NORTHAMPTON ENERGY AND SUSTAINABILITY COMMISSION

APPROVED MINUTES

February 13, 2020
City Council Chambers
212 Main Street, Northampton, MA 01060
4:00 PM – 6:00 PM

Attendees: Wayne Feiden, Chair, David Pomerantz, Vice Chair, Alex Jarrett, Rachel Maiore, Adin Maynard, Ashley Muspratt, Richard Parasiliti, Ben Weil, Chris Mason

Facilitator: Wayne Feiden
Scribe: Adin Maynard

Public Comment:
Sharon Moulton deadline for comments is Feb28 for MOU on TCI - Transportation Climate Initiative. Sharon encourages NESC members to individually support the TCI. See attachment at end of minutes. To submit a comment, go to: https://default.salsalabs.org/Teec440c7-f6dc-4848-b572-57a1501458be/8b32803c-b79d-41b8-abc6-cbd52b5aa4a9

Review/approve minutes of 1/9/20: Alex Jarrett moved to approve the minutes as amended to add the referenced attachments: the updated CRRP 'Outline and Decision Points' document. Rachel Maiore seconded the motion. Minutes approved with 2 abstentions by members who had not been present at the 1/9/20 meeting.

Discussion of future meeting times and duration:
For now, maintaining 2nd Thurs 4-6 pm meeting times.
However, based on Zoning Board Agendas, board that uses the room at 5:30 pm on occasional Thursday, some NESC meetings will only last until 5:30pm.
In the future, upon Planning's staffing acquisitions freeing up Wayne's availability, the 1st Tues of the month 4-6 pm is a potential.
Chris will put out another Doodle poll upon looking at additional meeting space and time options.

Decision points for Climate Resilience and Regeneration Plan:
Wayne passed around an updated list of CRRP topics and potential actions for each topic. (Attached) He described how there would likely be trade-offs between the effectiveness of various actions and their costs and/or the availability of information and resources. In many cases we still need to know what questions to ask.

1. Greenhouse Gas Emission Inventory
   Consensus that there is a gap in data and at what resolution we should be looking at carbon emissions and how we are measuring. Consider how important various data sets are, the cost of improving data, and how to improve data.

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Ex-officio, non voting:	Chris Mason

Ben gave example of using Google traffic data instead of 6 City traffic counters for more accuracy. Would need to be API for regular reporting. He referenced opportunity for UMass Comp Sci grad student

2. Carbon Offsets
   Potential of monetizing carbon offsets by managing conservation areas as 'forever wild.'
   How do offsets impact goals for carbon neutrality? What place do they have?
   David P. and Ben W. suggested that we may explore a grad student, through various funding sources including DOER, to explore offsets and how they fit into muni climate plans.

3. Buildings - thermal Load electrification costs
   Need to be clear on what City controls - muni held buildings that require funding and political will. Private owned buildings have unique challenges that must be understood. Leveraging influence over affordable housing funding - how to decarbonize new multifamily buildings? Wayne referenced the challenges presented by The Community Builders (a MassDevelopment Developer) who is developing a passive house certified project in Northampton and their challenge of electrifying domestic hot water.

4. Conservation and Electrification of Transportation
   Electrification is 2nd to conservation and infrastructure. What are capital costs and models required to reduce carbon emissions associated with transportation?
   Alex J looks to local control / ordinances as a way

5. Renewable Energy Costs
   Infrastructure costs and benefits

Some consistent themes and questions were seen to run through each topic:

- What are costs?
- What are benefits?
- What data is needed?
- What can city government do? (e.g., passing ordinances)
- What educational/behavior efforts would be effective?

Wayne encouraged commissioners to identify more topics to include and for NESC members to take the lead on researching topics to help ascertain additional questions that need to be asked.

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IDEAS FOR NEW TOPICS:

- Waste reduction requirements, composting, 0-waste targets are typical of Community Climate plans.
    - Chris M. - companies responsible for packaging and taking responsibility for their waste 'cradle to cradle'
    - Ashley M. - food waste diversion - managing organics
- EDUCATION and Habit changing \
    - Adin suggests that behavior change goes beyond education and outreach and includes ways to shape social norms and habits. Changing habits related to Energy consumption could be its own topic.
    - Suggestion that habit changing is integral to each topic. There is brief discussion that someone needs to lead to ensure this makes it into each prioritized topic. Rachel offers to be the point person on this as it fits into her public health interests and experience.
- GOVERNMENT ACTION
    - Alex wanted to understand the breadth of government action available to use. He said he would check the work of the City Council Community Resources Committee.

Commissioners signed up to research various topics before the next meeting:

Alex:	Effective government action. He will also coordinate with City Council Community Resources Committee
Ben:	VMT part of GHG inventory. Finding funding.
Ashley:	Carbon offsets
Adin & Ben:	Thermal load electrification
Alex & Adin:	Conservation and electrification of transportation
Alex:	Waste
Rachel	Education/behavior efforts

NESC Norms and Expectations – Ashley Muspratt

Ashley reads NESC charter. Proposes NESC member responsibilities. (see attached draft)

- Commissioners need to be aware of City policy, projects. NESC members have a responsibility to be engaged and aware of relative topics.
- Adjust Meeting structure: After public comments have a standing 10 min for new and ongoing projects, and relative updates by Chris, City Dept. heads, and other NESC members.

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- Add a Standing agenda item for each NESC member to provide updates based on tasks completed since last meeting.
- Meetings conclude with a review of actionable items, included into the Minutes, to be accomplished by the next meeting.
- Sub committees - to adhere to open meeting laws and quorum requirements. Sub committees are a necessity for NESC productivity. Not a problem for small groups to meet as long as it is posted in a timely matter in compliance with Open Meeting requirements.
- Member responsibilities - come prepared, commit to being productive outside of meetings, be accountable. Alex suggests to add that NESC members be direct if they need help and to notify the Chair if tasks will not be completed.
- Chair responsibilities- solicit agenda items from NESC members. Wayne suggests that the Chair take on time keeping responsibilities, instead of having a separate member be time keeper. Chris offers that the most productive meetings have all members contributing to time keeping/ task managements.

Actionable follow up:
Ashley will revise based on comments and NESC will vote on her proposal at the March meeting. Final adopted 'Norms and Expectations' will be made available to the public on the NESC webpage.

"Actionable Item" presentations – Ben Weil
(See attached power point.)

Context of energy use in MA and region
Ben provides detail on the context of MA energy use historic and projected
Proposes that a municipal thermal energy utility tasked with developing and owning thermal micro grids coupled with local (e.g., individual buildings) heat pumps and thermal storage buffer units. Describes how this can provide a cost effective way to electrify our community while not 'stranding' existing hydronic equipment. The technology presented includes ground and air source heat pump technologies tying into new municipal underground thermal infrastructure.

Municipal Projects - Chris Mason
Chris suggests it should include other departments, not only his office. (e.g., Planning, DPW, Central Services, Building Commissioner). There is a general agreement that Chris should curate the updates,

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and there is no need to be redundant month over month. Hold the block of 10 minutes each meeting. David P. offers that financing overview included, to educate NESC members.

Action Items:

- **Chris**: new Doodle Poll with new meeting sites for 2-hr meeting times
- **All Commissioners**: Identify topics to add to Wayne's CRRP list.
- **Various Commissioners**: research various topics before the next meeting
- **Ashley**: Update Norms & Expectations document and send to Chris to distribute in time for next meeting.
- **Presenters**: send presentation documents to Chris for inclusion in minutes

Attachments

- Transportation Climate Initiative email
- CRRP Information needs
- Draft NESC member responsibilities
- Muni Thermal Utility PowerPoint

Adjournment: Adjourned at 6:15 PM.

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Ex-officio, non voting: Chris Mason

City of Northampton

Chris Mason <cmason@northamptonma.gov>

Fwd: Support transit improvements and emission reductions. Submit comments on TCI today.

1 message

Sharon M Moulton <smm2250@aol.com> Thu, Feb 13, 2020 at 4:09 PM
To: Chris Mason <cmason@northamptonma.gov>

Sent from my iPhone

Begin forwarded message:

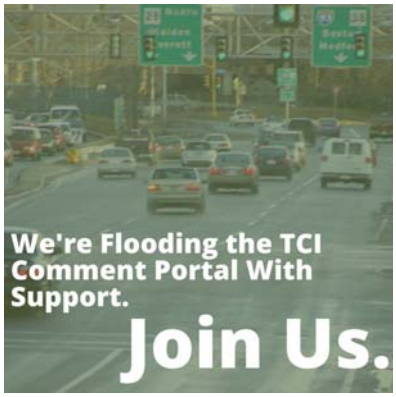
From:Sharon Moulton
Subject: Fwd: Support transit improvements and emission reductions. Submit comments on TCI today.

-----Original Message-----
From: Environmental League of Massachusetts <etomlinson@environmentalleague.org>
To: Sharon Moulton <smm2250@aol.com>
Sent: Thu, Feb 13, 2020 1:16 pm
Subject: Support transit improvements and emission reductions. Submit comments on TCI today.

ENVIRONMENTAL LEAGUE OF MASSACHUSETTS

Support the Transportation and Climate Initiative

The Transportation and Climate Initiative (TCI) is a collaboration of ten states and D.C. that would cap transportation emissions and place a fee on fuel imports. **TCI is a once in a generation opportunity to reduce greenhouse gas emissions and raise much needed revenue to modernize our transportation system on a regional scale.** Unreliable transit is taking time residents should be spending at work or with their families. Those without choices have to drive and the resulting traffic congestion is further damaging our environment, public health, and quality of life.



Submit a Comment

Right now, the leaders of the TCI states are soliciting feedback on the program and will decide this spring if they will participate.

Help us show a flood of public support for a strong Transportation and Climate Initiative by submitting a public comment on a draft framework to reduce climate pollution from transportation.

Here are some ideas to guide you as you write your comment.

Environmental League of Massachusetts
15 Court Square, Suite 1000 | Boston, Massachusetts 02108
617-742-2553 | info@environmentalleague.org

Planning & Sustainability ▪ City of Northampton

resilience | regeneration | design | conservation | placemaking | mobility | accessibility | community development | historic | zoning | GIS | agriculture

Wayne Feiden, FAICP, Director of Planning & Sustainability ▪ Wfeiden@NorthamptonMA.gov ▪ 413-587-1265

Climate Resilience and Regeneration Plan Information Needs (ideal, not all practical)

For various GHG emission targets

How do we modify and expand the list?

1. **Greenhouse Gas Emission Inventory**
    a. Filling the gaps in the existing inventory (city operations and private operations)
    b. Improve modeling of weak data (e.g., total vehicles miles traveled and gas)
    c. Updating the inventory so we have baseline AND a later time period
2. **Carbon Offsets (Carbon sequestration and storage)**
    a. Quantify amount of carbon storage/offsets to meet reach carbon neutrality in 2020, 2025, 2030, 2035, 2040, and 2045.
    b. Quantify pricing of carbon offsets in California carbon exchange market
    c. Land needs if local carbon offset storage
3. **Building thermal load electrification costs- models and capital cost estimates to electrify**
    a. City building heating and cooling, including conservation investments.
    b. City water heating needs, including conservation investments
    c. Residential commercial (tenant) heating and cooling
    d. Residential commercial (tenant) water hearing
    e. Residential home ownership heating and cooling
    f. Residential water heating and cooling
4. **Conservation and electrification of transportation loads- models and capital costs to**
    a. Invest in infrastructure to allow greater percentage of walkable and bikable trips
    b. Invest in housing opportunities for walkable locations
    c. Sidewalk, bike infrastructure, transit infrastructure to reduce single-occupancy vehicle trips
    d. Electrification of city vehicles
    e. Electrification of private vehicles
5. **Renewable energy costs**
    a. Investments for a two-way renewable energy grid
    b. Tradeoffs solar PV (trees, local, imported)
6. _____
7. _____
8. _____
9. _____

NESC Meeting Norms and Expectations
Last Updated: February 13, 2020

NESC Charter: "…assist and ensure that the city identify, develop, implement, and manage programs and policies…consistent with the goals of the Sustainable Northampton plan, the city's climate change protection commitments, and other city plans / goals."

Therefore, fulfilling this mandate demands that:

1) Commissioners be informed of city projects, policies, proposals relevant to energy and sustainability

2) Commissioners be engaged and invested in the work of NESC given the scope of our mandate, urgency of our work, and the opportunity we have to accelerate the city's decarbonization, energy transition, bring ideas and best practices to the fore, etc.

To meet these demands, NESC adopts the following norms and expectations related to meeting structure and Commissioner responsibilities:

Meeting Structure	-Following the public comment period, the next 10 minutes of meeting agendas shall be reserved for updates on new and ongoing projects, and any other city initiatives relevant to NESC. This is led by Chris Mason with contributions from any other city officials. -There shall be a standing agenda item for a report out from each Commissioner on work conducted since the last meeting. The time allocation for this agenda item will be adjusted according to the assignments and reporting needs. -Agenda items shall all have time limits and a Timekeeper shall be assigned at the start of every meeting. -Where relevant or possible, agenda items shall emerge with action items that Commissioners take responsibility for tackling between meetings. -Meetings conclude with a go around of individual to-dos before next meeting. These are recorded in the minutes. -Meetings are 2 hours long and once per month. The Commission will revisit this on a quarterly basis to determine if meeting frequency should be increased.
Sub-Committees	-Shall be formed to collaborate on research and recommendations that would ultimately be presented to the full Commission. -Shall adhere to open meeting law: meetings posted and held in public locations, minutes recorded, contain ≤3 Commissioners.
Commissioner Responsibilities	-Arrive at meetings on time. -Come prepared, having read minutes and the agenda, and having completed work assigned at the previous meeting. -Commit to conducting work outside of meetings. Actively volunteer for assignments and/or propose research and deliverables to take on (e.g., identifying best practices, preparing presentations, proposing policy ideas). -Adhere to deadlines and be accountable to commitments. -Be prepared to report out to the Commission at each meeting; reports should include a recommendation or next step.

	-Inform the Chair if feeling overwhelmed by duties and need assistance from another Commissioners.
Chair Responsibilities	-Actively solicits agenda items from Commissioners (e.g.,, sends an email or calendar reminder two weeks prior to the next meeting) -Seeks and invites expert speakers who can inform NESC's work -Appoints a rotating Timekeeper at the start of each meeting. -Acknowledges and gives speaking opportunity to all Commissioners who are raising their hands to address an agenda item. -Ensures that Commissioner's comments are concise and on-point, and respectfully cuts off any Commissioners who are dominating air time. -Ensures the Commission's work moves forward according to established deadlines. Will nudge Commissioners as needed.
Timekeeper Responsibilities	-Ensures that the Commission moves on from each agenda item within its allotted time. -Ensures that agenda items are adequately progressing from deliberation to action within their allotted time period. Flag for the Commission when the pace needs to be accelerated. -Has authority to support Chair in keeping Commissioner comments concise and on point.

Commented [AM1]: Eliminate timekeeper role – that's what the chair does. But all commissioners responsible for holding themselves to this…

A MUNICIPAL THERMAL UTILITY

Contributing to a zero-carbon Northampton

Ben Weil
Northampton Energy and Sustainability Commission Member

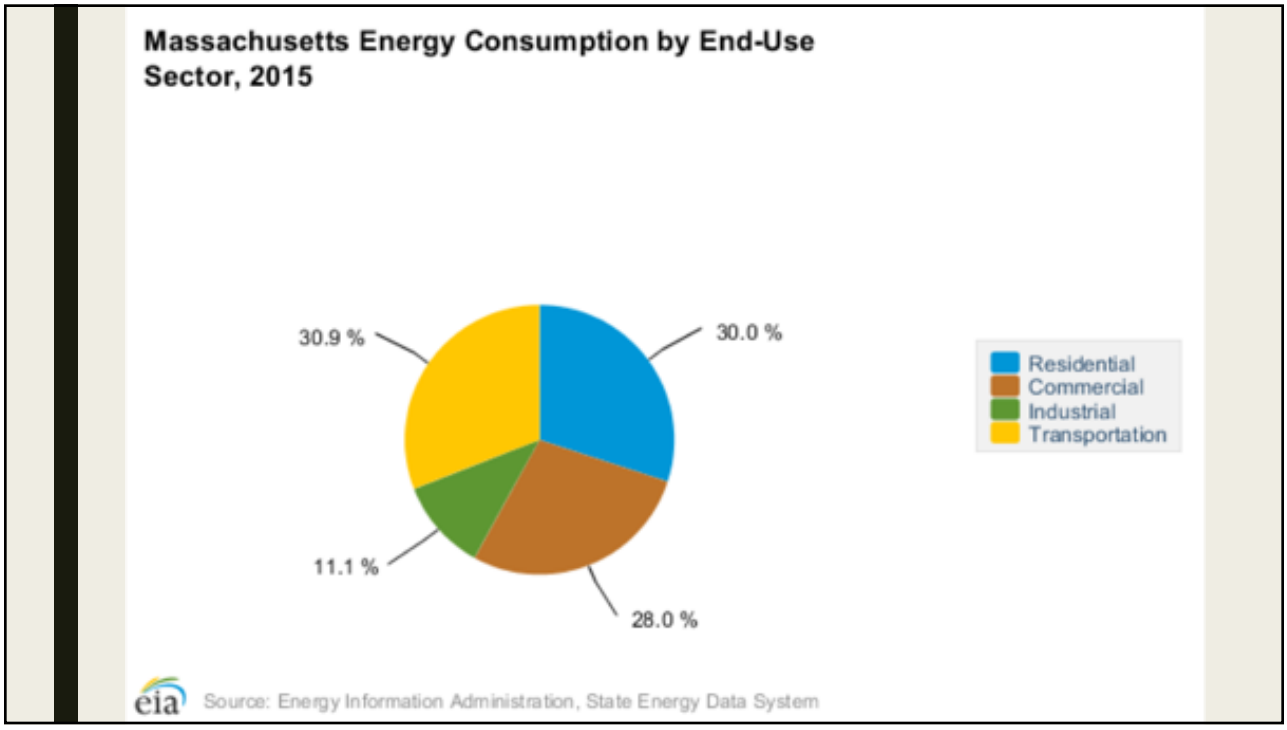
2/11/20

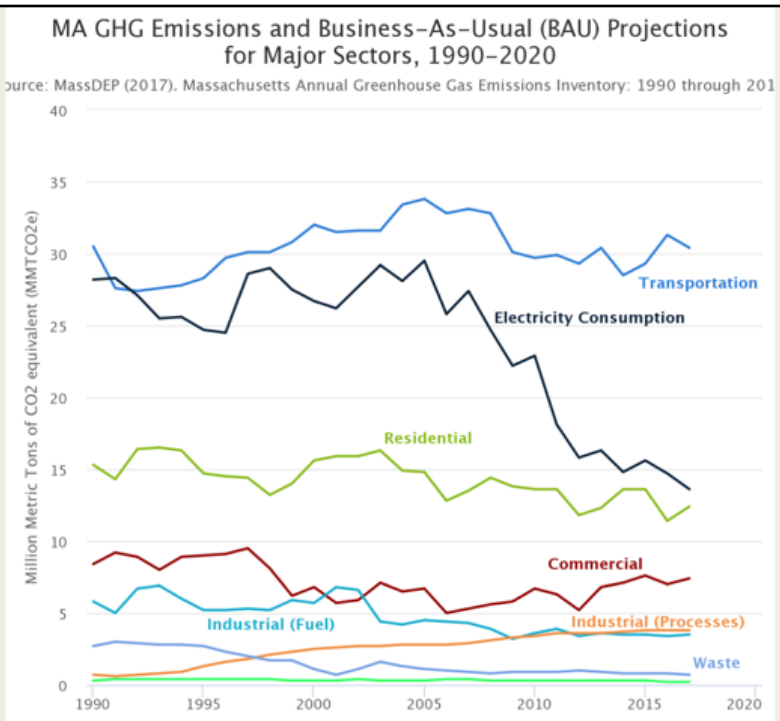
Zero carbon heating and cooling by 2030

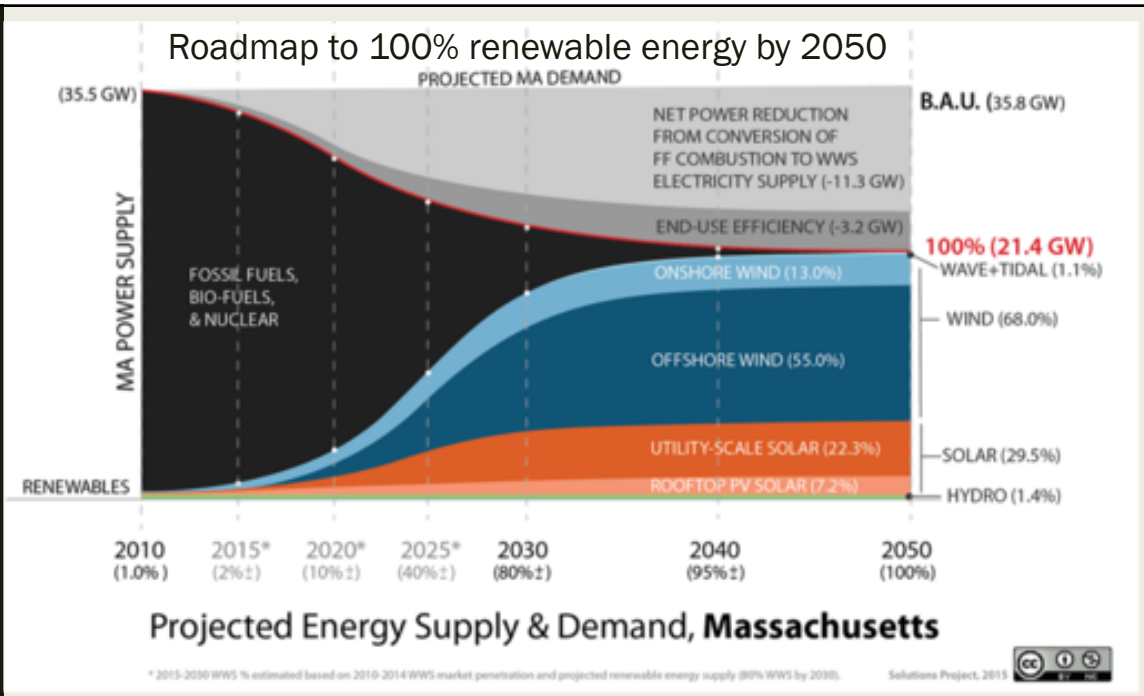
- Why focus on heating and cooling?
- Do we have the technology?
- Do we have time?
- How do we pay for it?
- How can the city drive change?

WHY HEATING AND COOLING?

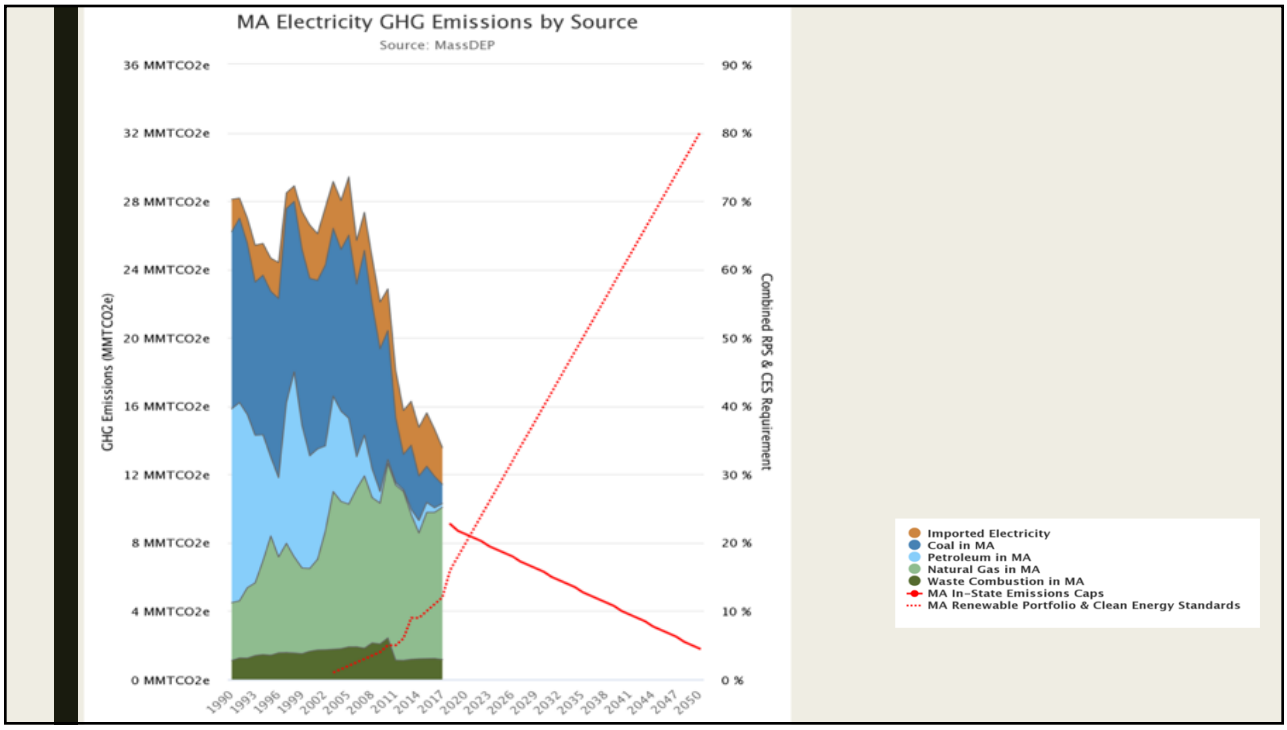
75% of building energy use and mostly uses fossil fuels

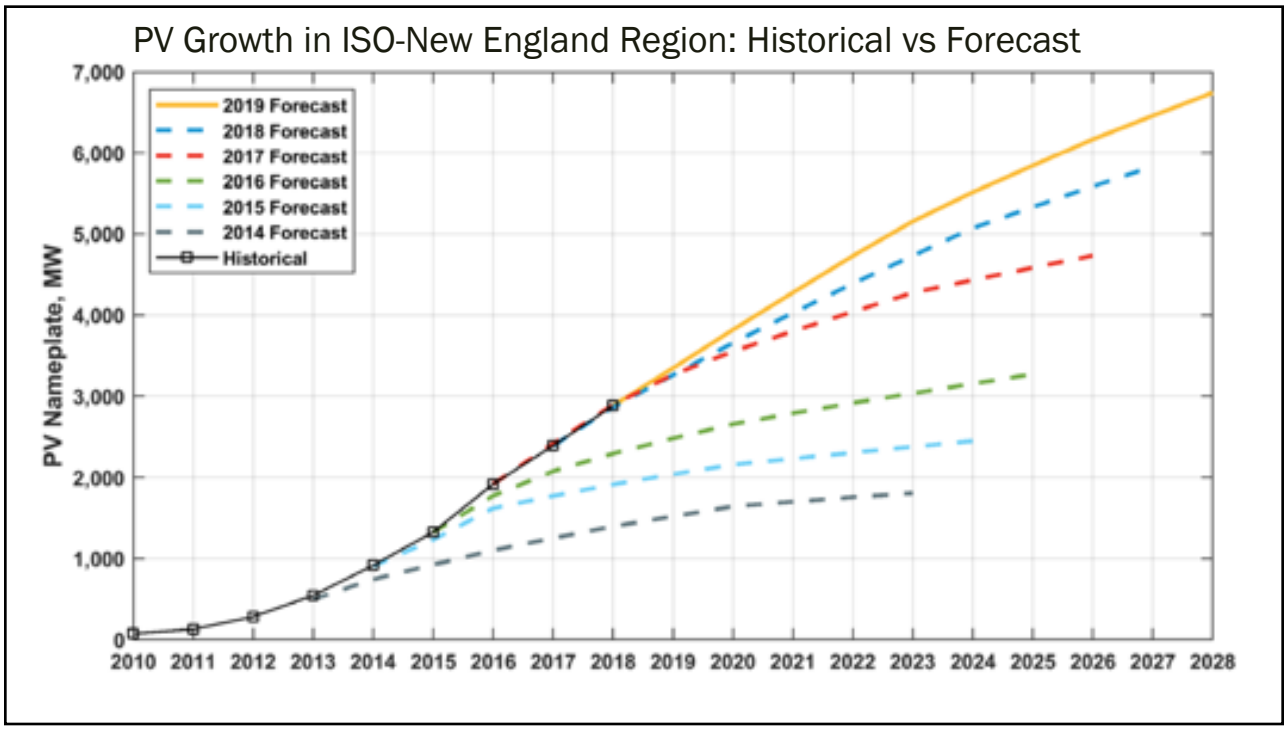




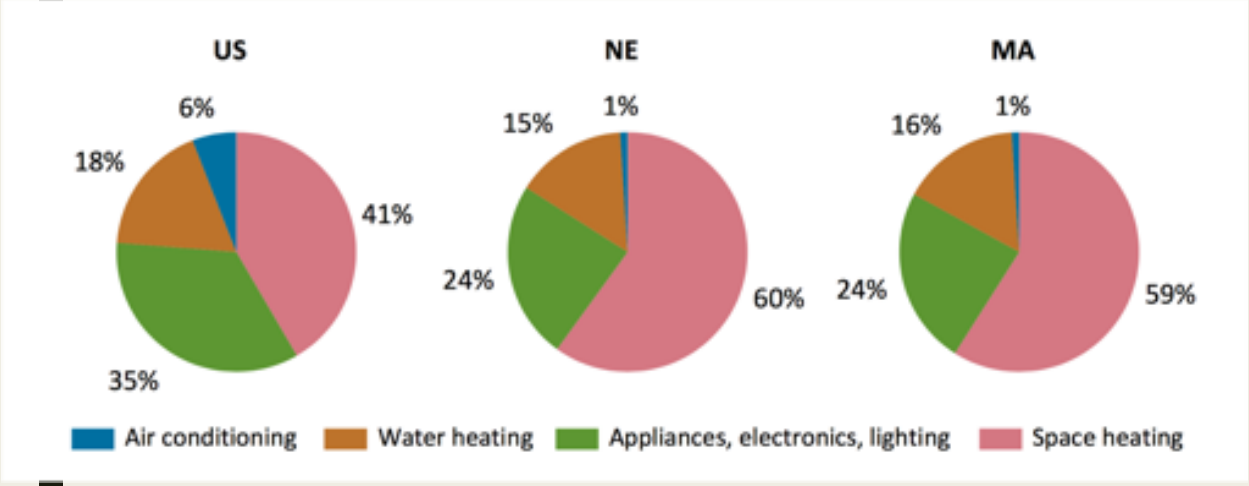


2017 The Solutions Project. Jacobsen et al. *Energy Environ. Sci.*, 2015, 8, 2093


MA Electricity GHG Emissions by Source
Source: MassDEP
GHG Emissions (MMTCO2e)
Combined RPS & CES Requirement
36 MMTCO2e
32 MMTCO2e
28 MMTCO2e
24 MMTCO2e
20 MMTCO2e
16 MMTCO2e
12 MMTCO2e
8 MMTCO2e
4 MMTCO2e
0 MMTCO2e
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
1990 1993 1996 1999 2002 2005 2008 2011 2014 2017 2020 2023 2026 2029 2032 2035 2038 2041 2044 2047 2050
Imported Electricity
Coal in MA
Petroleum in MA
Natural Gas in MA
Waste Combustion in MA
MA In-State Emissions Caps
MA Renewable Portfolio & Clean Energy Standards

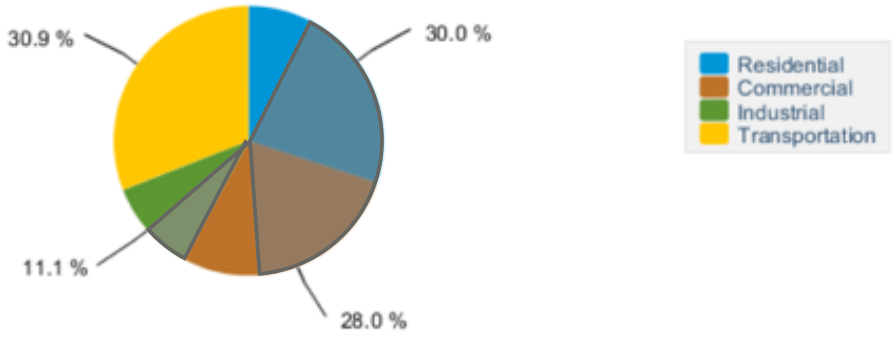

PV Growth in ISO-New England Region: Historical vs Forecast
PV Nameplate, MW
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2019 Forecast
2018 Forecast
2017 Forecast
2016 Forecast
2015 Forecast
2014 Forecast
Historical
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028

Residential Energy Use Breakdown



75% energy use is THERMAL

Massachusetts Energy Consumption by End-Use Sector, 2015

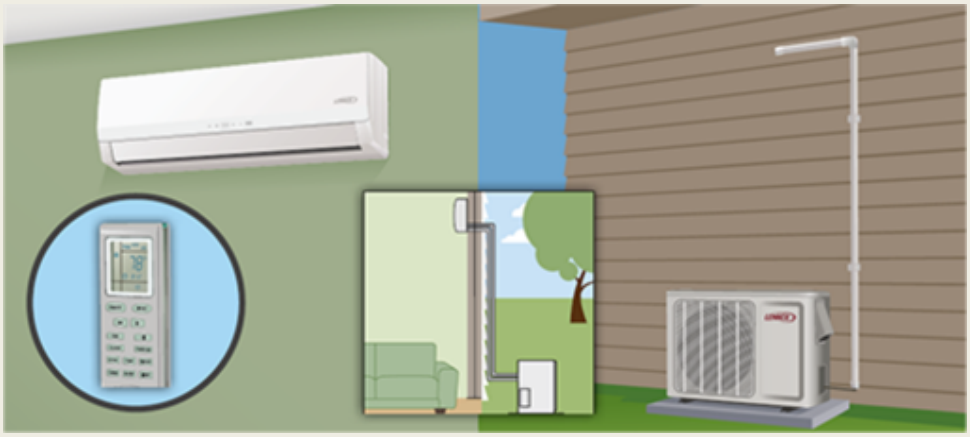


eia Source: Energy Information Administration, State Energy Data System

DO WE HAVE THE TECHNOLOGY?

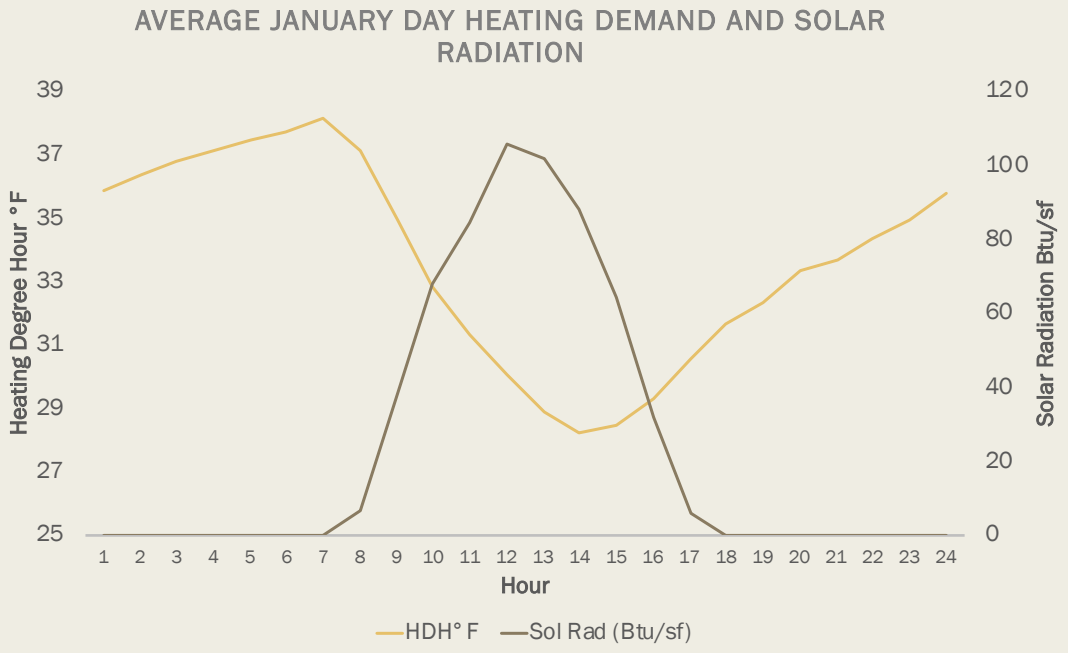
The heat pumps and shared thermal technology

Ductless Minisplit heat pump

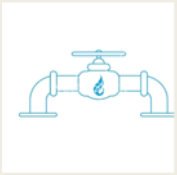


Why doesn't every building just switch to ductless air source heat pumps?

- Low SIR, IRR, or long payback period given:
  - *Energy prices: high electric cost and low gas cost*
  - *uncertain or short tenure in building*
  - *"stranded assets"*
- Diseconomy of scale
  - *modularity makes **marginal cost** of larger system larger than for other heating systems*
  - *Multi-head energy efficiency penalty*
  - *piping length energy distribution penalty*
  - *invasiveness of installation*
  - *works best with **small**, **open** plan, **good envelope** buildings.*
- System dis-benefits:
  - *lowest efficiency/highest demand during coldest weather with least renewable production.*
  - *High GPW refrigerants with leak potential proportional to number of joints and fittings.*
  - *Lost opportunity of temperature setbacks*



Efficiency of heaters depending on source



	Power Plant	Transmission	Heater	System
Gas heater		97%	96%	93%
Gas CC	45%	94%	300%	126%
Oil IC	33%	94%	300%	93%

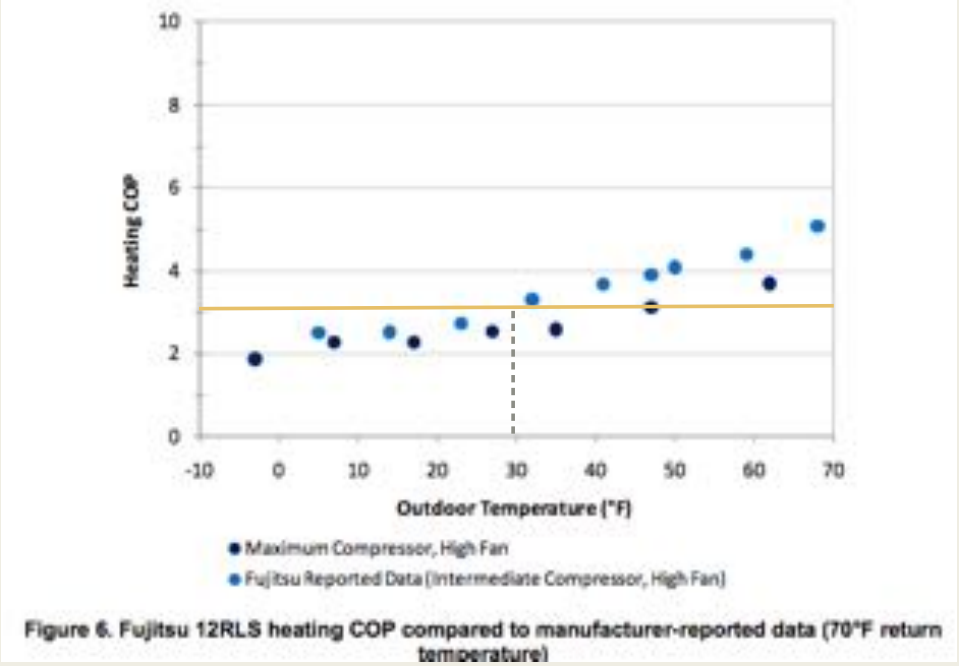
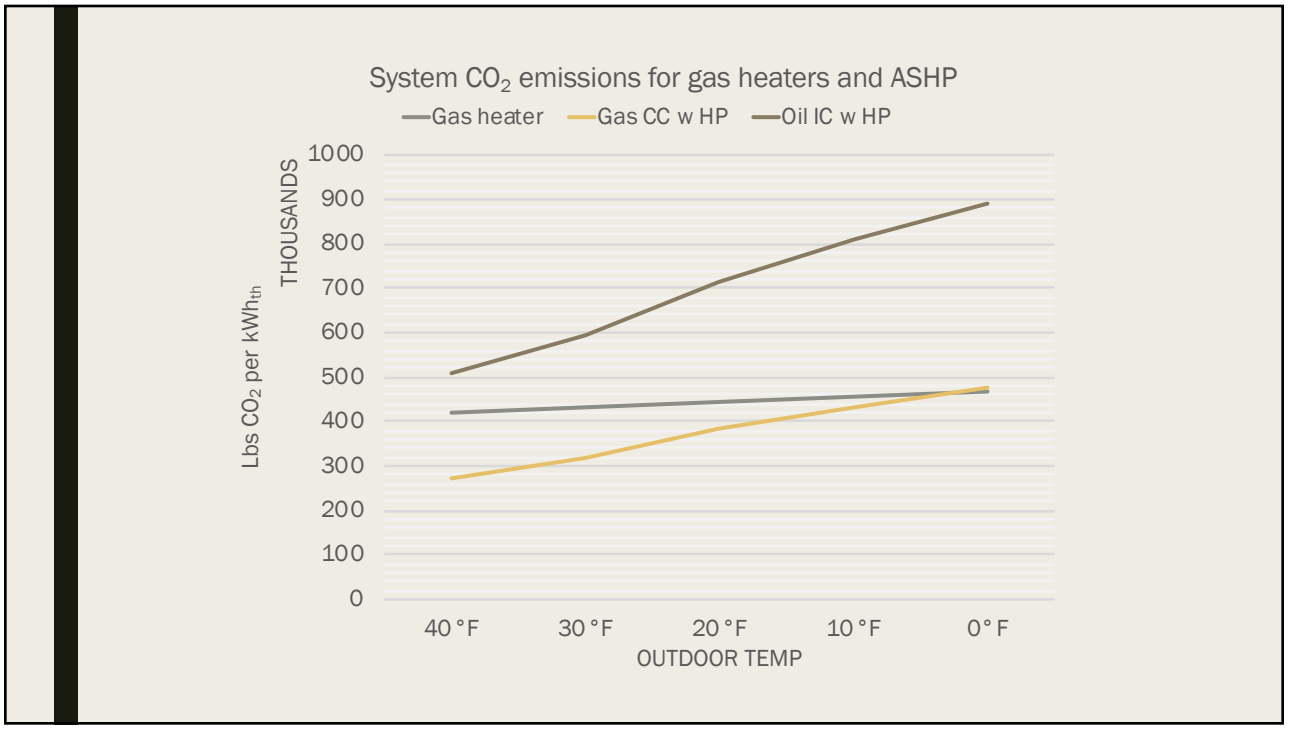
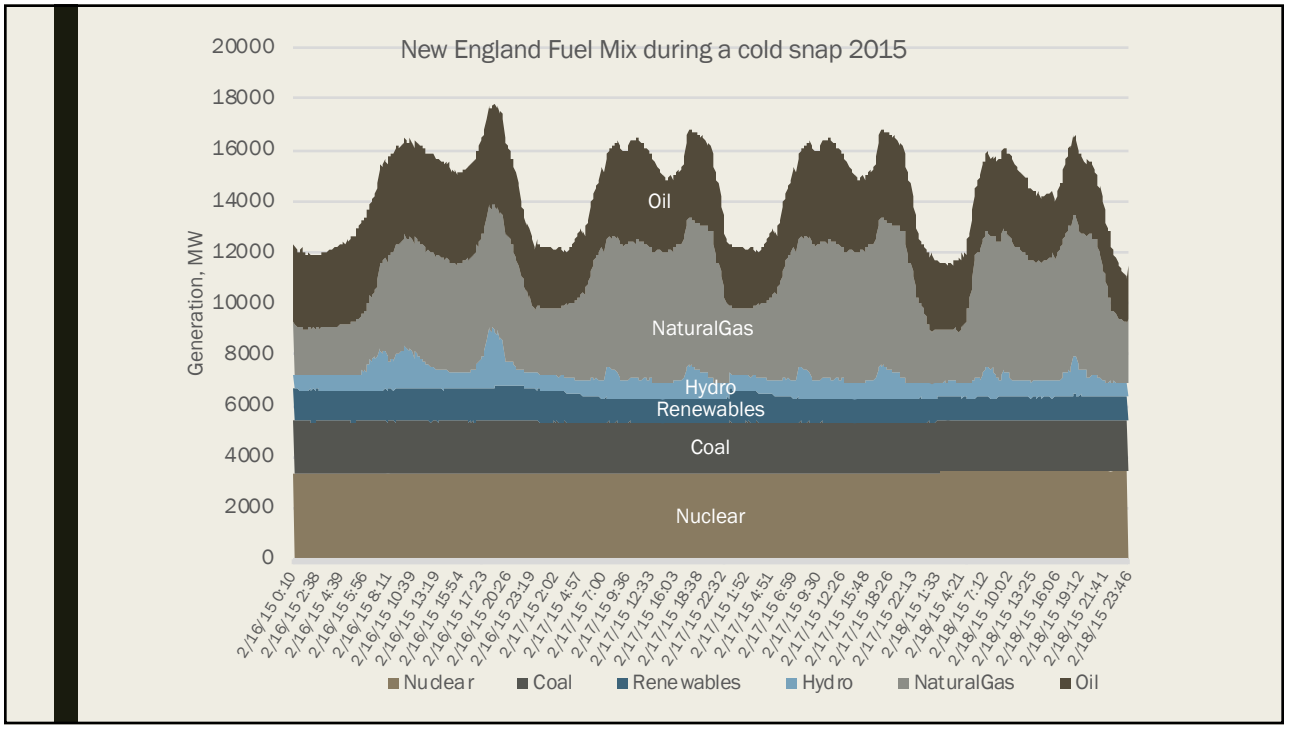


Figure 6. Fujitsu 12RLS heating COP compared to manufacturer-reported data (70°F return temperature)


System CO_2 emissions for gas heaters and ASHP
Gas heater
Gas CC w HP
Oil IC w HP
THOUSANDS
Lbs CO_2 per kWh_{th}
1000
900
800
700
600
500
400
300
200
100
0
40 °F
30 °F
20 °F
10 °F
0° F
OUTDOOR TEMP


New England Fuel Mix during a cold snap 2015
Generation, MW
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Oil
NaturalGas
Hydro
Renewables
Coal
Nuclear
Nuclear
Coal
Renewables
Hydro
NaturalGas
Oil

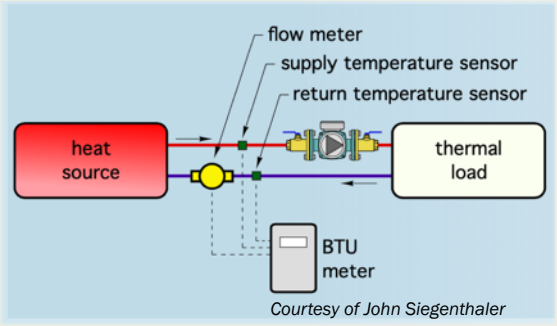
Hydronic alternatives can solve system dis-benefits

Refrigerant + air	Hydronic
• Lowest efficiency/highest demand during coldest weather with least renewable production.	• Thermal storage (PCMs, Tanks, Ground)
• High GWP refrigerants with leak potential proportional to number of joints and fittings.	• Distribution by water, refrigerant loops are short, isolated and factory constructed. • Potential use of trans-critical CO_2
• Lost opportunity of temperature setbacks	• Heat pumping to water allows for buffer tanks that allow long cycles at low power.

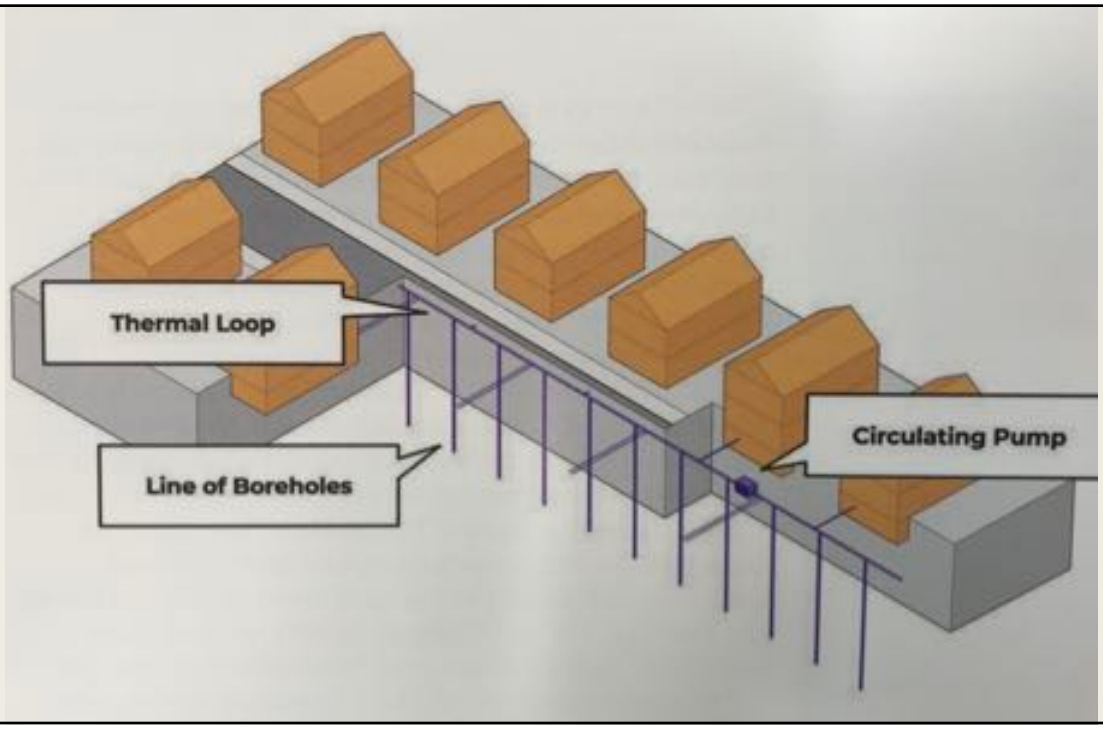
Ground source heat pump to water

Courtesy of ISTEC

Heat meter



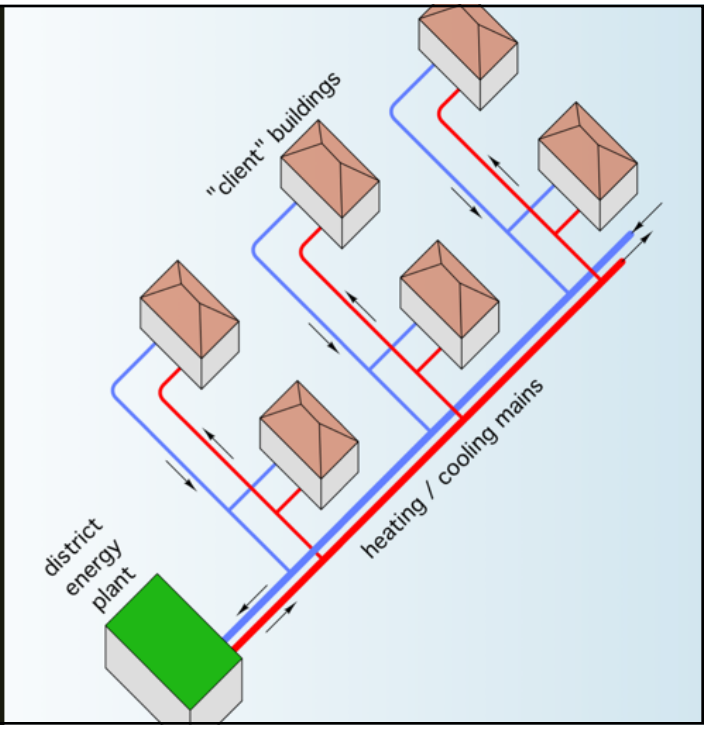
Courtesy of John Siegenthaler



District energy hydronics

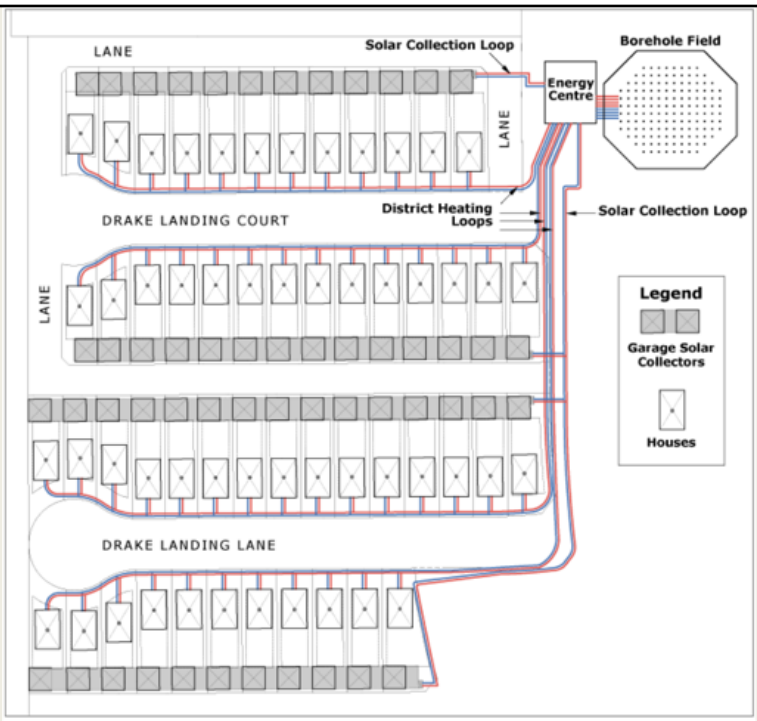
Temperatures can range:

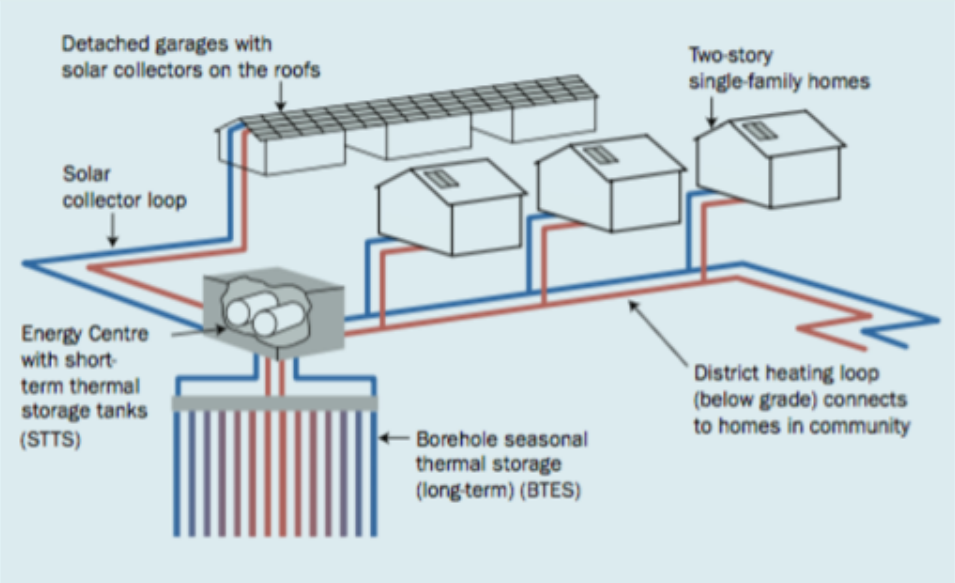
- Low (50 to 80°F) requiring heat pumps in each client
- Medium (100 to 180°F) allowing some client buildings to use a simple heat exchanger only.
- High (over 200°F)… not recommended



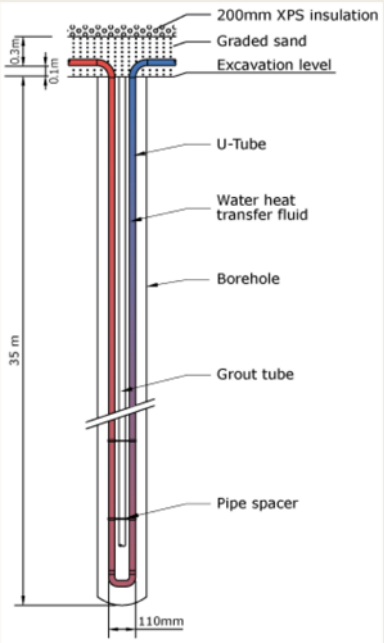
thermal storage

District Solar Heating Example: [Drake Landing, Alberta, Canada]





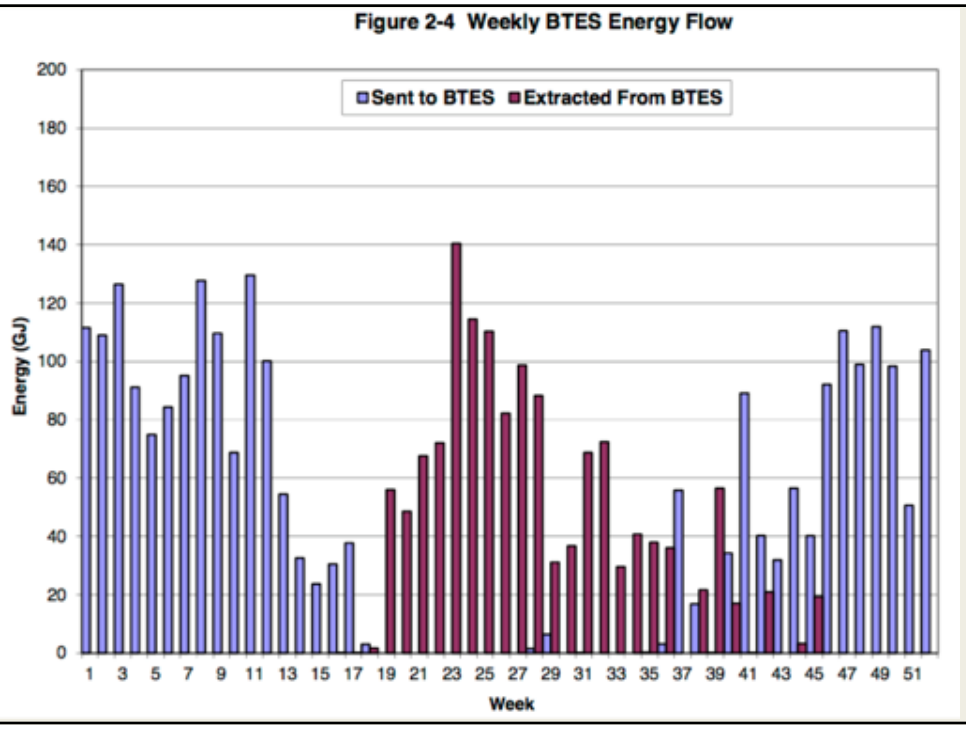
Borehole Thermal Energy Storage



Top: This image of the borehole thermal energy storage under construction shows the interconnection of the 144 equally spaced boreholes, each containing a cross-linked polyethylene (PEX) u-tube heat exchanger used to store heat in and extract heat from 44,500 yd^3 of soil.

Bottom: The borehole thermal energy storage (Top) resides under a portion of this community park. The horizontal piping in the top photo is roughly 6 ft below the finished grade shown here.

The Energy Centre houses the system's mechanical equipment, including two short-term thermal storage (STTS) tanks with a volume of 63,000 gallons, district heating and storage pumps, heat exchangers, auxiliary boilers and system controls.



Current Status

- 12th year of reliable operation with no unscheduled interruptions in heating delivery operations;
- 100% solar fraction in the 2015-2016 heating season, meaning all the heat required by the houses for space heating was supplied by solar energy;
- Consistent solar fractions above 90% over the last 5 years, with an average of 96% for the period 2012-2016;
- High solar fraction of 92% even during the very cold winter of 2013-2014;
- Coefficient of performance (COP) above 30.
- Net-zero electricity for pumping power, which includes pumping through the solar collectors, district heating loop and borehole thermal energy storage (BTES)

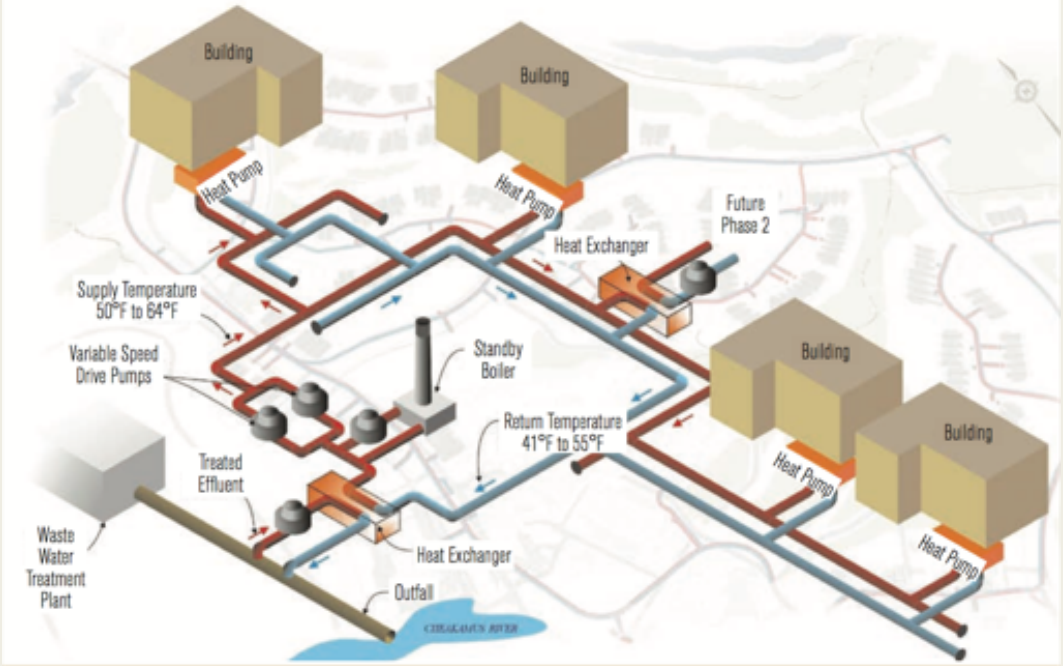


FIGURE 1 **Whistler Athletes Village district energy sharing system. Two pipe closed loop can provide both heating and cooling.**

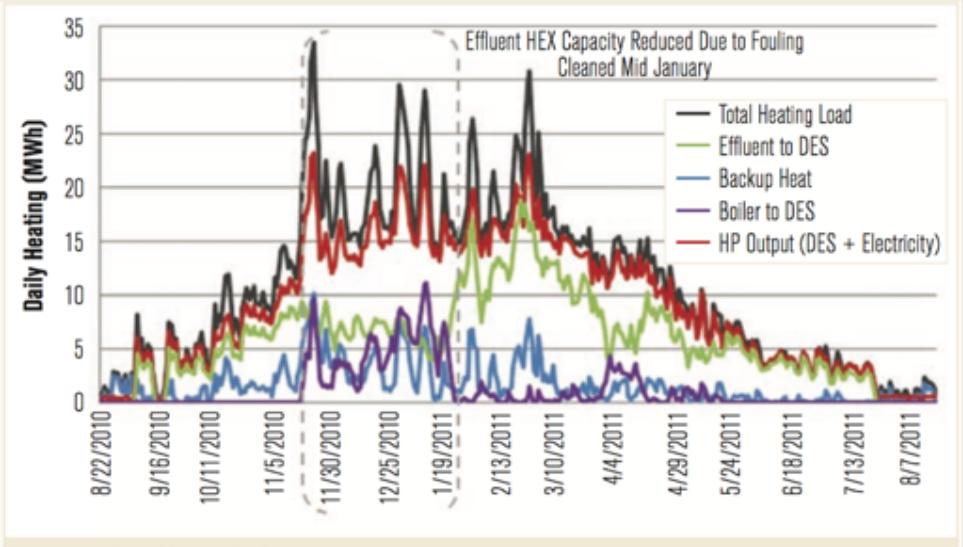


FIGURE 2 **Annual heating load.**

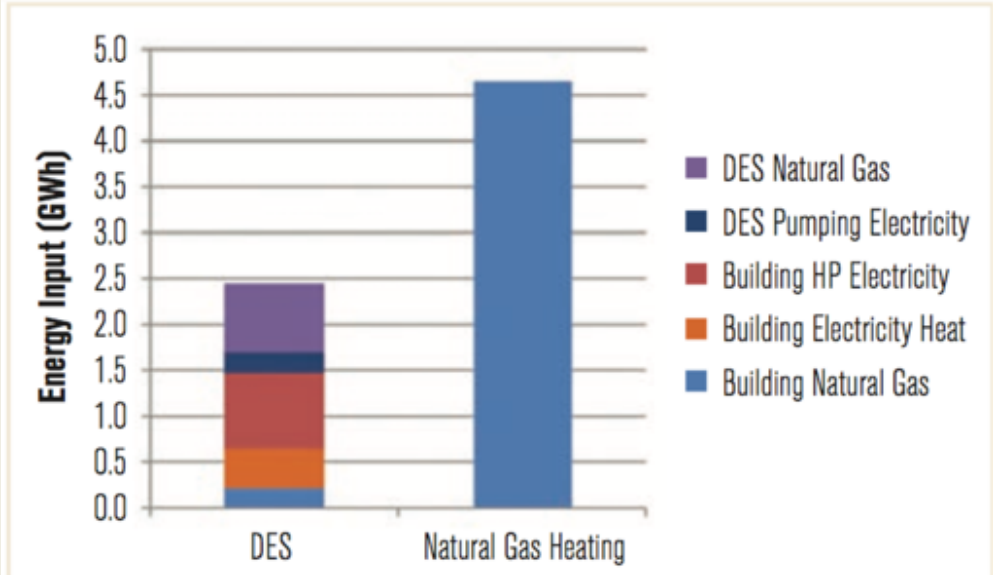
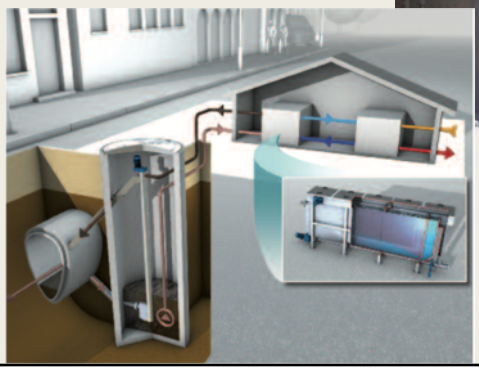


FIGURE 4 District energy vs. natural gas heating.

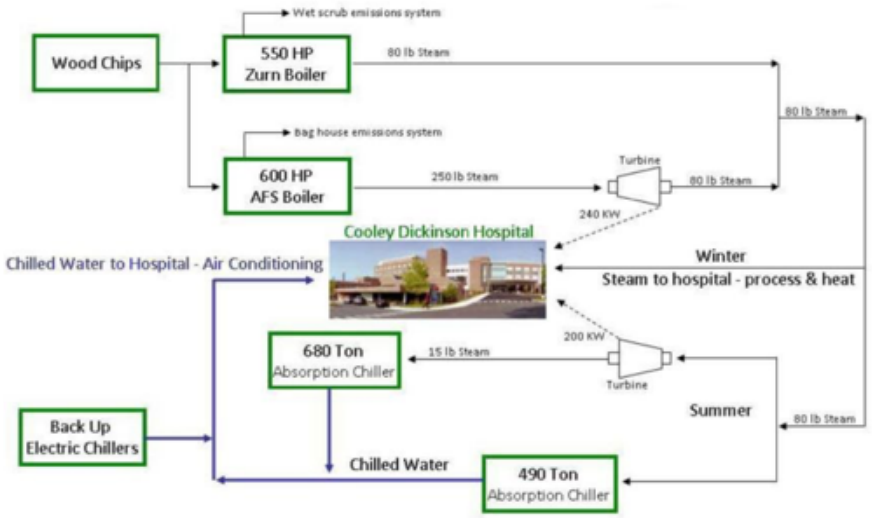
raw sewage heat recovery

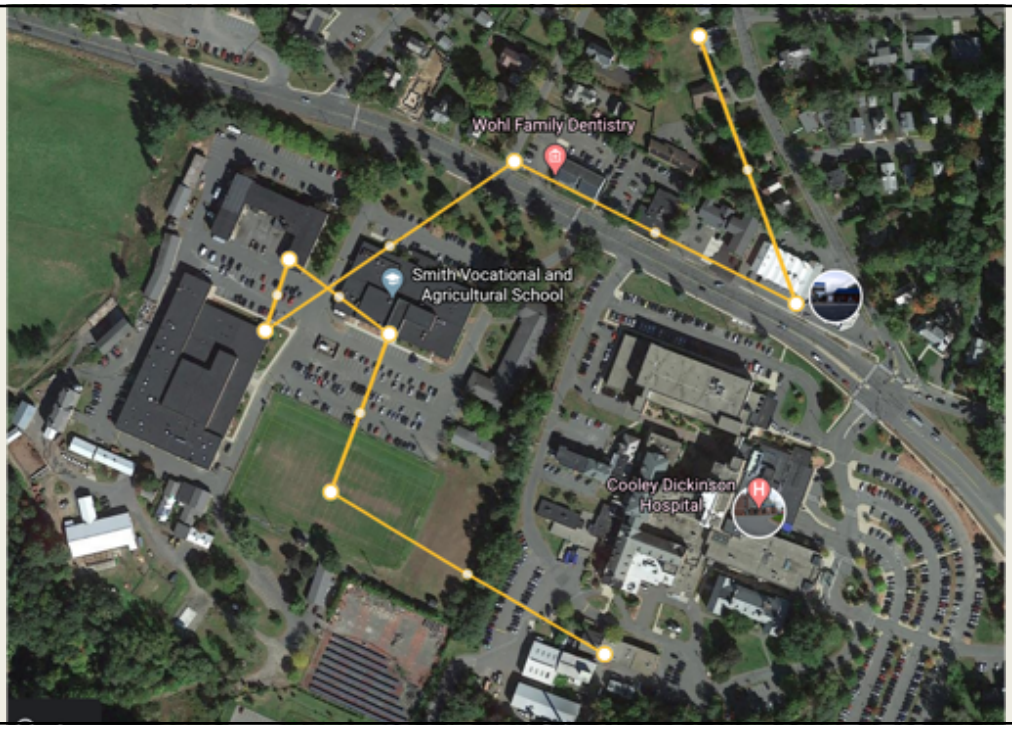
- STRAUBING, GERMANY
- Low-rise apartment complex, 11 buildings, units: 102
- In operation since 2010
- A partial flow of wastewater (20 L/s) is taken from a main sewer running outside the apartment buildings
- 2 heat exchangers extract up to 210 kW of thermal energy from the wastewater
- heat pump COP of 5.0, heat output of approx. 260 kW (887 kBtu/h)



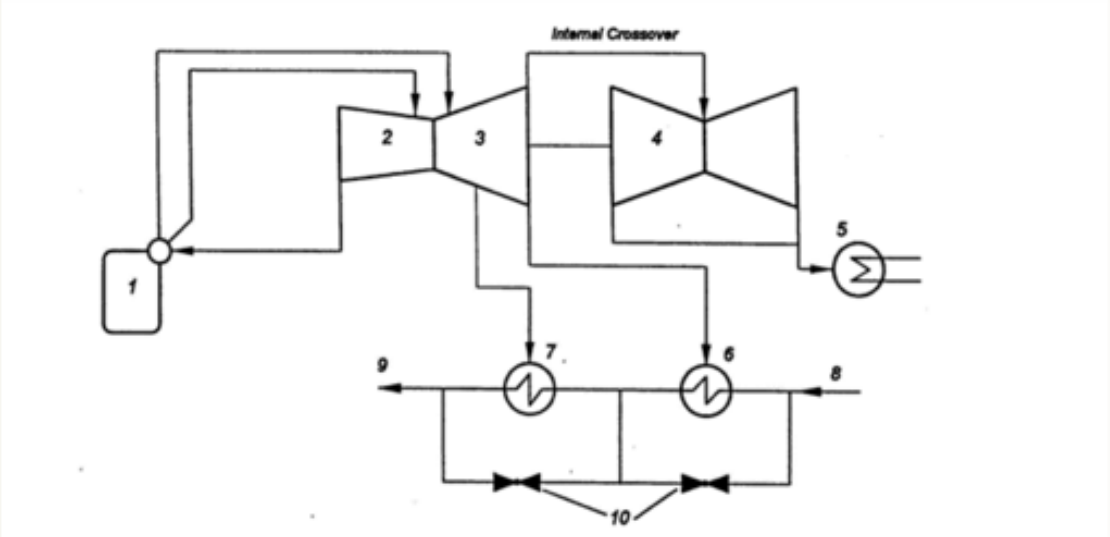
COOLEY DICKINSON HEALTH CARE

MASSACHUSETTS GENERAL HOSPITAL AFFILIATE



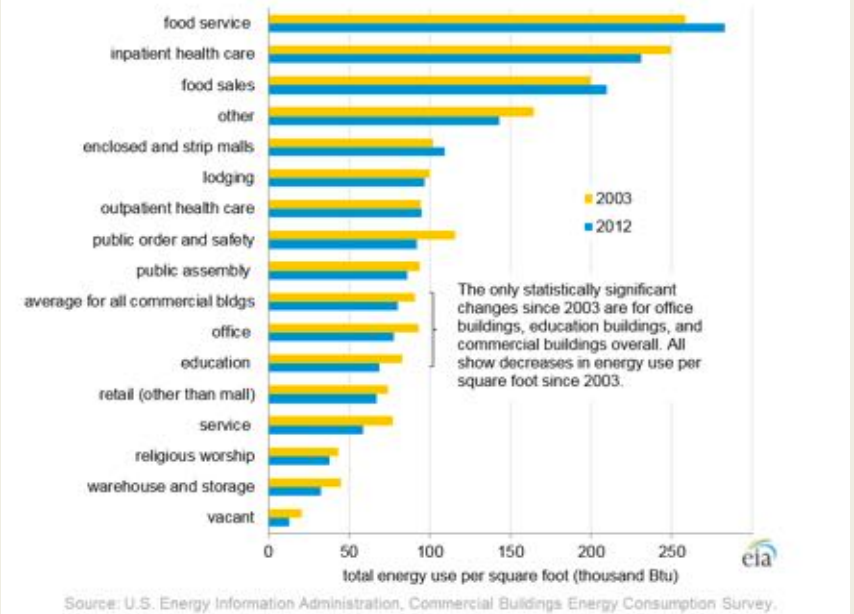


District Heating Configuration for a Turbine with Internal Crossover, Using Modified Existing Extraction Points

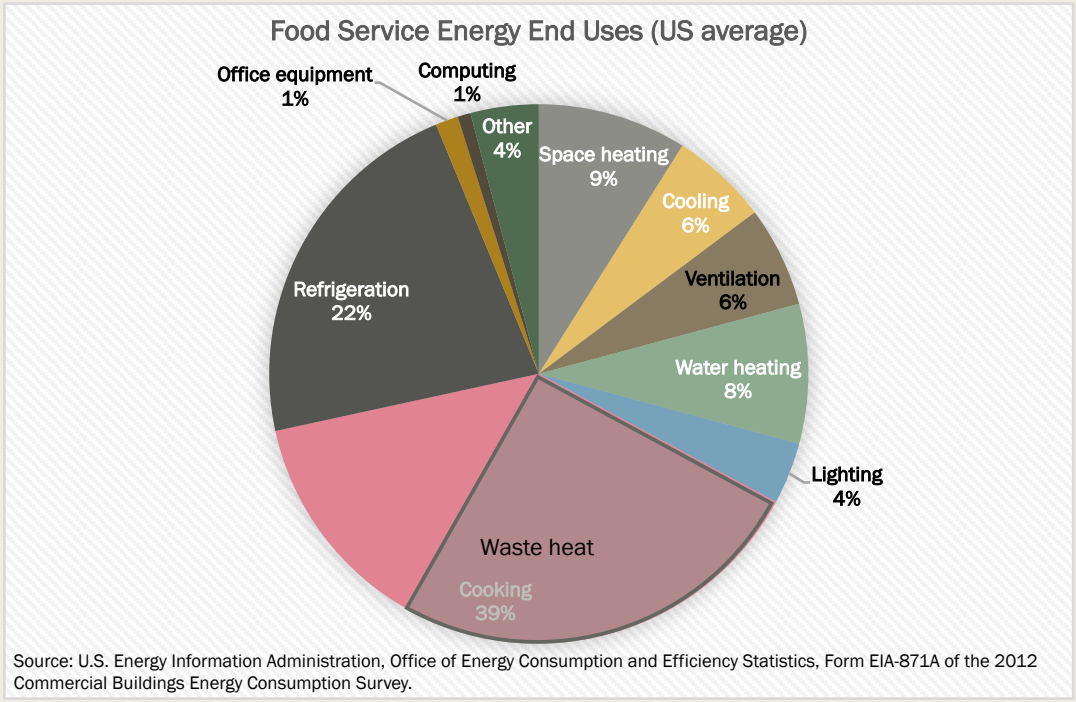


1-Boiler, 2-HP Turbine, 3- IP Turbine, 4-LP Turbine, 5-condenser, 6-DH Stage One heat Exchanger, 7-DH Stage Two Heat Exchanger, 8-Return from DH System, 9-Supply to DH System, 10-Bypass

Figure 4. Food service buildings and hospitals are the most intensive users of energy overall

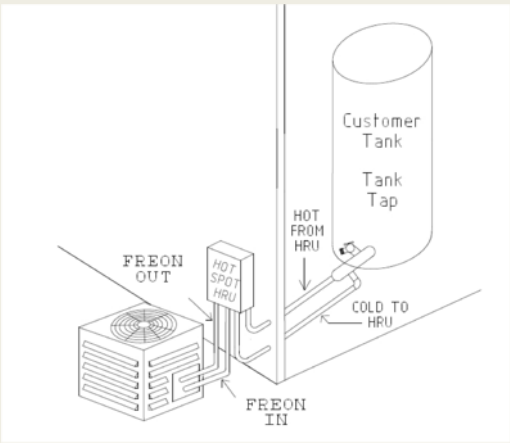


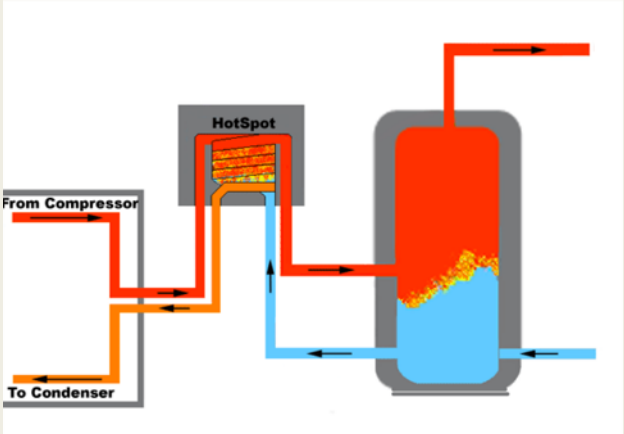
Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey.



Source: U.S. Energy Information Administration, Office of Energy Consumption and Efficiency Statistics, Form EIA-871A of the 2012 Commercial Buildings Energy Consumption Survey.

Heat recovery from refrigerator and freezer compressors

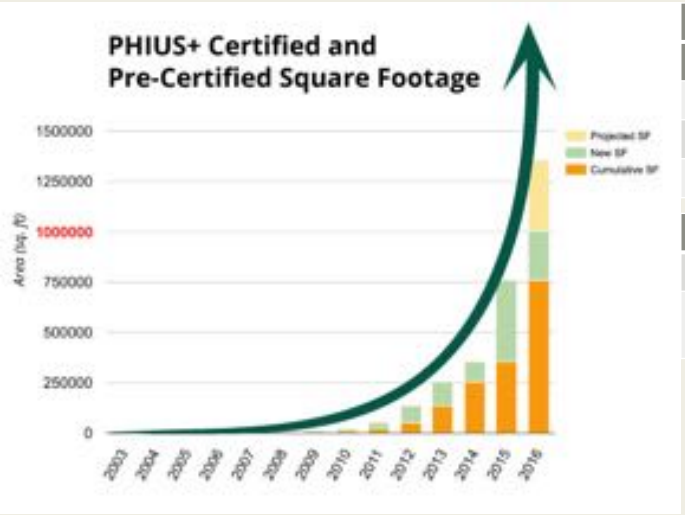




IS THERE TIME?

equipment replacement cycle to zero carbon (or really close) by 2030

10 years is a long time

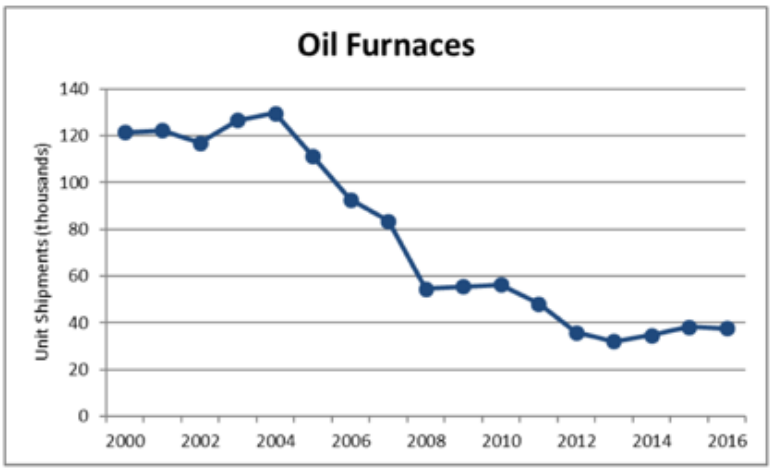


	Prescriptive R-values	
IECC year	2006	2015
windows	2.86	3.12
roof	38	49
walls	19	20

ASHP best avail	2008	2018
COP @ 17°F	2.4	3.2
% Rated Capacity at 5°F	40%	84%

Equipment replacement cycle

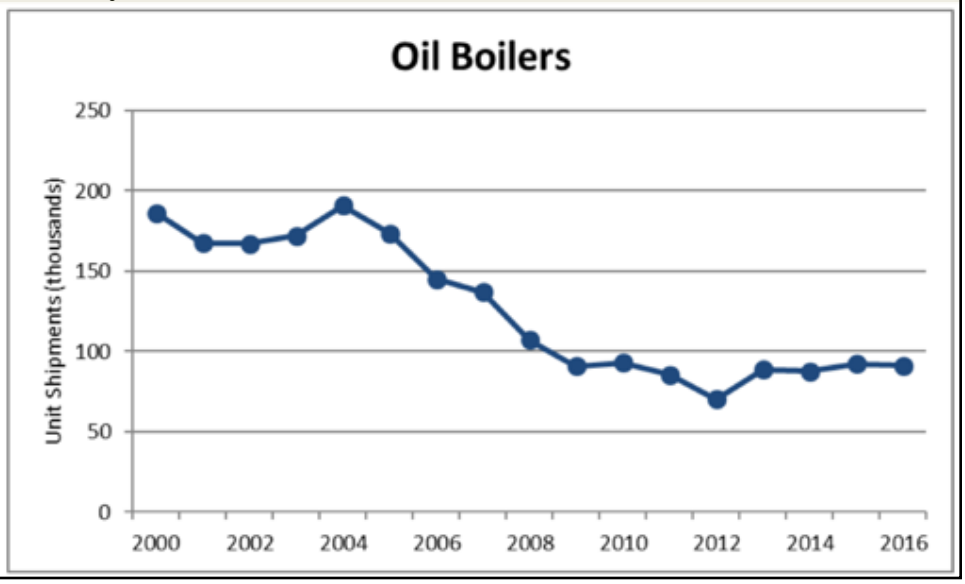
- Furnaces: 16 to 27 years



Source: *AHRI* (http://www.ahrinet.org/Resources/Statistics/Historical-Data/Furnaces-Historical-Data.aspx)

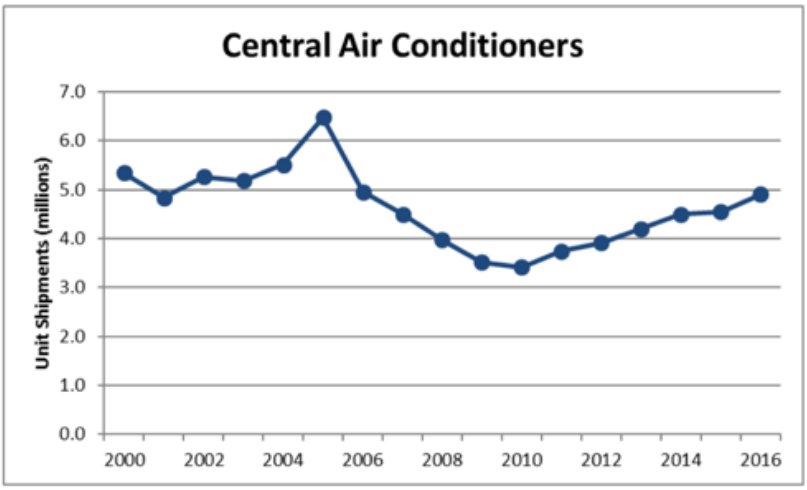
Equipment replacement cycle

- Boilers: 18 to 28 years



Equipment replacement cycle

- AC: 10 to 16 years



Source: *AHRI* (available at http://www.ahrinet.org/Resources/Statistics/Historical-Data/Central-Air-Conditioners-and-Air-Source-Heat-Pumps.aspx)

Stranded Assets and Sunk Costs

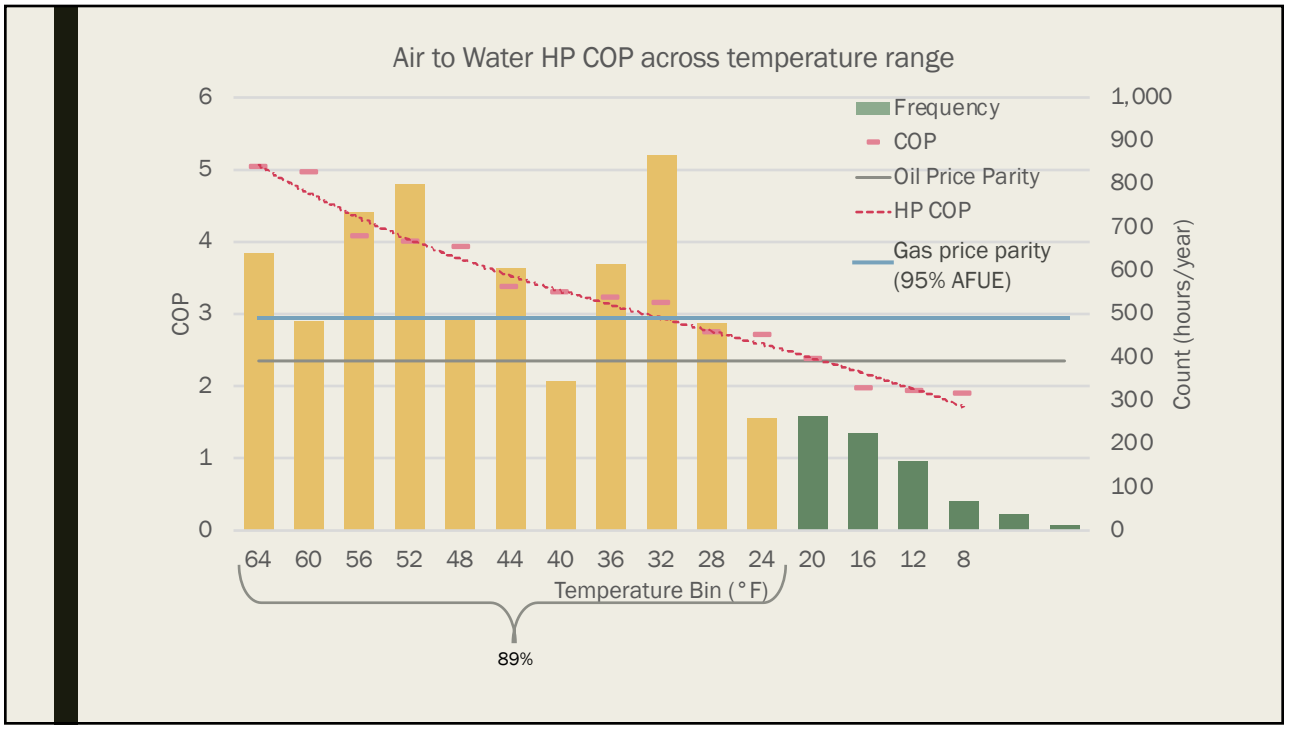
Stranded Assets

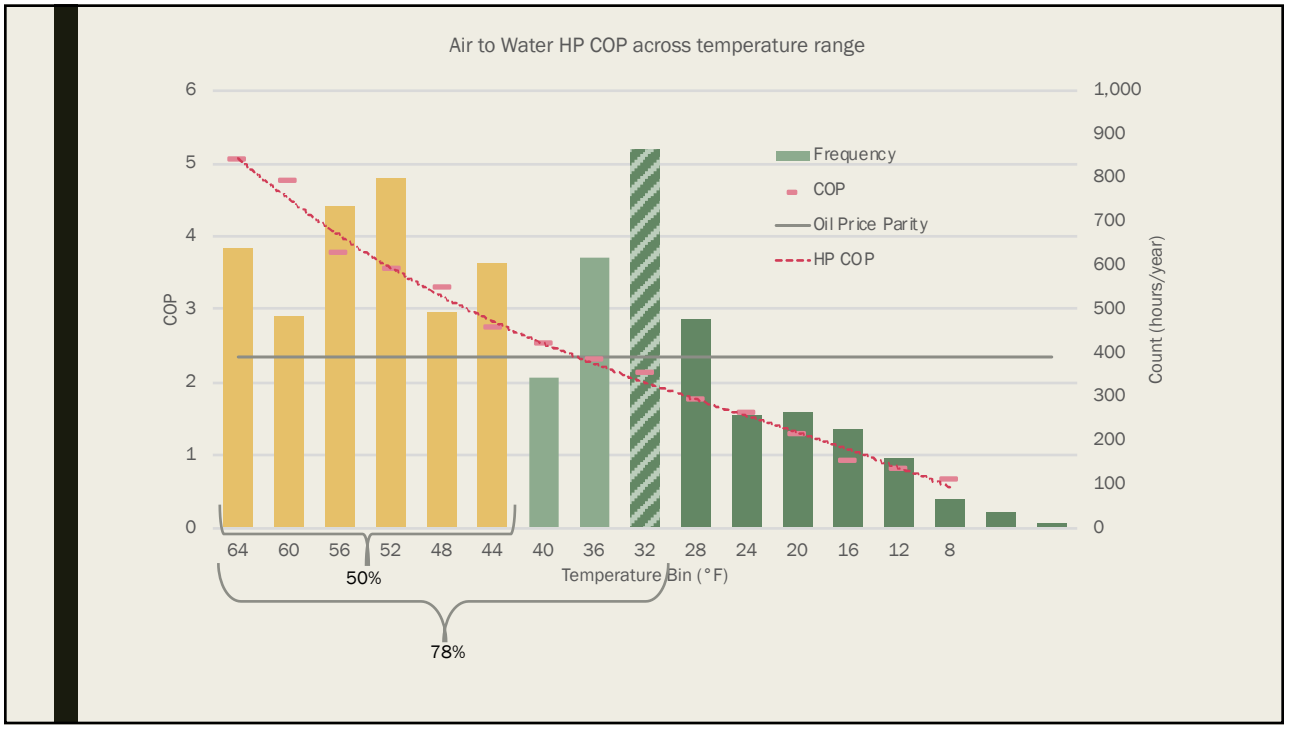
- Replacement cycle means most will be near or at end of life by 2030.
- Not Stranded!: Most HP or district solutions are complimented by legacy equipment.
- Solution: **amortize cost of upgrade over equipment lifecycle not arbitrary payback period.**

"Sunk Cost Fallacy"

- The best use for any equipment with operating costs is to not need to use it!
- As long as a HP or district system costs less to operate and pay for, then it is the better choice.
- Solution: pay for upgrade in increments such that:

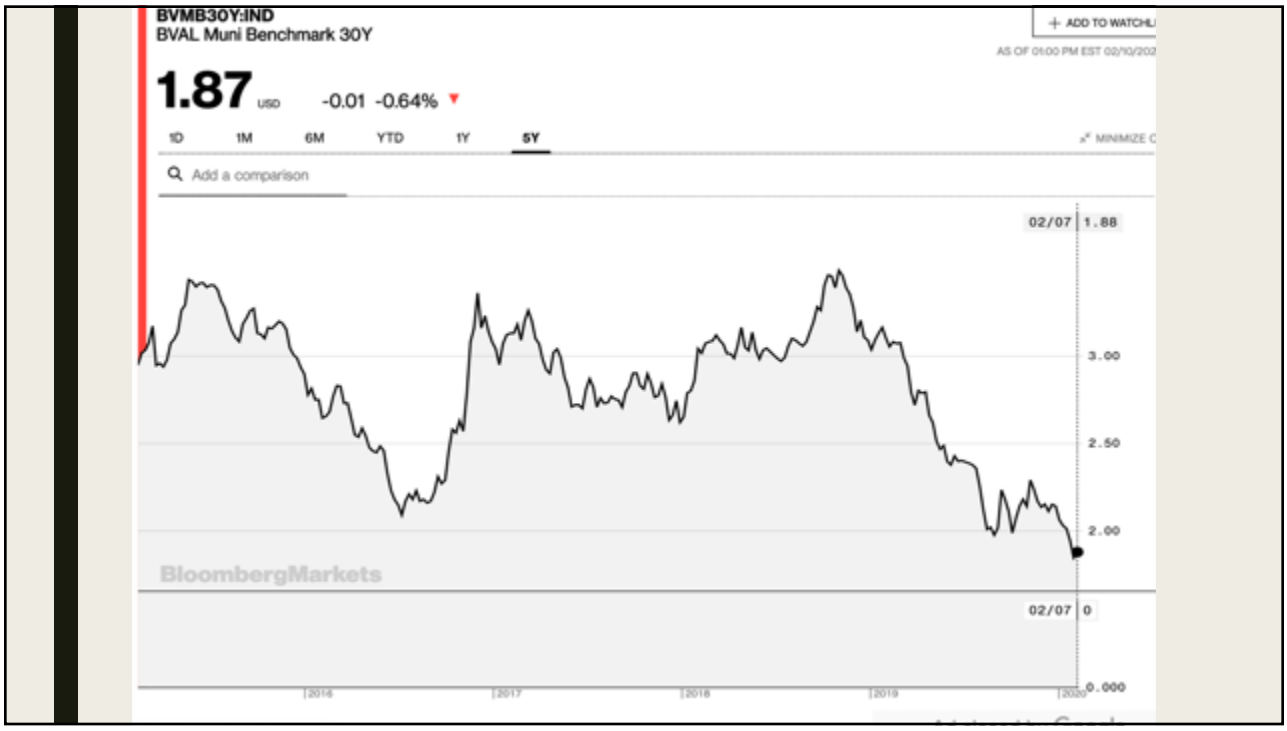
$$Payment + new\ operating\ cost < savings$$


Air to Water HP COP across temperature range
COP
Count (hours/year)
Frequency
COP
Oil Price Parity
HP COP
Gas price parity (95% AFUE)
Temperature Bin (°F)
89%


Air to Water HP COP across temperature range
COP
Count (hours/year)
Frequency
COP
Oil Price Parity
HP COP
Temperature Bin (°F)
50%
78%

HOW DO WE PAY FOR IT?

30-year bond and a rental model



ASHP rental example

	$2.50/gal	$0.18/kWh	
	Gal oil	kWh	Cost
Current	900	0	$ 2,250
with ASHP	137	7832	$ 1,753
Savings			$ 497
ASHP cost to muni			$ 6,000
30-year amortized @ 2% interest			$ 204
Muni overhead 20%			$ 41
Net annual savings			$ 252
Monthly rent			$ 20

District low temp GHX loop with rented heat pump example

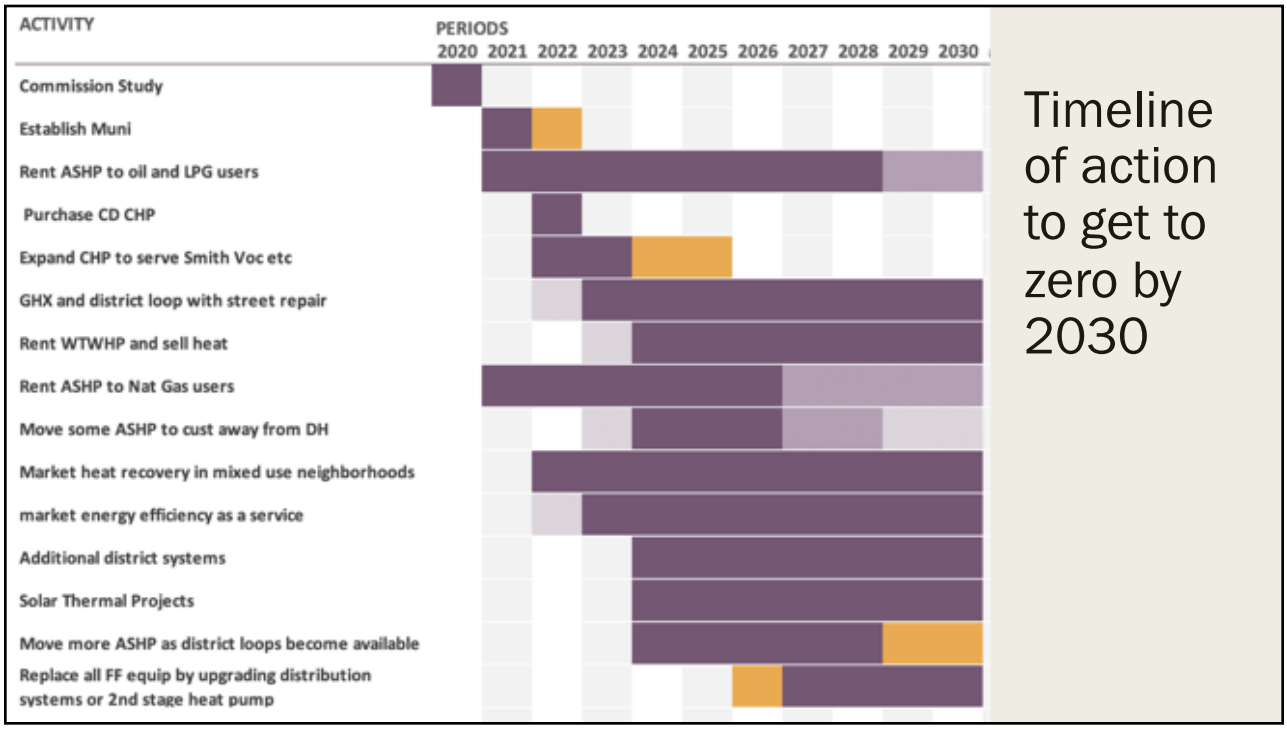
	Gas	DH HP	
	95%AFUE	avg COP 4.4	
	$1.70/therm	$0.18/kWh	
	therms	kWh	Cost
Current	951	0	$ 1,616
with DH HP	0	5559	$ 1,275
Savings			$ 341
DH HP			$ 4,000
30-year amortized @ 2% interest			$ 136
Muni overhead 20%			$ 27
Net annual savings			$ 178
Monthly rent			$ 14
Max heat rate ($/Therm)			$ 0.19

HOW CAN THE CITY DRIVE CHANGE?

a municipal thermal utility

Capabilities and Characteristics of Municipal Utility

- No profit motive. Shareholders = ratepayer = voters
- Financing on a time-scale that matches investment lifetime with low interest rate: Long-term bonds
- Strong negotiating position and bulk purchasing
- Access to connective services of the city (water, sewer, DPW, streets)
- A municipal utility can implement Energy Efficiency as a Service payments (e.g., Seattle)
- Complementary to municipal aggregation on electricity
- Meter data enables targeted EEMs and fault detection



Timeline of action to get to zero by 2030

ACTION ITEMS

NESC recommendations to City Council and Mayor

Recommend:

- study Thermal Municipal Utility and set deadline to begin setting it up.
- city map heat sources and sinks
- invest in municipal properties to use low-temp hot water, and to provide thermal storage
- reach out to community to understand priorities for governance, etc. of thermal muni
- outreach to companies that are willing to finance and manage projects