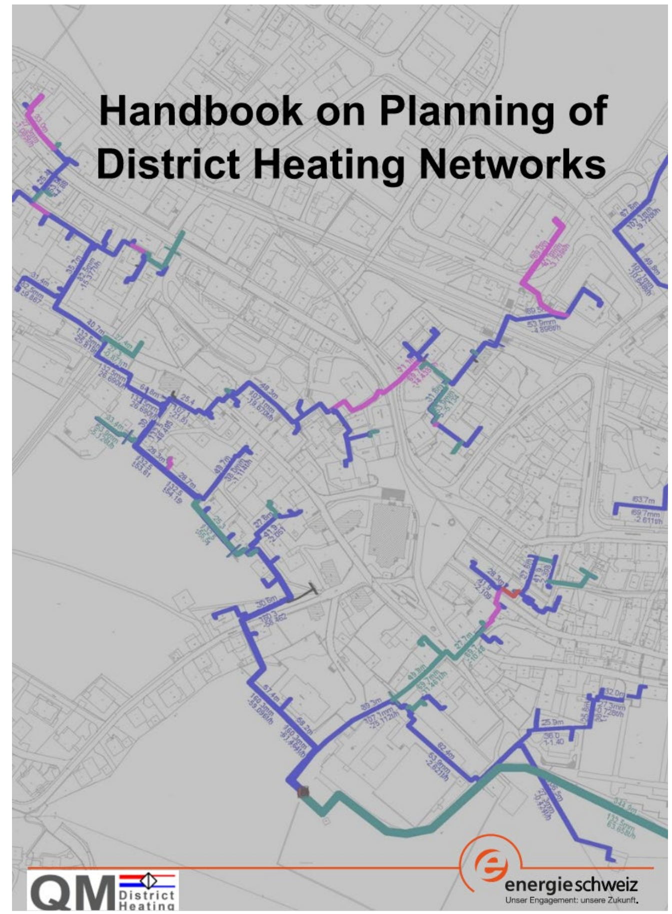
Programme of Research, Development and Demonstration on District Heating and Cooling

District Heating and Cooling Connection Handbook

Bård Skagestad[1], Peter Mildenstein[2]

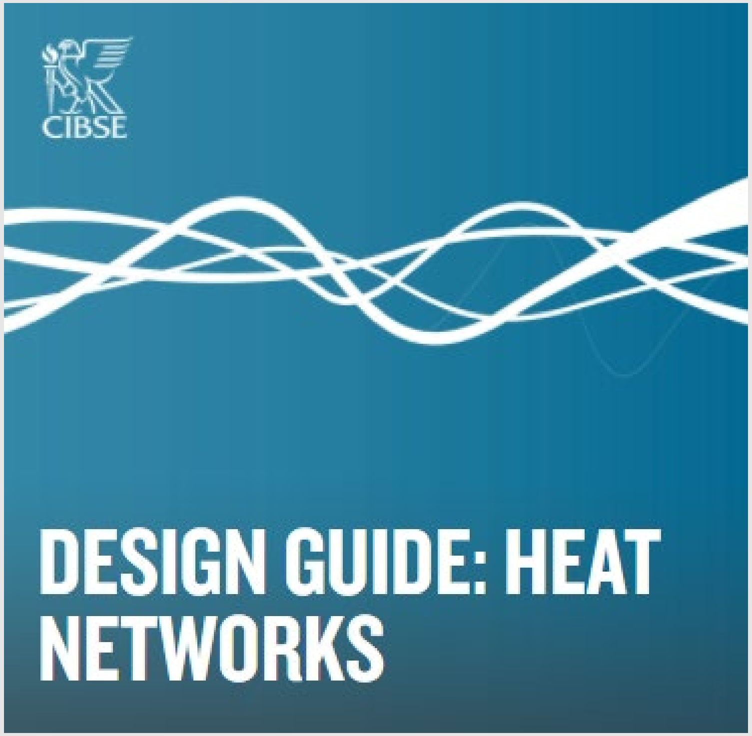
[1]Kattner/FVB District Energy Inc. Canada
[2]Sheffield Heat and Power Group, UK

Additional District Energy Reading



- 2021 publication
  https://publica.fraunhofer.de/eprints/urn_nbn_de_0011-n-6402040.pdf

Community Heat Pump Energy Planning Resources (Cont.)



Join us for the next webinar in the series:

- Date: December 15, 2021
- Topic: Commercial Scale In-Building Equipment for 4th & 5th Generation Water Sources

Register at https://www.ashrae.org/CHPSWebinars

NYSERDA Resources

- Funding Opportunity PON 4614
- Fact Sheets of Prior Winners at PON 4614
- List of Solution Providers focused on this Marketplace
- Report regarding Regulatory Issues affecting this Marketplace
- Please see www.nyserda.ny.gov/district-thermal-systems

ASHRAE Task Force for Building Decarbonization

Learn about the ASHRAE Decarbonization Initiative and the ASHRAE Task Force for Building Decarbonization (TFBD) at

https://www.ashrae.org/decarb

Explore ASHRAE Learning Institute Courses

https://www.ashrae.org/instructor-led-courses

Find a Topic that Fits You:

- Commissioning
- Energy Efficiency
- Environmental Quality
- HVAC&R Applications
- Standards and Guidelines
- CoV-2 Mitigation

See all the ways to learn and grow with ASHRAE at
https://www.ashrae.org/professional-development/learning-portal

Evaluation and Certificate

- ASHRAE values your comments. All webinar registrants will receive a separate email from ALI-Education (edu@ashrae.org) with a link to the Webinar Survey and Certificate of Attendance. Once the survey is complete, you will be directed to the certificate. Questions should be sent to edu@ashrae.org.
- A copy of the presentation is available at: https://www.ashrae.org/consumerdsgn2021NYSERDAchp
- If you have any questions about the webinar certificate, please contact Kelly Arnold, Coordinator Professional Development, karnold@ashrae.org.
- If you have any questions about the webinar presentation, please contact Tiffany Cox, Course Administrator, tcox@ashrae.org.

ASHRAE Certification

- More than **3,000 certifications** earned to-date
- Elevate your **reputation** among peers, in the workplace and among clients
- **NEW!** Digital Badging:

- ❑ Embedded metadata uniquely linked to you
- ❑ Shareable in electronic media, including LinkedIn and email
- ❑ Instant recognition, with real-time, third-part verification

- Visit **www.ashrae.org/certification** to learn more