2022 Trade Ally Kickoff

February 2022

CenterPoint Energy

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Meet Your CenterPoint Energy Go To Contacts

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Energy Efficiency Engineers

Kickoff Agenda

- 2022 customer rebates and programs, Trade Ally incentive program details, and submitting rebates
- Natural gas price update
- Factors to consider when your customer wants to decarbonize
- Racked tankless water heaters: Are the savings and efficiencies there?

2022 Commercial & Industrial Rebate Programs & Services

Jake Schwietering
Trade Ally Representative, CenterPoint Energy

Conservation Improvement Program Overview

- Energy utilities in MN are required to promote and deliver energy efficiency programs for their customers (State legislation)

- Regulated by the MN Department of Commerce (DOC), Division of Energy Resources (DER), and the MN Public Utilities Commission (PUC) to ensure:
  - Ratepayer dollars are used effectively
  - Annual energy savings and spending are reported accurately

- MN is a national leader regarding energy efficiency and has been recognized by the American Council for an Energy-Efficient Economy (ACEEE)

2022 C & I Rebate Programs & Services

- Heating system rebates
- Smart thermostats
- Water heating rebates
- Process equipment rebates
- Commercial laundry
- Commercial fireplace
- Garage door hinge
- Garage air curtains
- Foodservice equipment rebates

Prescriptive rebates

- Custom rebates

Custom rebates

- Natural Gas Energy Analysis
- Steam Trap Audit program
- Multi-Family Building Efficiency program
- Design / Engineering programs

Programs & Services

What's A Prescriptive Rebate?

What is a prescriptive rebate?

- A standardized, predetermined list of equipment and rebates for CenterPoint Energy customers who add, replace, or retrofit natural gas equipment with high-efficiency equipment.
- These rebates are set dollar amounts or rates.

Prescriptive rebate offerings:

- Boilers and boiler system components
- Space heating system
- Water heaters
- Commercial laundry
- Garage door hinges and air curtains
- Commercial fireplace
- Process equipment
- Foodservice equipment

CenterPointEnergy.com/BusinessRebates

Boiler System Rebates

Equipment	Customer rebate	Efficiency rating	Trade ally incentive
High-efficiency hot water boilers	**$1,800**/MMBtuh input	85 - 87.9%	**$150**/boiler
Condensing efficiency hot water boilers	**$3,500**/MMBtuh input	≥ 88%	**$300**/boiler
Steam boilers (high- and low-pressure)	**$500**/MMBtuh input	≥ 83% thermal efficiency	**$300**/boiler

Replacing a dual fuel boiler with a single fuel?
REMEMBER: Back-up system removal is not an option if the customer is firm classification. Dual-fuel customers need to check with CenterPoint Energy before switching to a single fuel boiler because firm capacity may not be available in their area.

MN Department of Labor and Industry registered boiler list:
http://workplace.doli.state.mn.us/codesearch/legacy.aspx

Boiler System Component Rebates

CenterPoint Energy

Equipment	Customer rebate	Unit requirements	Trade ally incentive
Boiler tune-ups	**25%**	Of tune-up cost; up to $300/boiler; eligible every other year	**$10**/tune-up
Steam trap repair/replacements*	**35%**	Of repaired/replaced equipment cost	**$5**/trap
Boiler turbulators	**35%**	Of equipment and installation costs, up to $750/boiler	**$75**/boiler
Modulating burner replacements	**$450**	Per MMBtu input; up to 25% of equipment cost	**$100**/burner
Stack dampers	**$250**	Per MMBtu boiler input; not to exceed 35% of equipment and installation costs	**$25**/damper
Boiler reset controls	**$150**	Per control system; not to exceed equipment cost	**$10**/control
Boiler cut-out controls	**$150**	Per control system; not to exceed equipment cost	**$10**/control
Linkageless controls	**$300**	Per MMBtu boiler input	**$50**/control
Pipe insulation (hydronic heat, low- and high-pressure steam heat)	**$2.50**	Per lineal foot (LF), retrofit only	**$.20**/LF (Min. $20, max. $200/site)

**Trap type includes float and thermostatic (F&T), bucket and thermostatic. Orifice traps do not qualify.*

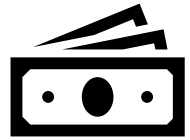
Commercial Heating Boiler Tune-ups

- Boiler tune-ups are eligible for a rebate every other year
- Don’t wait! Be sure to complete and submit your customers rebate applications as soon as the tune-up is complete
- Boiler tune-up rebate is 25% of the tune-up cost, up to $300/boiler, eligible every other year
- Trade Ally incentive is $10/tune-up. That adds up quickly!

Other Heating System Related Rebates

CenterPoint Energy

Equipment	Customer rebate	Efficiency rating	Trade ally incentive
Forced-air furnaces	$150/furnace	92% - 93.9% AFUE	$40/unit online form submission $20/unit paper form submission
Forced-air furnaces	$300/furnace	94% - 95.9% AFUE	
Forced-air furnaces	$400/furnace	≥96% AFUE	
Smart thermostats	$50/thermostat		$7.50/unit online form submission $3.75/unit paper form submission
Condensing unit heaters	$300/heater (not to exceed 25% of equipment cost)	≥88% thermal efficiency	$25/heater
Single package vertical unit	$150/unit	≥90% efficiency	$40/unit online form submission $20/unit paper form submission
Infrared heaters	$250/heater	Low-intensity tube-type	$25/heater
CO garage sensors	$100/sensor	Retrofit only	$10/sensor
Garage door hinge (spring-loaded)	$15/hinge		$25/door
Garage air curtains	$20/sq ft garage door area		$100/curtain
Demand control ventilation	$100/sensor	Retrofit only	$10/sensor
Electronic ignition hearth	$75/hearth		$20/unit online form submission $10/unit paper form submission



Bonus trade ally incentive amount for online rebate application submission

Commercial Laundry Rebates

Equipment	Customer rebate	Trade ally incentive
Ozone laundry (retrofit only)	**$35**/lb washer capacity	**$100**/kit
Modulating clothes dryer (retrofit only)*	**$250**/kit	**$50**/dryer

**Retrofit valve. Moisture sensors do not qualify.*

Water Heating Rebates

Equipment	Customer rebate	Efficiency rating/UEF	Trade ally incentive
Water heaters (condensing)	**$200**/100,000 Btuh input	≥88% efficiency	**$25**/unit
Tank water heaters (≤75,000 Btuh, atmospheric)	**$75**/unit	≥.64 UEF (medium usage bin ≤55 gal) ≥.68 UEF (high usage bin ≤55 gal) ≥.80 UEF (high usage bin >55 gal)	**$15**/unit
Tank water heaters (≤75,000 Btuh, power vent)	**$250**/unit		**$15**/unit
Pipe insulation (domestic hot water)	**$2.50**/ lineal foot (LF)	Retrofit only	**$.20**/LF (Min. $20, max. $200/site)

Note: For tank water heaters ≤75,000 Btuh rebate to apply, the new equipment must be listed and Uniform Energy Factor (UEF) or thermal efficiency verified on the current Air-Conditioning, Heating, and Refrigeration Institute (AHRI) or ENERGY STAR® websites.

Industrial Process Equipment

Equipment	Customer rebate	Efficiency requirement	Trade ally incentive
Process boiler (steam)	**$500**/MMBtuh input	≥ 83%	**$100**/boiler
Process boiler (hot water)	**$500**/MMBtuh input	≥ 85%	**$100**/boiler
Industrial equipment tune-up	**25%** of tune-up cost		**$100**/tune-up
Stack economizers (non-condensing)	**$500**/MMBtuh input		**$100**/unit
Stack economizers (condensing)	**$1,000**/MMBtuh input		**$100**/unit

CenterPointEnergy.com/ProcessRebates

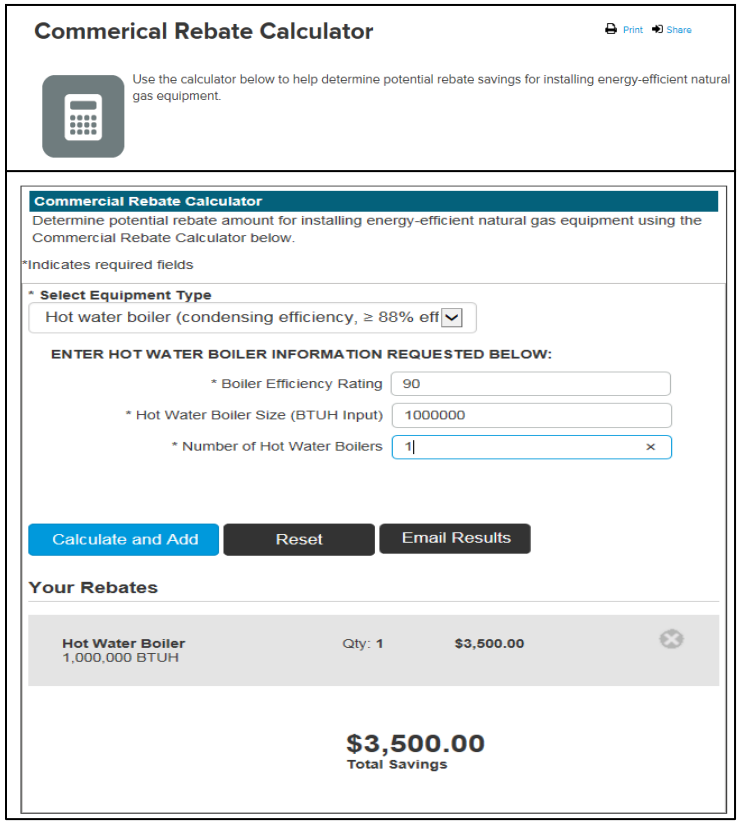
So, What Will The Prescriptive Rebate Amount Be?

Estimate your customers rebate amount when you're installing new or replacing old equipment using our Commercial Rebate Calculator

2 Easy Steps:

1. Select the equipment piece
2. Enter in required info

CenterPointEnergy.com/RebateCalculator



Custom Rebates

What's A Custom Rebate?

What is the custom rebate program?
The custom rebate program is designed to provide rebate opportunities for natural gas-saving technologies not covered in our Prescriptive rebate offerings for natural gas consumption in a manufacturing process, or for heating or water heating.

Criteria to determine rebate level
- A buy-down to as low as a one-year payback
- Up to 50% incremental equipment cost
- Up to 25% of equipment cost

For a project to be approved for a custom rebate:
- Contact CenterPoint Energy early in the idea or proposal stage to review the project.
- Provide project scope, energy savings calculations and project costs.

Custom rebates also qualify for a trade ally incentive!

CenterPointEnergy.com/MNCustom

Engineering Assistance Program

Engineering Assistance program:
If further engineering assistance is needed identifying energy efficiency projects, this program provides funding for a portion of the engineering fees.

- Customers can receive up to $5,000 for a portion of the engineering fees for study, design, and installation of qualifying EE projects

- Customer may be eligible for an additional $5,000 if qualifying natural gas technologies are installed.

Preapproval is required:
Contact CenterPoint Energy early in the idea or proposal stage to review the project.

CenterPointEnergy.com/MNCustom

Commercial & Industrial Audit Services

Scoping Audits

What is it?

This program can help identify opportunities for major energy-efficiency improvements for customers with more complex systems.

How the Scoping Audit works:

- CenterPoint Energy provides funding to offset a portion of the study costs for a third party to detail the energy-savings potential
- Funding could be up to 90% of the study cost (capped at $15,000/customer)
- Funding levels dependent upon project gas-saving potential
- Rebates are also available for qualifying implemented gas-saving measures for even more bottom-line savings

CenterPointEnergy.com/ScopingAudit

Steam Trap Audit Program

What is it?
An audit of your customers' steam distribution systems can help increase their efficiency by identifying steam traps in need of replacement or repair.

When failed traps are identified, customers may be eligible for our prescriptive steam trap rebate which provides 35% of the replaced or repaired trap equipment cost.

How the Steam Trap Audit Program works:
- Customers may participate in the program every other year
- The program pays for the steam trap audit at a rate of $15/tested trap, up to 100% of the audit's cost
- Trade allies receive an incentive of $15/facility audit

CenterPointEnergy.com/SteamTrapAudit

Natural Gas Energy Analysis

What is it?

A Natural Gas Energy Analysis can help businesses of any size find energy savings.

A certified energy auditor will visit the facility and:

- Inspect the building envelope and installed natural gas equipment
- Examine how the equipment is operating
- Identify opportunities to improve efficiency and potentially qualify for rebates
- All analyses receive a detailed report with specific recommendations to help develop an energy-savings plan. Participants are also eligible for free direct-install natural gas-saving measures, including programmable thermostats, energy-efficient faucet aerators and showerheads, and weather stripping for exterior doors.

Looking for a comprehensive natural gas and electric audit?

CenterPoint Energy is partnering with Xcel Energy to offer our joint customers a comprehensive electric/natural gas energy audit. If you receive your electric service from Xcel Energy, you can request a joint electric/natural gas site visit for a total co-pay of $500. See website for additional details.

CenterPointEnergy.com/EnergyAnalysis

Natural Gas Energy Analysis

CenterPoint Energy

Analyses available

Type of analysis	Scope	Co-pay
Basic analysis*	Basic review of facility with high-level report, covering non-process loads. Most appropriate for small customers.	**$50**
Comprehensive analysis**	Comprehensive review of facility with detailed technical report and calculations, covering non-process loads. Most appropriate for mid-to-large customers.	**$200**
Ad hoc services* ** for specific energy use analysis, such as steam trap surveys for a heating system and infrared scans	Custom analysis and/or additional services targeted to special customer needs and preferences, including infrared scans, steam trap surveys, and analysis of process loads.	**Based on services provided**

Basic analysis is only available to customer with a Firm A or Firm B rate class.

**Customers with a Firm A and Firm B rate class may opt in to the comprehensive-level analysis.*

***Ad-hoc services provides for specialty technical analysis of facilities, based on special needs of the customer, regardless of rate class. Customers with process loads, regardless of size will receive a custom analysis.*

CenterPointEnergy.com/EnergyAnalysis

Design/Engineering Programs

Recommissioning Program

A recommissioning study helps commercial customers identify low- and no-cost energy-saving measures that reduce operating costs and improve existing mechanical system efficiency for an entire facility of a particular system.

Our Recommissioning program offers funding for customers to offset a portion of third-party study costs that identify energy-saving measures.

Funding levels are dependent upon projected natural gas savings potential. CenterPoint Energy will also rebate qualifying implemented natural gas saving measures.

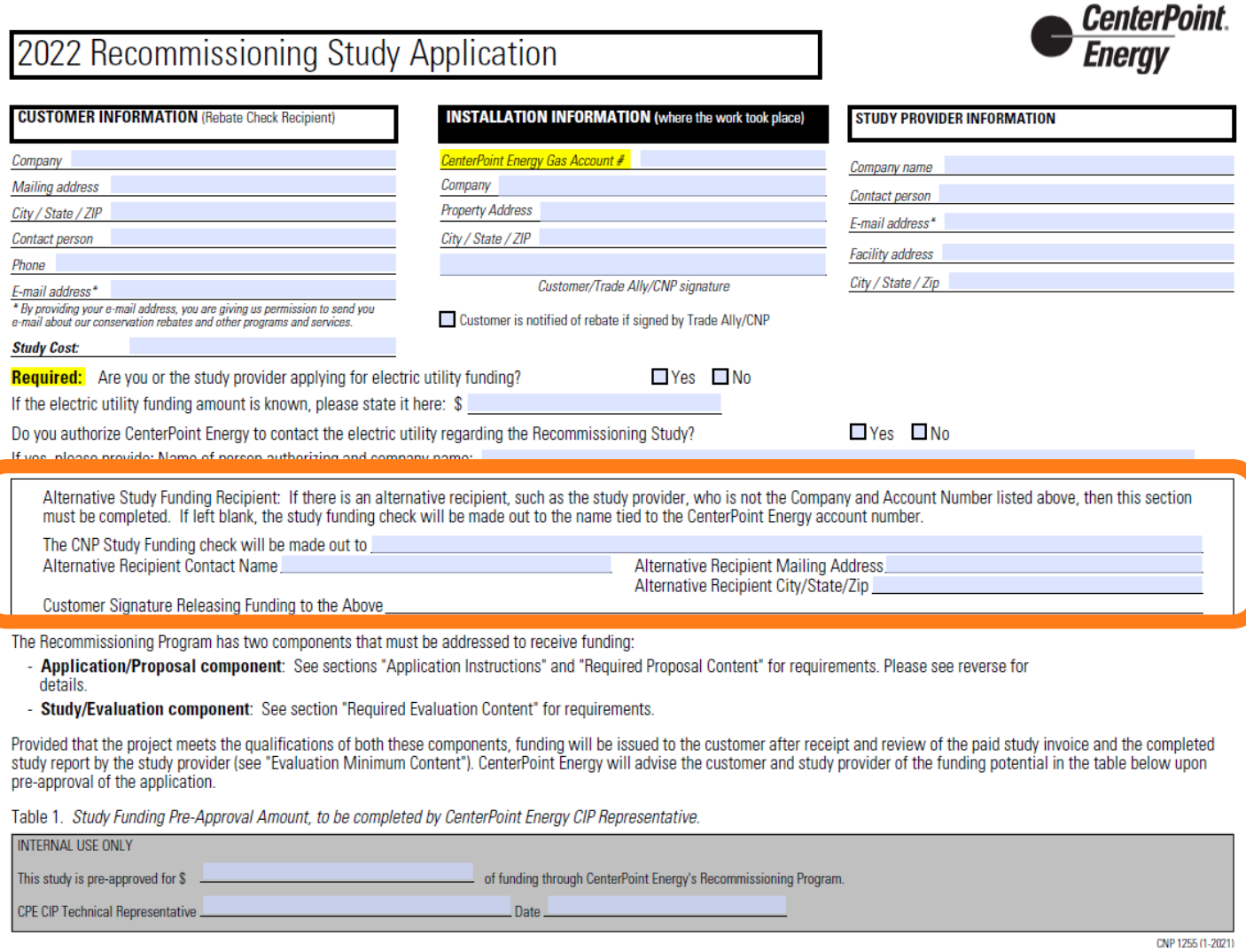
Offsets a portion of the costs of a third-party study that identifies energy-saving measures.

1. Study Funding
   - Funding is a function of the customer's usage and predicted savings potential
   - Up to 75% of study cost, not to exceed $5,000

2. Implementation Rebates
   - $5.00/Dth saved
   - Must have 1 -10 year payback

CenterPointEnergy.com/EngineeringPrograms

Recommissioning Program



2022 Recommissioning Study Application

CUSTOMER INFORMATION (Rebate Check Recipient)

Company
Mailing address
City / State / ZIP
Contact person
Phone
*E-mail address**

* By providing your e-mail address, you are giving us permission to send you e-mail about our conservation rebates and other programs and services.

Study Cost:

INSTALLATION INFORMATION (where the work took place)

CenterPoint Energy Gas Account #
Company
Property Address
City / State / ZIP

Customer/Trade Ally/CNP signature

☐ Customer is notified of rebate if signed by Trade Ally/CNP

STUDY PROVIDER INFORMATION

Company name
Contact person
*E-mail address**
Facility address
City / State / Zip

Required: Are you or the study provider applying for electric utility funding? ☐ Yes ☐ No

If the electric utility funding amount is known, please state it here: $

Do you authorize CenterPoint Energy to contact the electric utility regarding the Recommissioning Study? ☐ Yes ☐ No

If yes, please provide: Name of person authorizing and company name:

Alternative Study Funding Recipient: If there is an alternative recipient, such as the study provider, who is not the Company and Account Number listed above, then this section must be completed. If left blank, the study funding check will be made out to the name tied to the CenterPoint Energy account number.

The CNP Study Funding check will be made out to

Alternative Recipient Contact Name

Alternative Recipient Mailing Address

Alternative Recipient City/State/Zip

Customer Signature Releasing Funding to the Above

The Recommissioning Program has two components that must be addressed to receive funding:

- **Application/Proposal component**: See sections "Application Instructions" and "Required Proposal Content" for requirements. Please see reverse for details.
- **Study/Evaluation component**: See section "Required Evaluation Content" for requirements.

Provided that the project meets the qualifications of both these components, funding will be issued to the customer after receipt and review of the paid study invoice and the completed study report by the study provider (see "Evaluation Minimum Content"). CenterPoint Energy will advise the customer and study provider of the funding potential in the table below upon pre-approval of the application.

Table 1. *Study Funding Pre-Approval Amount, to be completed by CenterPoint Energy CIP Representative.*

INTERNAL USE ONLY

This study is pre-approved for $ of funding through CenterPoint Energy's Recommissioning Program.

CPE CIP Technical Representative Date

CNP 1255 (1-2021)

Trade Ally Reminder:
The study funding rebate payment for a recommissioning study can be made out to the study provider with agreement and consent from the customer.

Industrial Process & Commercial Efficiency Program

- Program is designed to address a facility's long-term comprehensive energy needs by identifying and overcoming energy conservation barriers.
- Targeted for mid-size industrial manufacturing process customers using a minimum of about 2,000 Dth annually OR large commercial customers that have large-scale heating plant systems

The program is delivered in 3 phases:

Phase 1 – identifies opportunities

Phase 2 – develops an energy action plan

Phase 3 – implements energy-saving measures

CenterPointEnergy.com/EngineeringPrograms

Energy Design Assistance (EDA)

EDA provides building design consulting services, provided by our third-party energy modeling firm, at no cost to participating customers that includes:

- Energy modeling
- Predicted energy use
- Strategies for energy savings
- Projected energy cost savings for those strategies

- CenterPoint Energy offers a rebate for projects that realize over 5% energy savings

- Program is offered collaboratively with the customer's electric utility, subject to availability

- EDA is for new construction and/or major renovation

- Customers who achieve Passive House certification will be eligible for higher rebates and/or reimbursement for certification costs

- LEED certification assistance is available to reimburse customers for a portion of the costs associated with certification

CenterPointEnergy.com/EngineeringPrograms

Other Energy-Saving Programs

Energy Data Portal

What is the Energy Data Portal?

- A FREE program designed to make natural gas energy benchmarking easy
- The portal offers a secure, online solution to request and receive whole-building natural gas energy use data
- Data is automatically transferred to ENERGY STAR Portfolio Manager® where CenterPoint Energy commercial and multi-family customers can track building energy performance.

CenterPointEnergy.com/BenchmarkingResources

Energy Star® Verification Assistance Program

ENERGY STAR® Verification Assistance Program requires a buildings application be certified by a registered engineer or architect.

Here's how the program can help:

- CenterPoint Energy will reimburse first-time participant customers for the cost of the ENERGY STAR® application verification up to a maximum of $1,500 per building.
- Subsequent-year participant customers qualify for half the cost of the ENERGY STAR® application verification up to a maximum of $750 per building PLUS up to an additional $750 if documentation is furnished of an implemented natural gas savings measure resulting in CenterPoint Energy rebate.
- Customer must provide a copy of the verified application and documentation of the verification costs.

Multi-Family Building Efficiency Program

Program is designed to address a facility's long-term comprehensive energy needs by identifying and overcoming energy conservation barriers.

- Targeted for 5+ unit multi-family customers
- Offered jointly with Xcel Energy
  - Customers must receive electric service from Xcel Energy and natural gas service from either Xcel Energy or CenterPoint Energy.
- Offered at no cost
- Includes an energy audit coupled with installation of energy efficient items such as energy efficient showerheads, door weatherstripping, and LED light bulbs throughout the entire building
- Receive 30-60% higher rebates for completed projects

MultiFamilyEnergySolutions.com

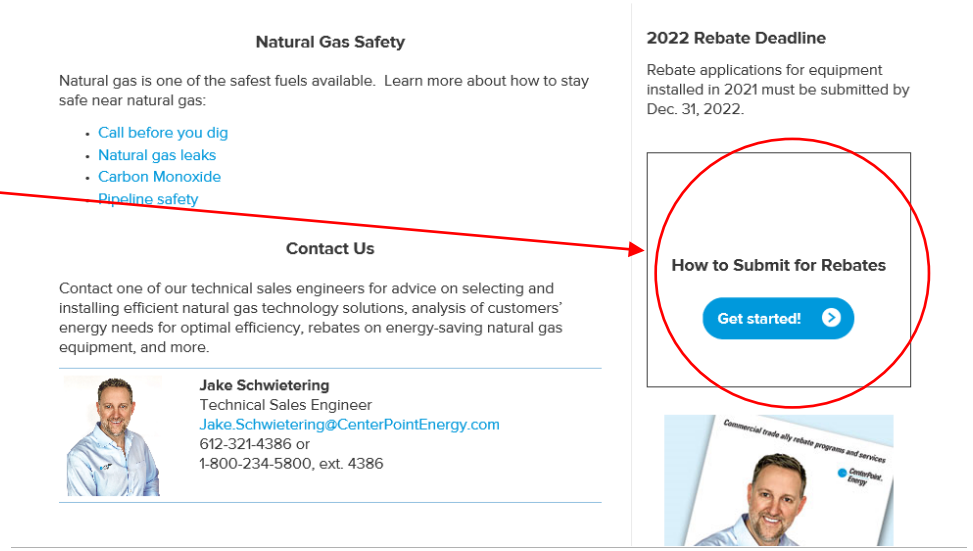
Rebate Processing Guidelines

How To Submit Online Rebate Applications

Online rebate application submission for:

- Single package vertical unit
- Forced-air furnace
- Smart thermostats
- Electronic ignition hearth

CenterPointEnergy.com/CommercialTradeAlly and click on "How to submit for rebates"



Double trade ally incentives:
Increased from $20 to $40 per unit

- Single package vertical unit
- Forced-air furnace
- Electronic ignition hearth

Bonus Trade Ally Incentives

Increased from $3.75 to $7.50 per unit

- Smart thermostat

How To Submit Paper Rebate Applications

Commercial rebate processing

Download fill-and-print rebate forms at
CenterPointEnergy.com/BusinessRebates.

Ways to submit completed applications:

MNCommercialRebates@CenterPointEnergy.com

Commercial Rebate Processing
CenterPoint Energy
PO Box 59038, Minneapolis, MN 55459-0038

Fax to: 612-321-4561

To secure a rebate, applications and dated sales invoices must be RECEIVED by Dec. 31.

Rebate Application Tips & Tricks

2022 Commercial Boiler Tune-Up Rebate Application

MINNESOTA

Program dates: Jan. 1, 2022 through Dec. 31, 2022
1) Review the **Terms & Conditions** on the back of this form to ensure all program requirements are met.
2) Enclose paid in full invoice showing tune-up cost (excluding taxes).
3) For questions about rebates, please call your account manager or trade ally representative at (612) 321-4330 or (800) 234-5800, Ext. 4330.

CUSTOMER INFORMATION (Rebate Check Recipient)

Company
Mailing address
City / State / ZIP
Contact person
Phone
*E-mail address**

** By providing your e-mail address, you are giving us permission to send you e-mails about our conservation rebates and other programs and services.*

INSTALLATION INFORMATION (where the work took place)

CenterPoint Energy Gas Account #
Company
Property Address
City / State / ZIP

Customer/Trade Ally/CNP signature

☐ Customer is notified of rebate if signed by Trade Ally/CNP

TRADE ALLY INFORMATION (Mechanical Contractor, Dealer, Distributor, Plumber)

Company
*Trade Ally ID# (6-digit)**
Mailing address
City / State / ZIP
Contact person
Phone
*E-mail address**

*CenterPoint Energy assigns 6-digit Trade Ally ID#'s to participating Trades. If you would like to obtain a Trade Ally ID# or do not know yours, please contact us. A Trade Ally ID# is not required to submit a rebate.

Multi-Family Affordable Housing Bonus Rebate
(Property must have a minimum of 66% income-eligible households to qualify; see reverse for requirements.)
☐ No ☐ Yes If yes, please provide:
Total number of housing units: _____ Number of units occupied by income-eligible households: _____

FOR OFFICE USE ONLY

Meter #	
SIC	
Rate Class	

BUILDING TYPE

Code	Building Type	Code	Building Type	Code	Building Type	Code	Building Type
☐ CV	Convenience Store	☐ CU	Education - College/University	☐ HC	Health/Medical - Clinic	☐ OF	Office - 3-4 Story
☐ RL	Retail - Large (> 30,000 sq ft)	☐ ES	Education - Primary	☐ HO	Health/Medical - Hospital	☐ OM	Office - 5-9 Story
☐ RS	Retail - Strip Mall (< 30,000 sq ft)	☐ MS	Education - Secondary	☐ HT	Hotel/Motel	☐ OH	Office - 10+ Story
☐ WH	Warehouse	☐ MF	Multifamily	☐ FF	Restaurant	☐ OT	Other
☐ MU	Manufacturing						

EQUIPMENT INFORMATION (see back for rebate amounts)

	Date of Tune-Up	Boiler and Location	Boiler Rating (BTUH Input)	Post Tune-Up Combustion Efficiency**	Tune-Up Cost† (excluding taxes)	CenterPoint Energy to Complete: Rebate Amount @ 25%
1.					$	$
2.					$	$
3.					$	$
4.					$	$
5.					$	$
6.					$	$
					Rebate total	$ 0.00

*** Attach flue gas analyzer test tape for reference, if available.*
† Rebate is paid on boiler tune-up labor, analyzer, supplies required to perform tune-up and truck charges.

White - CenterPoint Energy Yellow - Customer/Trade Ally CNP 1099 (1-2022)

How Do You Receive Trade Ally Incentives?

Commercial incentives

Three simple steps to incentives:

1. Submit a W-9

To comply with tax laws and to pay your incentives, we need a current copy of your W-9 on file every two years. Please fill out an EFT form and incentives will be direct-deposited.

2. Receive a trade ally ID

Once we have your W-9, you'll receive a 6-digit trade ally ID to track and pay your incentives. Include it whenever you submit rebate applications.

3. Send completed applications

After installations are complete, submit rebate applications. We will mail your customers' rebates upon processing and send your incentive checks to you quarterly.

Don't have your trade ally ID number?

Or, can't find yours? Please contact us at 612-321-4305 or RebateAccounting@CenterPointEnergy.com.

Questions & Answers

Natural Gas Pricing Update

January/February 2022

Eric Johansen
Energy Efficiency Engineer, CenterPoint Energy

Factors That Effect Natural Gas Pricing

Natural gas prices are a function of market supply and demand

Supply:
- Increases in natural gas supply = lower natural gas prices
- Decreases in supply = higher prices

- Demand:
- Increases in demand = higher prices
- Decreases in demand = lower prices

- Prices:
- Higher prices = reduced demand and encourage production
- Lower prices = increased demand and reduced production

Factors That Effect Natural Gas Pricing

Three major supply-side factors affect prices:

- Amount of natural gas production
- Level of natural gas in storage
- Volumes of natural gas imports and exports

Three major demand-side factors affect prices:

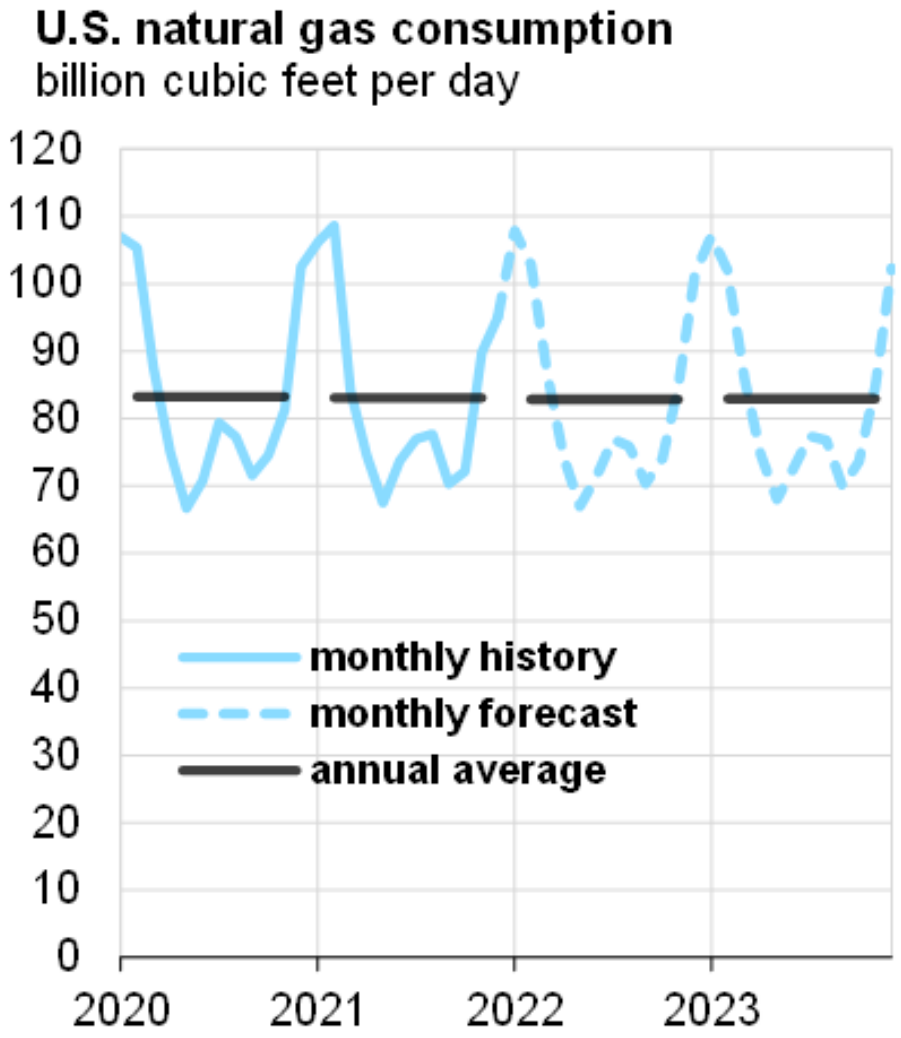
- Variations in winter and summer weather
- Level of economic growth
- Availability and prices of other fuels

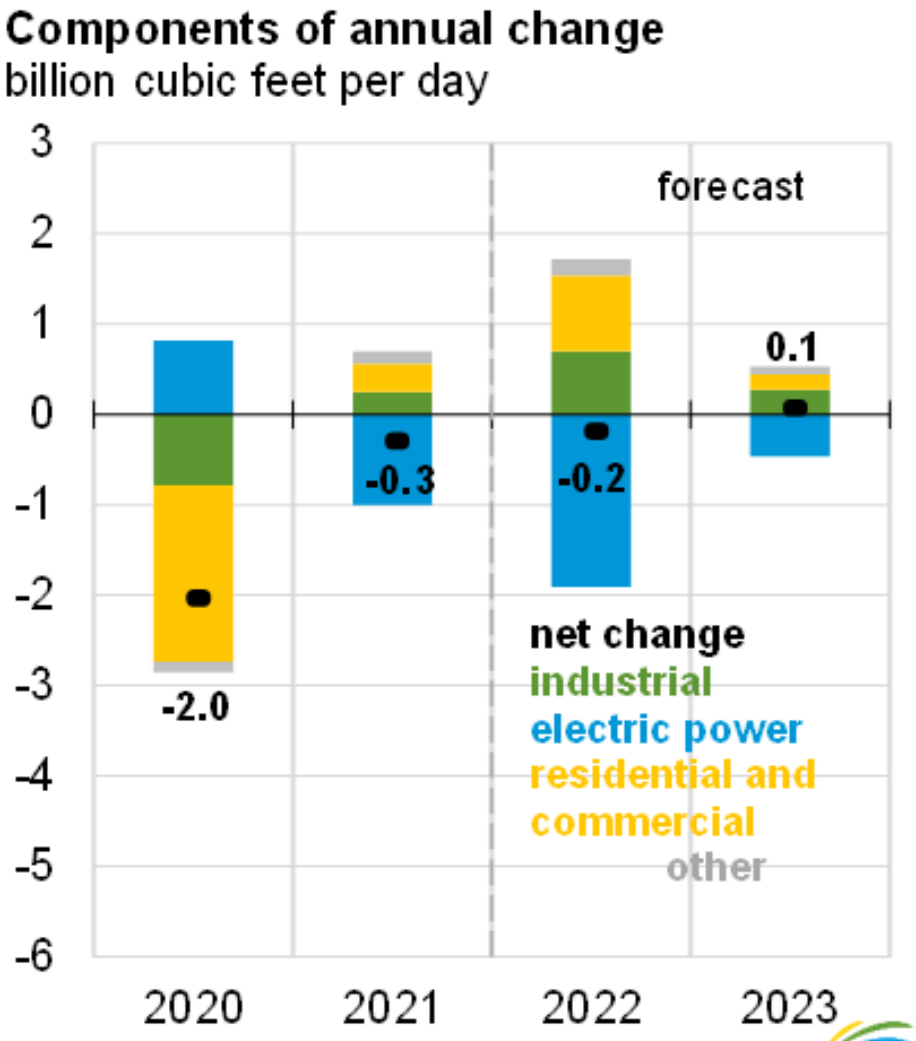
Consumption

- US natural gas consumption averaged 83.0 billion cubic feet per day (Bcf/d) in 2021, almost unchanged from 2020
- Consumption is expected to remain flat in both 2022 and 2023
- Largest natural gas-consuming sector in the United States is the electric power sector
- Electric power sector will consume 6% less than in 2021- result of rising electricity-generating capacity from renewable energy
- Industrial sector natural gas consumption forecast to increase by 3% during 2022, as demand for industrial goods and economic activity increases
- U.S. residential and commercial natural gas consumption will be up 4% from 2021

Source: EIA Short-Term Energy Outlook January 2022

Consumption





Source: U.S. Energy Information Administration, Short-Term Energy Outlook, January 2022

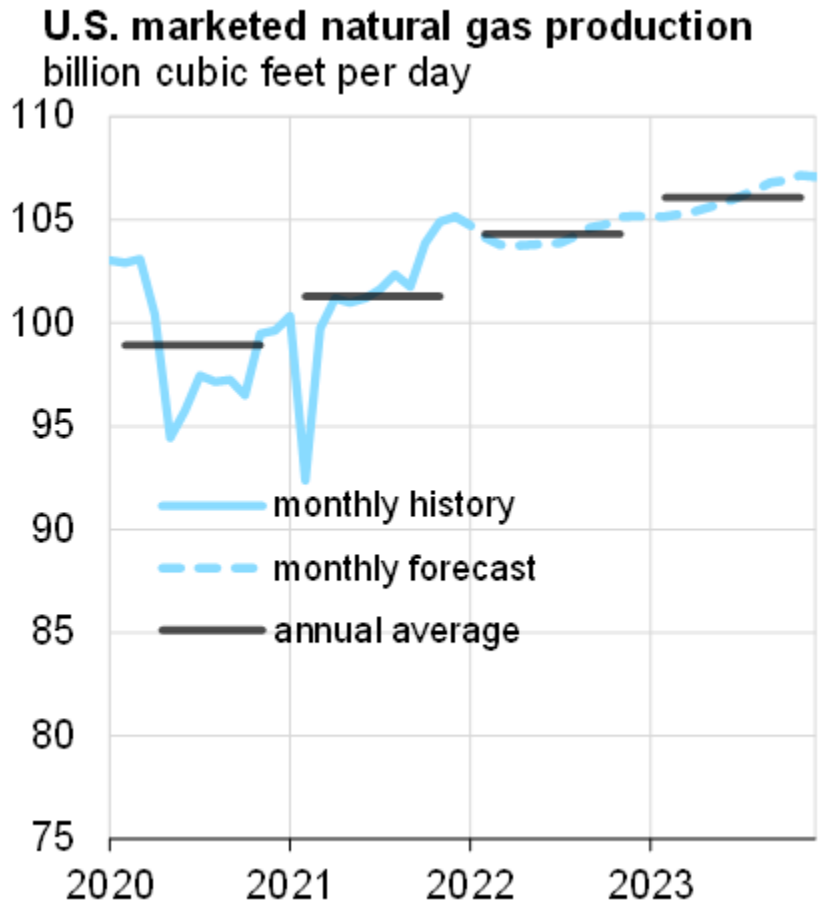
Production

- U.S. production of dry natural gas averaged an estimated 93.5 Bcf/d in 2021, up 2.0 Bcf/d (2%) from 2020

- Production grew in 2021 as drilling activity came back online, especially in the Permian Basin, where associated gas production in that region contributed to the overall growth in natural gas production

- EIA is forecasting natural gas production will increase by 3% in 2022

- Recent increases in oil and domestic natural gas prices contribute to an overall increase in drilling activity in 2022 that will lead to production growth from 2Q22 onward



Source: EIA Short-Term Energy Outlook January 2022

Winter Production Comparison

Winter Season Period-to-period change	Last Winter 2020-2021 ACTUAL	This Winter 2021-2022 FORECAST	3-YEAR WINTER AVERAGE
Winter average production (Lower 48)	89.9 Bcf/d	93.7 Bcf/d	91.2 Bcf/d
Canadian imports (net)	5.5 Bcf/d	5.2 Bcf/d	5.0 Bcf/d
LNG imports	0.1 Bcf/d	0.3 Bcf/d	0.3 Bcf/d

Winter-to-Winter pressure on natural gas prices

Source: Natural Gas Supply Association & Energy Ventures Analysis

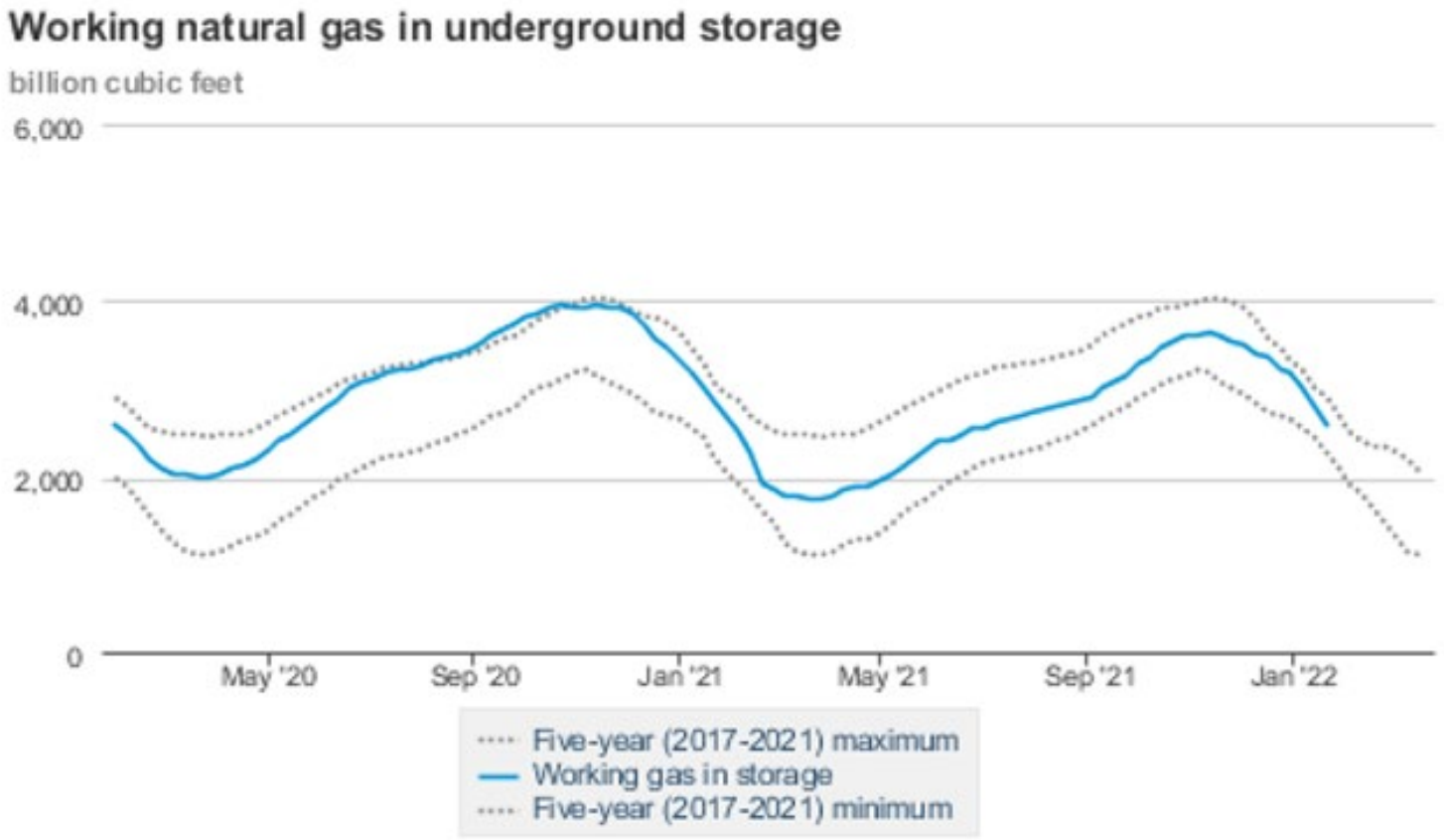
Storage

- Natural gas storage inventories entered the 2021–22 winter heating season at the lowest level since 2018
- At the end of March, traditionally considered the end of the heating season, natural gas inventories were 11% lower than in the same period in 2020 due to strong natural gas demand during the 2020–21 heating season, combined with a reduction in natural gas production.
- Demand growth outpaced supply during the 2021 storage refill season (April through October) causing net injections of natural gas into storage that were 4% below the five-year average and 3% below the 2020 refill season
- EIA is forecasting close-to-average storage withdrawals in 1Q22, resulting in inventories that total 1,822 Bcf at the end of March, which would be 8% more than the five-year (2017–21) average for that time of year
- For the 2022 April–October storage injection season, injections in EIA's forecast do not keep pace with the five-year average rate due to expected demand growth in the industrial sector and rising demand for U.S. exports

Source: EIA Short-Term Energy Outlook January 2022

Storage

Working gas in storage is currently 4.6% lower than levels a year ago and 3.1% higher than the 5-year average



Source: U.S. Energy Information Administration Form EIA-912, *Weekly Underground Natural Gas Storage Report*

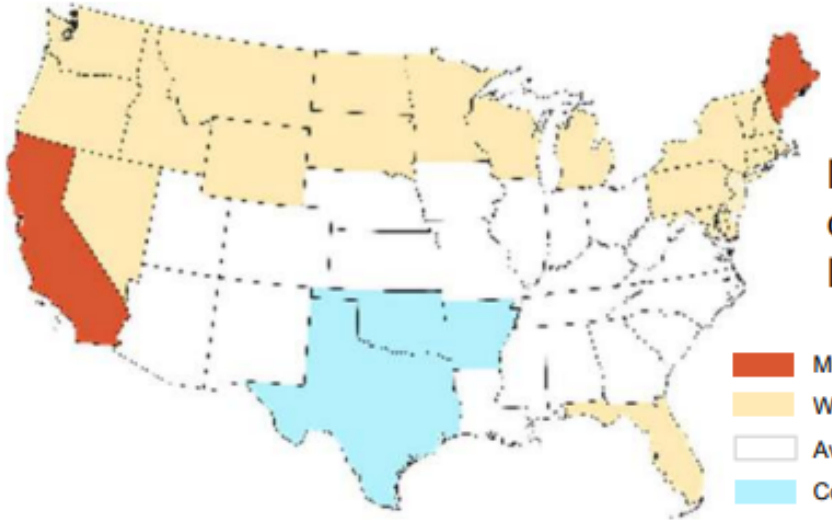
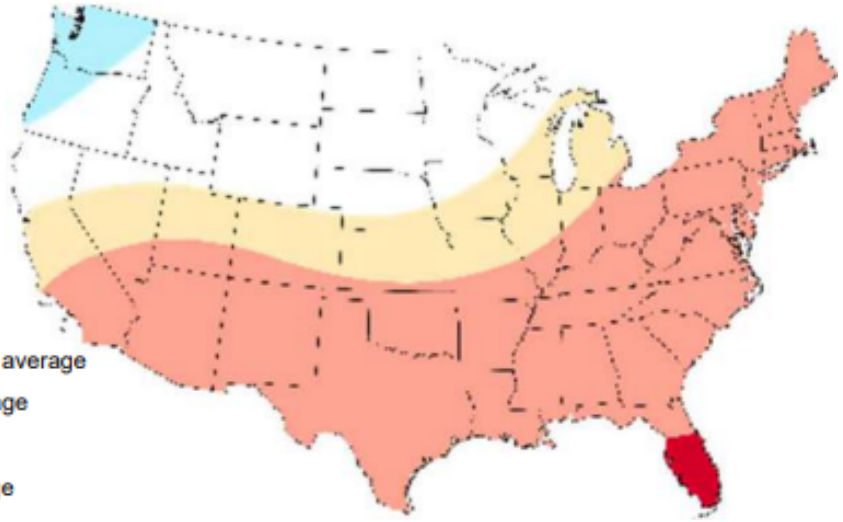
Winter Storage Comparison

Winter Season Period-to-period change	Last Winter 2020-2021 ACTUAL	This Winter 2021-2022 FORECAST
Start-of-winter inventory	3,924 Bcf	3,627 Bcf
Compared to 5-year average (Percent of total storage inventory)	1% higher	3% lower
Average daily withdrawal from storage	15.3 Bcf	12.9 Bcf
New storage capacity	+ 0 Bcf	+ 0 Bcf

Source: Natural Gas Supply Association & Energy Ventures Analysis

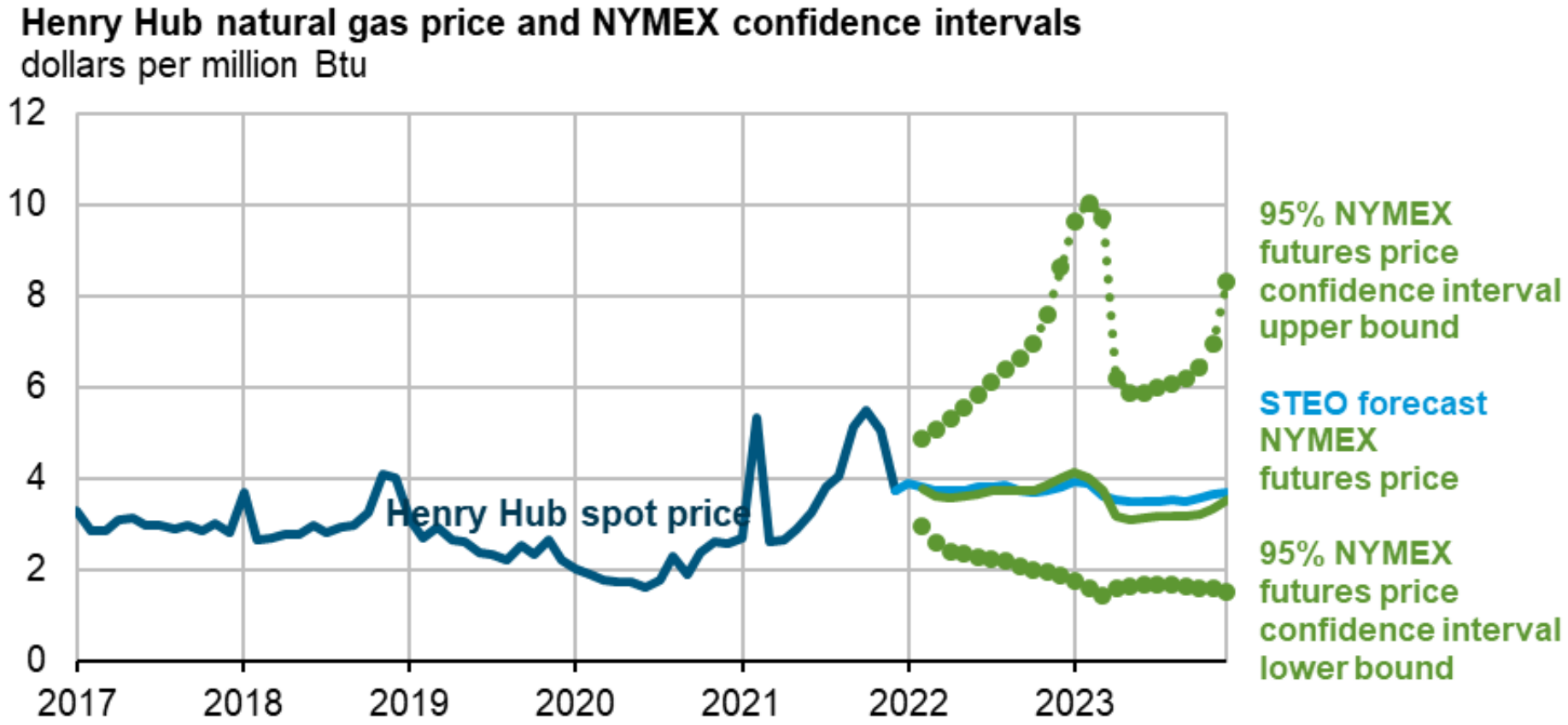
Winter Weather Comparison

CenterPoint Energy

Last Winter 2020-2021 ACTUAL	This Winter 2021-2022 FORECAST
Actual winter heating season: 3% *colder* than previous winter 1% *warmer than last three winters*	Forecast: 1% *colder* than last year *Same as last three winters*
	
3,398 Heating degree days (NOAA)	3,410 Heating degree days (EVA)

Source: Natural Gas Supply Association & Energy Ventures Analysis

Henry Hub & NYMEX Pricing Confidence Intervals



Note: Confidence interval derived from options market information for the five trading days ending Jan 6, 2022. Intervals not calculated for months with sparse trading in near-the-money options contracts.

Sources: U.S. Energy Information Administration, Short-Term Energy Outlook, January 2022, CME Group, and Refinitiv an LSEG Business

February 2021 Winter Storm Charges

- Winter weather and freezing temps caused a spike in demand and disrupted supply
- Prices increased for many utilities in Minnesota and across the country
- Beginning Sept. 2021 bills will have a surcharge to cover these costs for sales and transport customers who were sales customers at that time
- Charge will apply on a volumetric basis, depending on the amount of natural gas used going forward, not what was used in February 2021
- This was a separate line item on your monthly billing
- The charge will be higher in summer months ($0.04610/therm) than in winter months ($0.11526)
- Costs that CenterPoint Energy incurred in February 2021 are still under review by the Minnesota Public Utilities Commission (PUC)
- If amounts collected exceed costs that the PUC determines were prudently incurred, CenterPoint Energy will reduce our rates going forward or refund the excess

Natural Gas Pricing Summary

- Natural gas prices are expected to decline in Q2 of 2022 and 2023 compared with 2021 but prices in the forecast stay relatively high compared with recent years.

- Natural gas price volatility could result from weather-related increases or decreases in demand and uncertainties about the way rising levels of natural gas exports could affect the U.S. market.

- COVID-19 impacted demand patterns and stressed the supply chain in 2020 and 2021. These lingering effects have played a key role in the predicted higher price of energy and many other commodities.

- As more production flows to market, it will place downward pressure on prices, which lines up with EIA's prediction of declining natural gas prices in March of 2022.

- Heightened levels of uncertainty as a result of the ongoing COVID-19 pandemic raises questions about global energy consumption. In addition, uncertainty about winter weather and consumer energy demand also present a wide range of potential outcomes for energy consumption.

Source: EIA Short-Term Energy Outlook January 2022

Questions & Answers

Factors to Consider When Your Customer Wants to Decarbonize

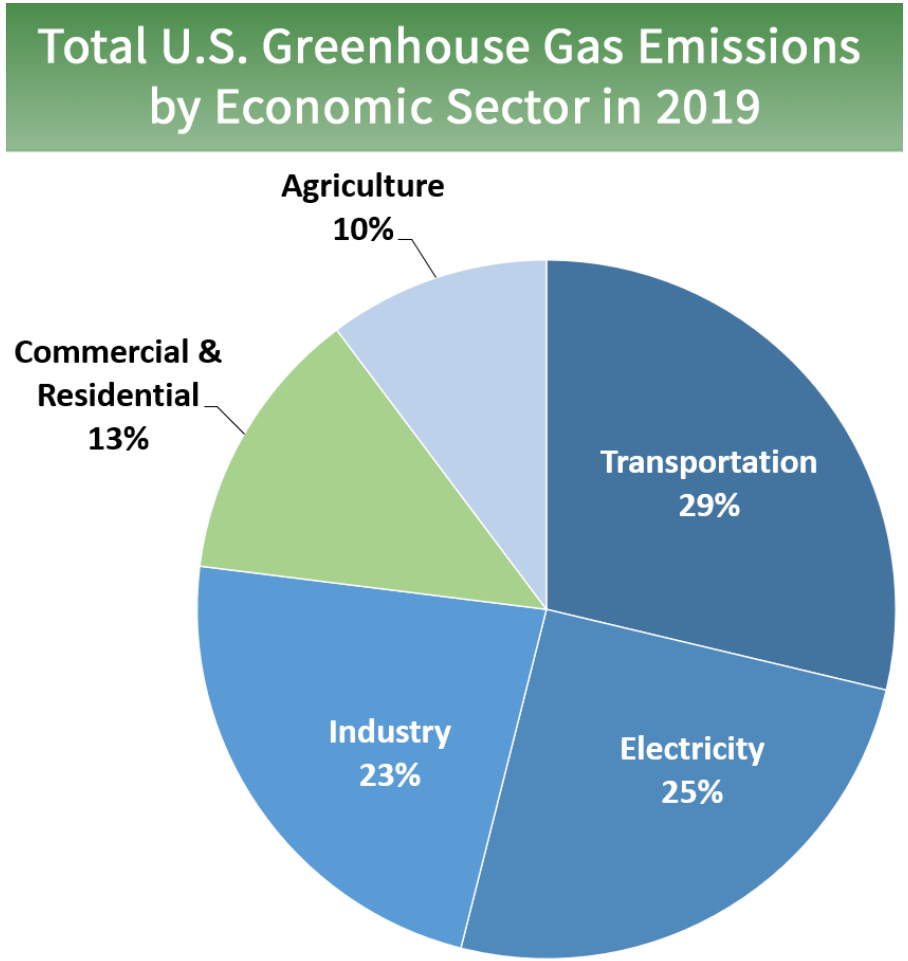
Nick VanDuzee
Energy Efficiency Engineer, CenterPoint Energy

Agenda

- US space and water heating emissions in context
- 2 main factors to consider when decarbonizing
- Heat pump pros and cons
- Decarbonizing with electricity (electrification)
- Decarbonizing with gas
- A solution appropriate for 2022
- Summary
- Time for questions

Some context regarding space and water heating emissions

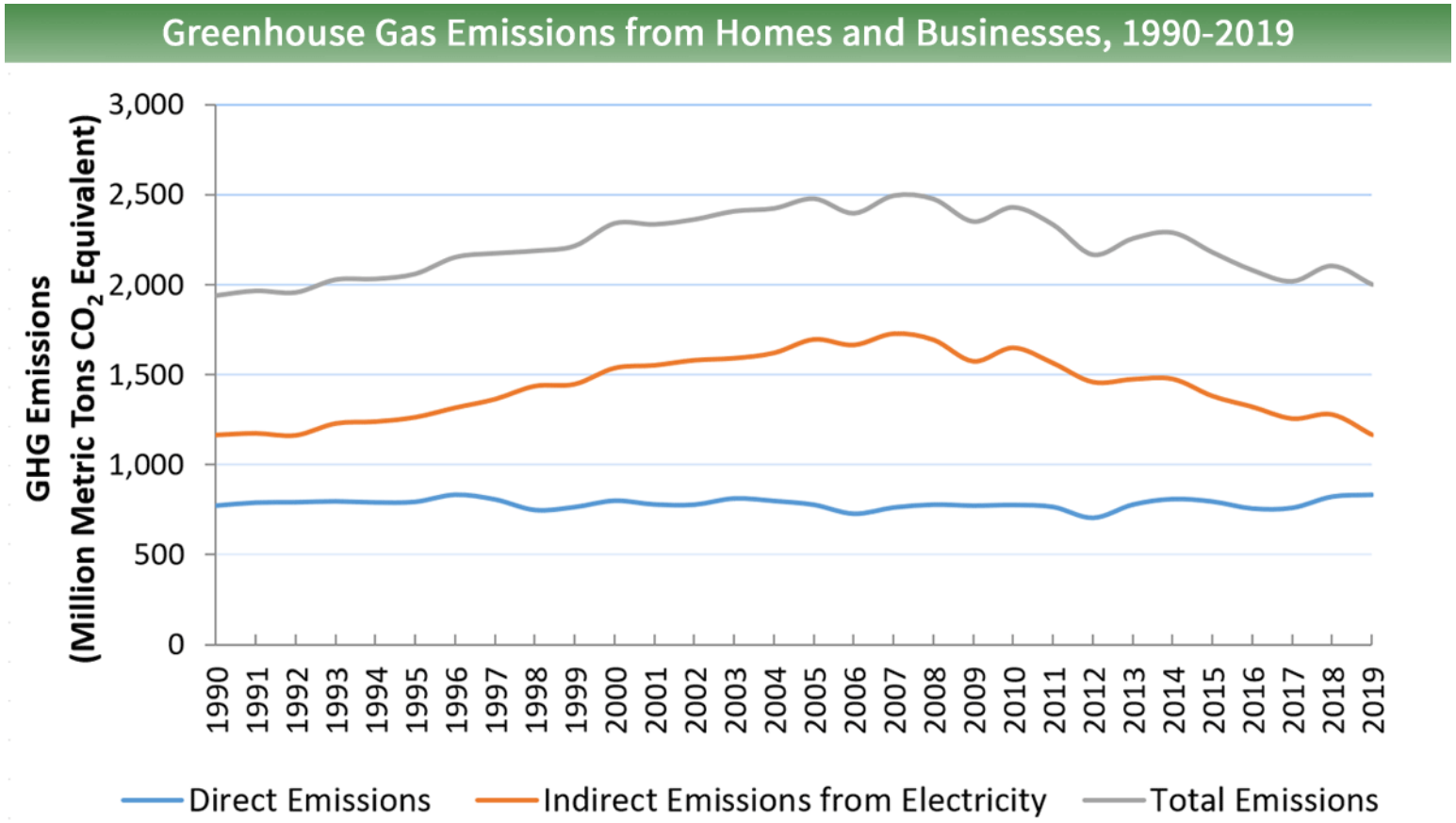
Commercial and residential emissions are 13% of U.S. emissions



Source: EPA, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#commercial-and-residential

Direct vs. indirect emissions

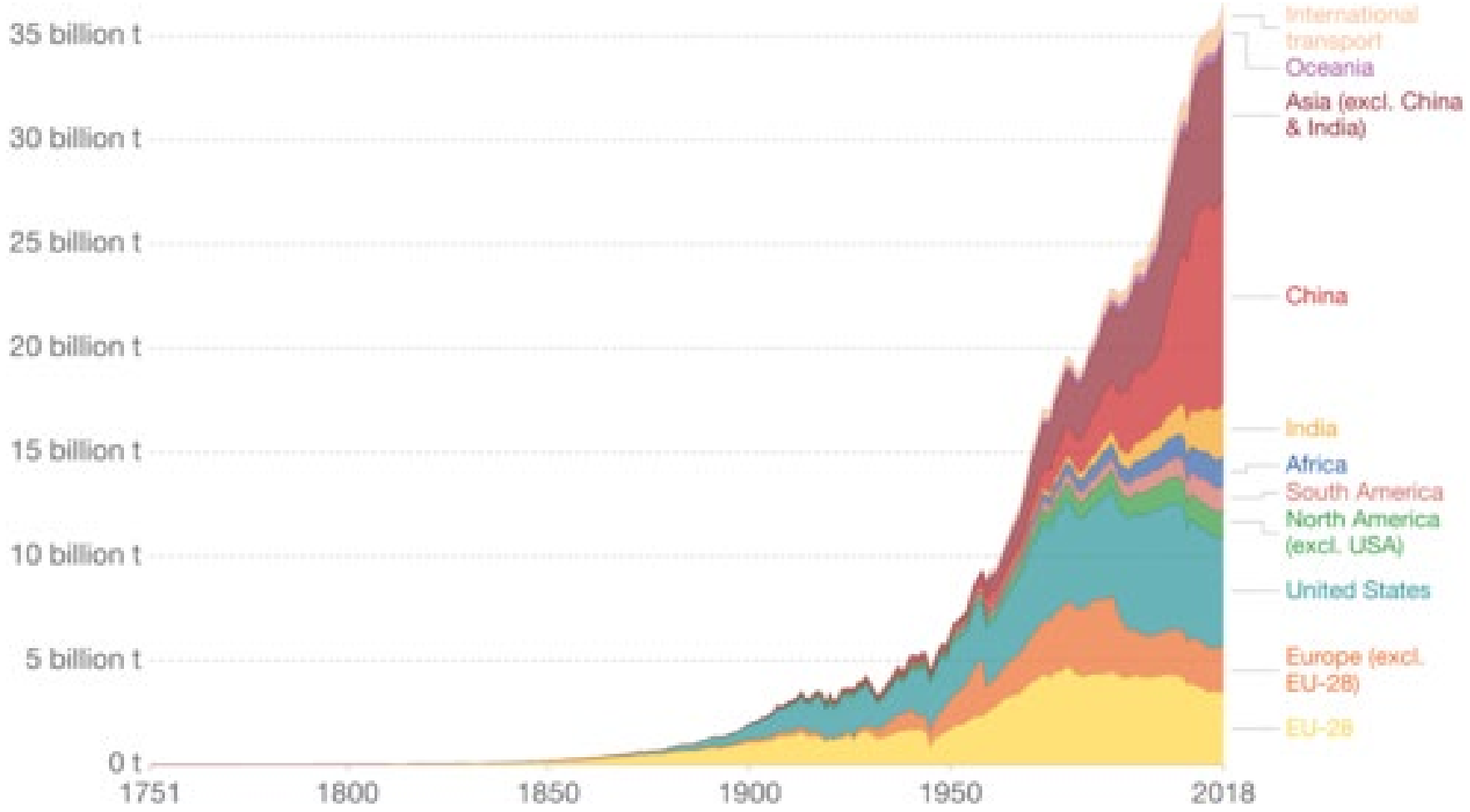
- Of the commercial and residential emissions, less than half (~42.5%) are from fossil fuels burned onsite



Source: EPA, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#commercial-and-residential

US emissions compared to the rest of the world

US emissions are about 1/7th of the world's emissions



Source: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

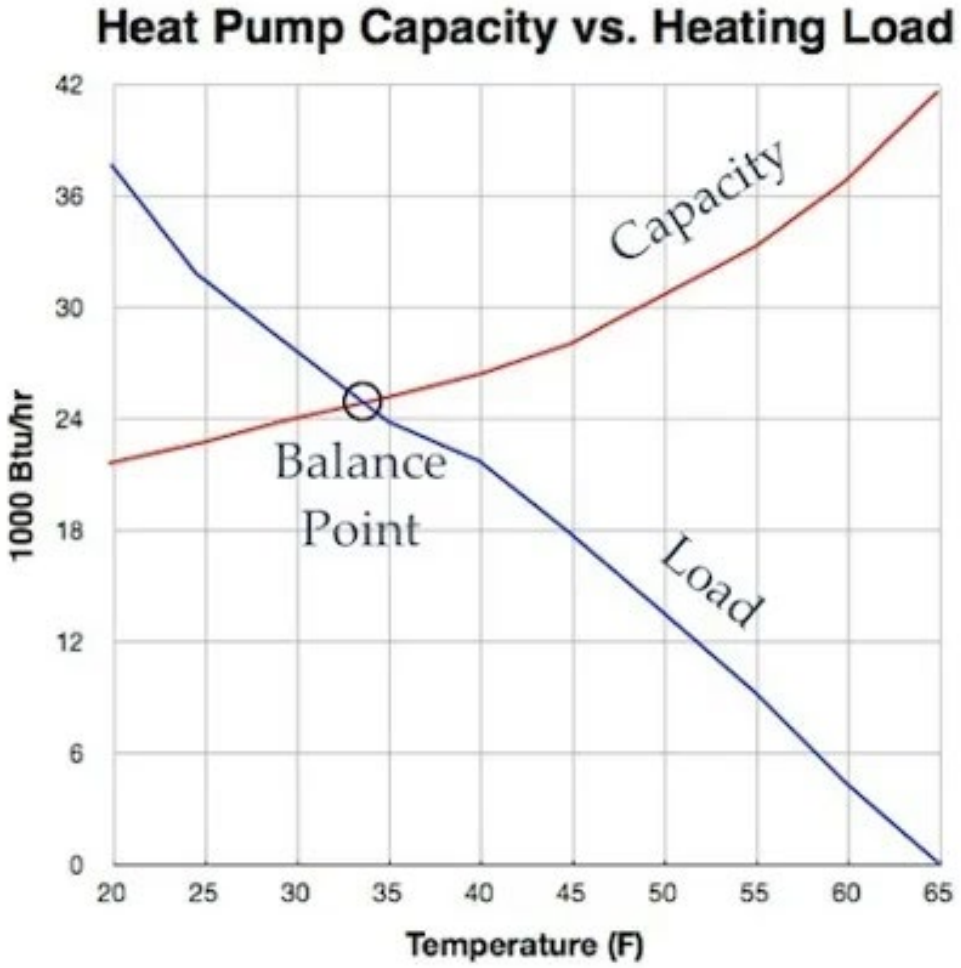
2 Factors to consider when decarbonizing

- Costs
  - Capital
  - Operating
  - Maintenance

- Operating considerations
  - How quickly can heat pump water heater recharge?
  - What's the lowest temperature that the heat pump can satisfy the heating load?
  - How seamlessly can the heat pump be made to operate with the back-up system?

Some background on heat pumps

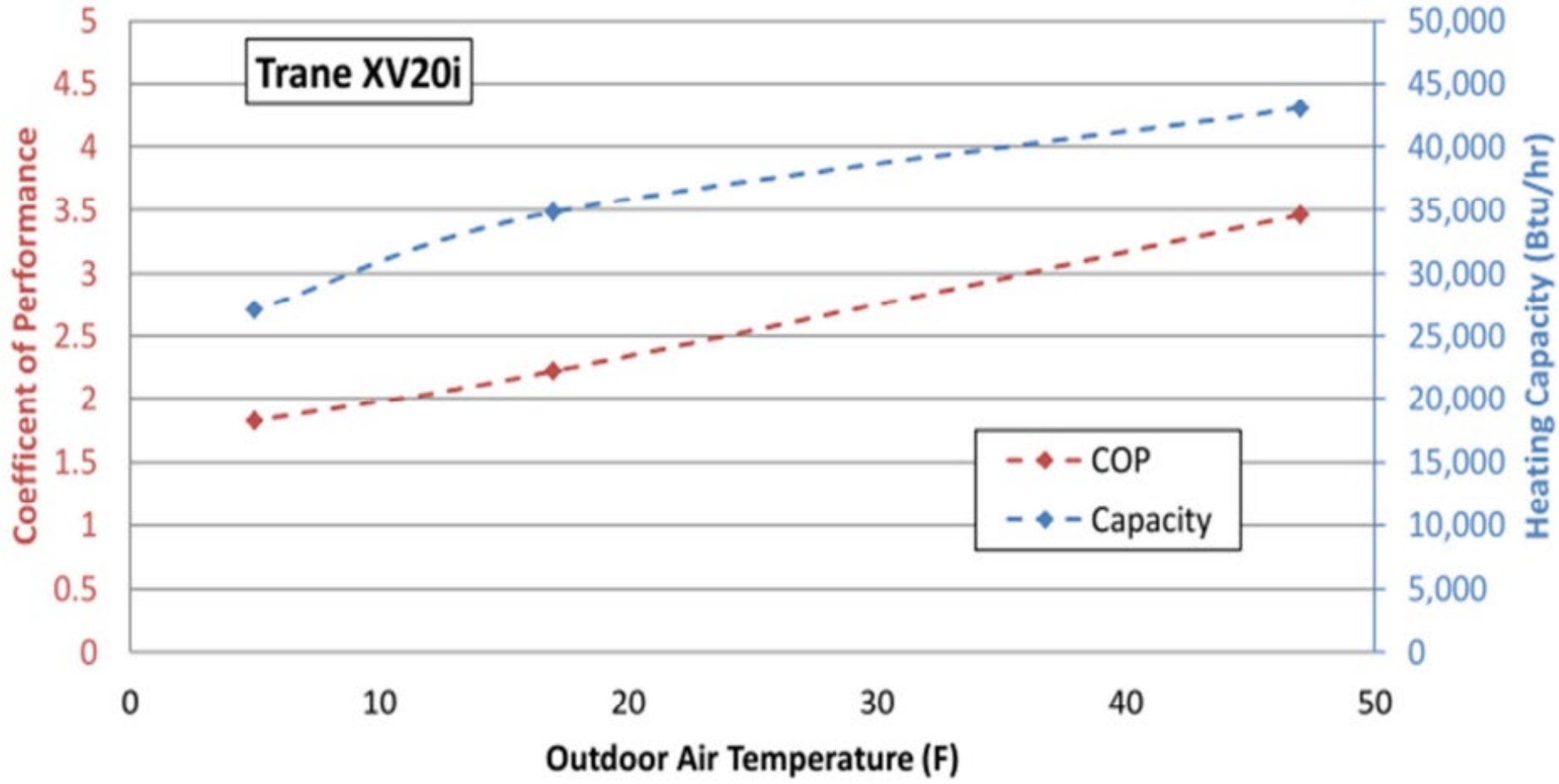
Heat pumps (esp. air source ones) lose capacity as temperature decreases



Source: https://www.energyvanguard.com/blog/finding-balance-heat-pump-heating-load-vs-capacity/

More background on heat pumps

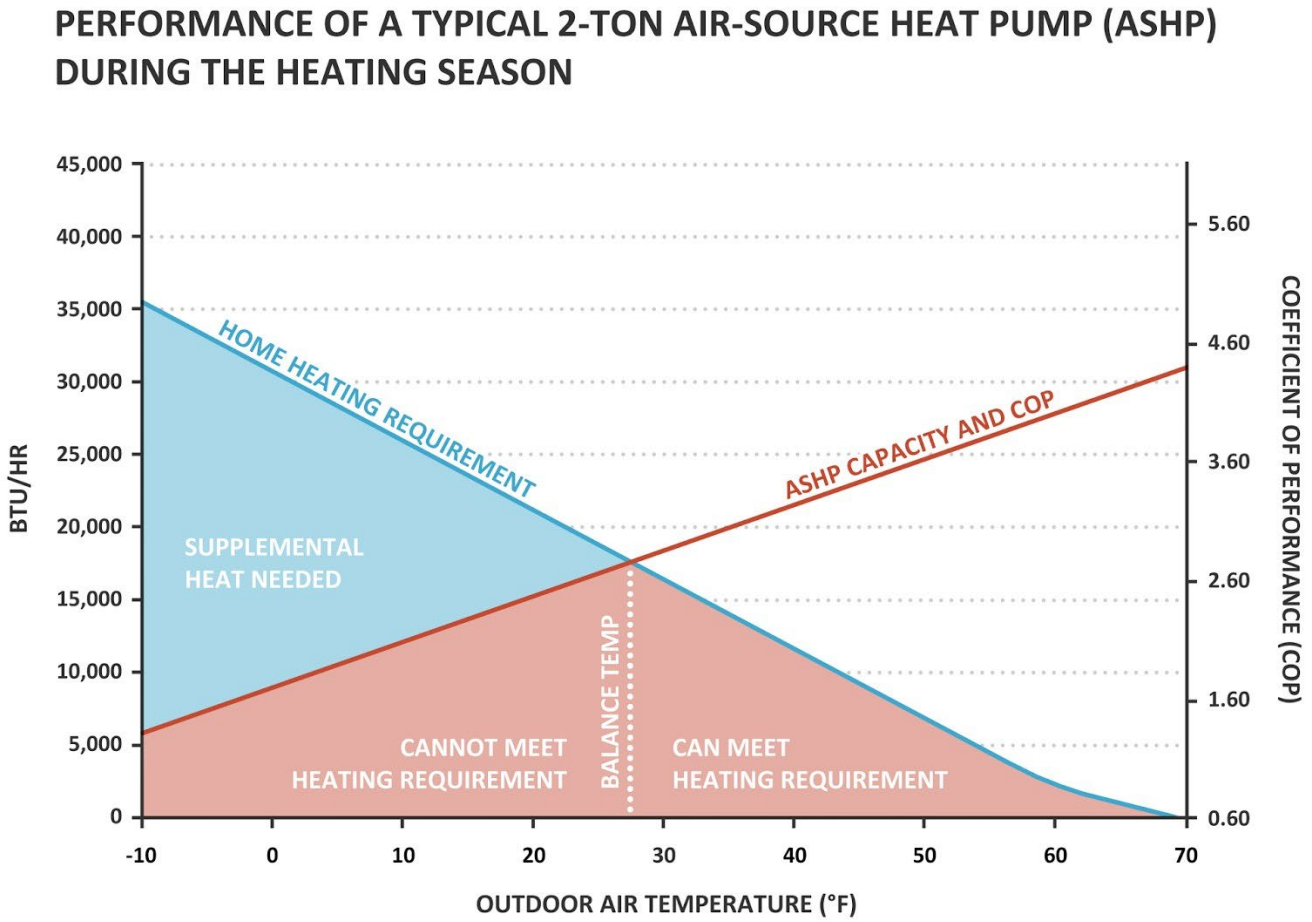
Heat pumps also lose efficiency (COP) as temperature decreases



Source: https://www.mncee.org/cold-climate-air-source-heat-pump-final-report

Putting it all together

Supplemental heat is needed in Minnesota



Source https://browningday.com/news/gauging-the-seasonal-efficiency-of-air-source-heat-pumps/

Heat pump water heater considerations

From the ENERGY STAR website:

HPWH Install Location Questions	Check Yes or No	
Is location in an unoccupied space where cooling and noise will not be an issue?	[ ] Yes	[ ] No
Does location offer more than 1,000 cubic feet of surrounding air (i.e., approximately the space of a 12 foot by 12 foot room)? (Efficiency will suffer in a closet – even one with louvred doors - and you need adequate clearance around air entry and discharge.)	[ ] Yes	[ ] No
Does location offer sufficient height to install? (HPWH are usually taller than traditional storage tank water heaters to accommodate the heat pump.)	[ ] Yes	[ ] No
Can location accommodate or does it already have a condensate drain or pump? (HPWHs produce condensate.)	[ ] Yes	[ ] No
Is ambient air temperature not consistently in freezing range (32 degrees F) or below? (HPWHs do not operate in freezing temperature like outdoors or in garages during northern climate winters.)	[ ] Yes	[ ] No
Does ambient air temperature remain between 40°- 90° F year-round? (An ideal spot would be near a furnace in a basement that is very warm all winter or a garage in very warm climates.)	[ ] Yes	[ ] No

Source: https://www.energystar.gov/products/water_heaters/high_efficiency_electric_storage_water_heaters/considerations

Heat pump water heater considerations in cold climates

2 more considerations for cold climates:

- In colder climates, most HPWHs are placed in unconditioned or semi-conditioned basements. However, if placed in conditioned space, HPWHs will produce cool and dry air that is a benefit in the summer months but will lead to higher heating bills in the winter months.

- When operating in heat pump mode, HPWHs do not heat water as quickly as conventional electric resistance water heaters, particularly when recovering after a significant draw. Consequently, to maintain performance, HPWHs may switch to a less efficient electric resistance heating mode. 3 During these times of recovery, colder ambient air and incoming water will lead to switching to a less efficient electric-resistance mode more often.

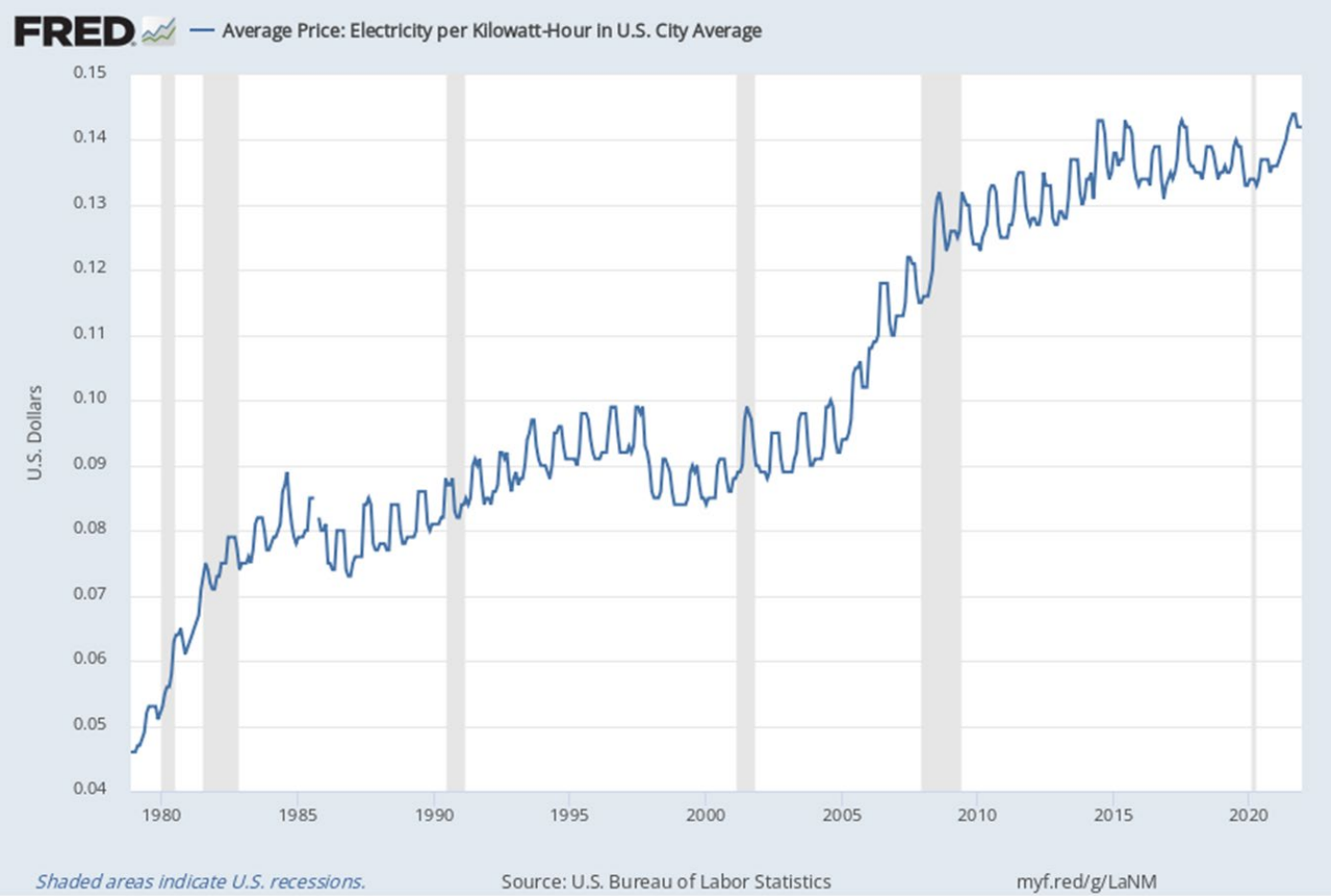
Source: https://www.energystar.gov/products/water_heaters/high_efficiency_electric_storage_water_heaters/considerations

Electric decarbonization of the grid

- Electric utilities have been and are continuing to decarbonize the grid rapidly
- An example of the approximate rate of reduction of a utility in the Twin Cities area
  - 2005 1.335 lbs CO2/kWh
  - 2030 0.267 lbs CO2/kWh – projected and on track to meet
  - 2050 0.000 lbs CO2/kWh - projected

Electricity prices – historical data

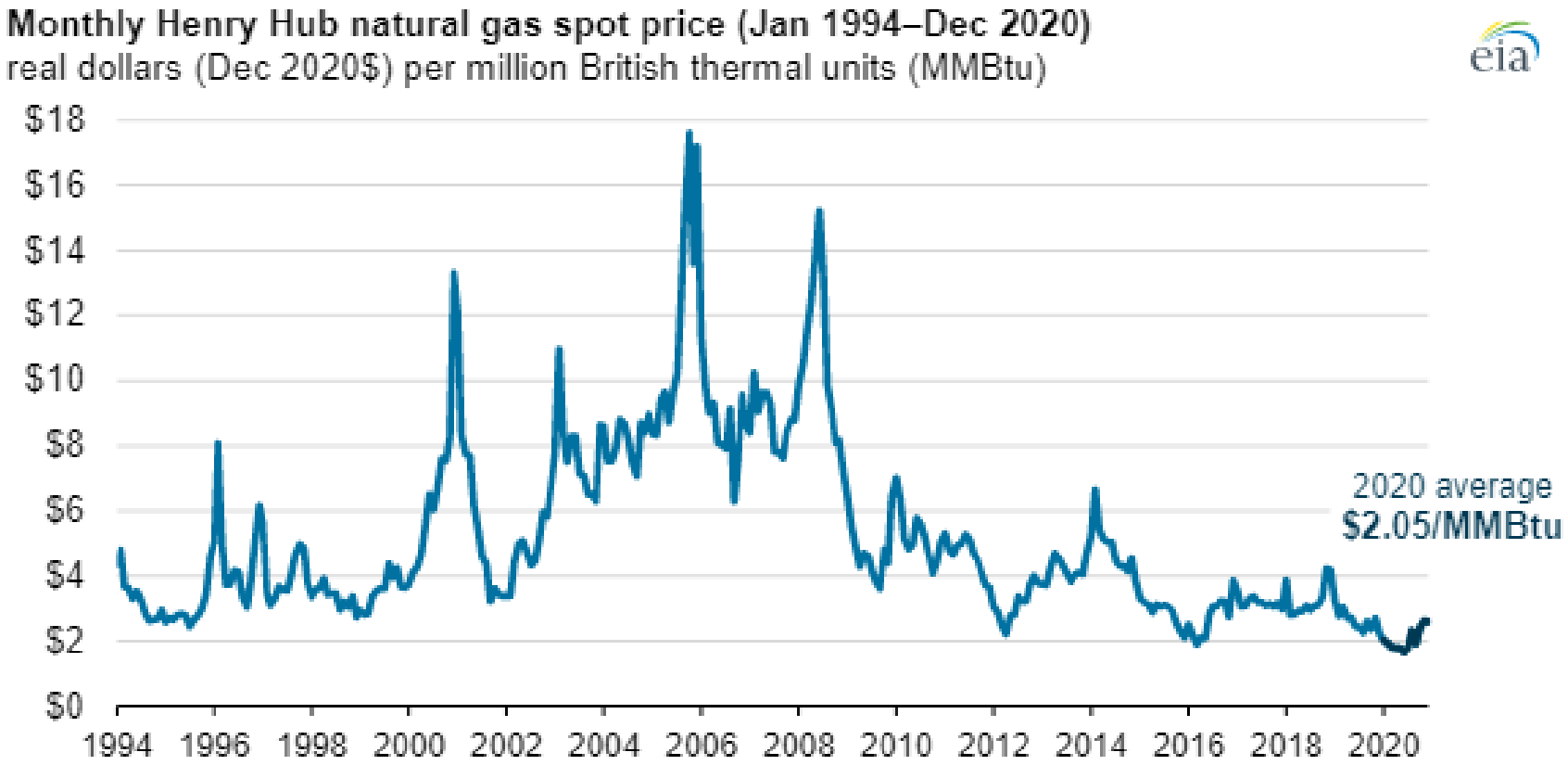
The price for electricity has increased ~60% in the last 20 years



Source: https://fred.stlouisfed.org/series/APU000072610

Natural gas prices – historical data

Natural gas prices spike from time to time, but show no long-term increase



Source: https://www.eia.gov/todayinenergy/detail.php?id=46376

Energy prices per million btu

- For a commercial facility, let's assume a gas price of $6/Dth and an electric price of $0.08/kWh
- Then knowing that each dekatherm (Dth) has 999,761 btus and each kWh has 3,412 btus…
- The price per million btu for gas and electric is $6 and $23.45, respectively.
- In other words, electricity is 3.9 times more costly.
- If we think about space heating at 47 oF, the COP of the heat pump might be 3.0 and the efficiency of the furnace might be 90%. Including the efficiencies would still yield electricity being 17% more expensive [($23.45/3)/($6/90%)] = 1.17. All temperatures below 47 would give a price increase of more than 17% since the COP would drop with decreasing temperature.

Space heating comparison

Dual fuel system gives comparable emissions savings with much lower operating cost

	$ 0.08	$ 6.00						
System	kWh	Dth	$/yr	% change	2022 lbs CO2/yr	% change	2022-2036 lbs CO2	% change
90% furnace		64.30	$385.78		7,529		112,936	
ASHP + Resistance	10,977		$878.15	128%	6,664	-11%	57,633	-49%
ASHP + 90% furnace	5,554	20.56	$567.65	47%	5,779	-23%	65,273	-42%

Source: CenterPoint Energy calculations

Gas decarbonization strategies

- The following are gas decarbonization strategies that are in various stages of development
  - Gas heat pumps
    - Space heating
    - Water heating
  - Alternative fuels and alternative energy carriers
    - Renewable natural gas (RNG)
    - Synthetic natural gas (SNG)
    - Hydrogen
  - Carbon capture

  - Don’t forget about traditional energy efficiency, which helps any fuel and which isn’t played out entirely yet

CenterPoint Energy's involvement in decarbonization

- 2021 MN CARD grant award for gas heat pump field study
- Member of the North American Gas Heat Pump Collaborative
- Member of the Low Carbon Resource Institute (LCRI); a national collaboration headed by EPRI and GTI
- A hydrogen pilot project in Minneapolis
- A company pledge to reduce our customer's gas carbon footprint by 20-30% by 2035

A rational recommendation for near term decarbonization

For the next few years, a hybrid (dual-fuel) space heating configuration might be the way to get the best of both worlds (reasonable prices increases with some emissions reductions).

	$ 0.08	$ 6.00						
System	kWh	Dth	$/yr	% change	2022 lbs CO2/yr	% change	2022-2036 lbs CO2	% change
90% furnace		64.30	$385.78		7,529		112,936	
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ASHP + 90% furnace	5,554	20.56	$567.65	47%	5,779	-23%	65,273	-42%

Summary

- All decarbonization strategies are more costly than business as usual
- The $/MMBtu is much better for gas than electric
- Keep in mind the operational realities of heat pumps
- Keep in mind the US space and water heating emissions relative to total global emissions
- Additional gas decarbonization strategies are getting closer to commercial viability
- Until the above become more widely available, a dual-fuel space heating system may be a good near-term solution for some customers

Questions & Answers

COMMERCE DEPARTMENT
ENERGY RESOURCES

Demonstration of Packaged Central Condensing Tankless Water Heating Systems in Multifamily Buildings

CenterPoint Energy Trade Ally Kickoff

February 16, 2022

Rich Swierczyna
Gas Technology Institute

Alexander Haynor
Center for Energy & Environment

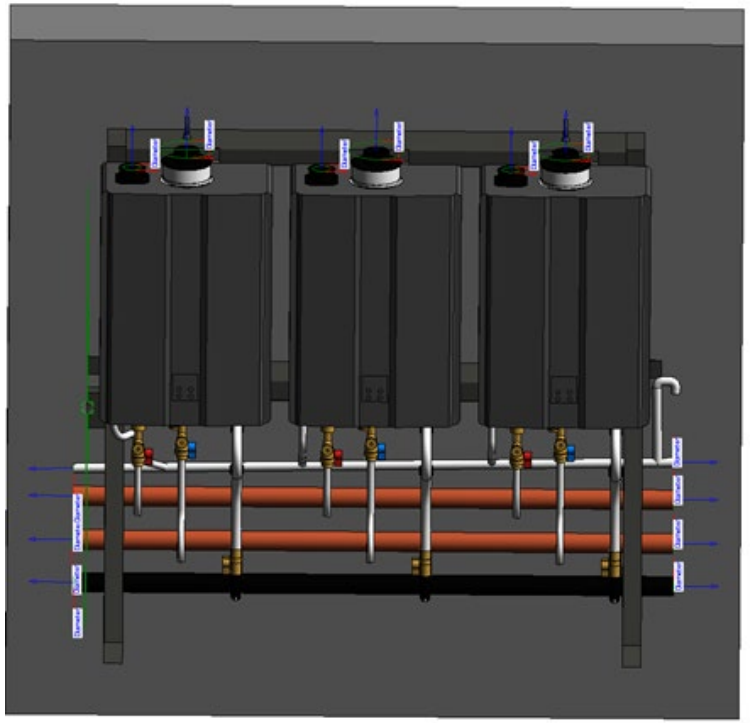
gti cee

Acknowledgements

This project was supported by a grant from the Minnesota Department of Commerce, Division of Energy Resources, through the Conservation Applied Research and Development (CARD) program, which is funded by Minnesota ratepayers.

The authors would also like to acknowledge the following GTI members of Utilization Technology Development for their financial support

Combined Condensing Tankless Water Heating (CCTWH) Technology



Overall Project - Summary

- **Demonstration**: Two CCTWH Systems installed at two multi-unit family buildings Twin Cities area
- **Analysis:** Develop CCTWH assessment tool and extrapolate to buildings based on occupancy, climate, etc.
- **Tech Transfer:** Measure assessment, model custom CIP measure

Overall Project - Summary

Site	Number of Units	Monitoring Period Start Date	Monitoring Period End Date	Days	Hot Water Use [Gallons Per Unit]
1-Tank Baseline	23	5/9/19	3/15/20	311	27.9
2-Tank Baseline	17	6/12/19	3/15/20	277	33.0
1-CCTWH	23	5/14/20	1/15/21	247	22.0
2-CCTWH	17	4/15/20	1/15/21	276	28.5

Image Source: CEE, Rinnai

Field Sites

Name	Location	Building type	Number of Units	Building Built	Number of Bedrooms	Occupancy
Site 1	St Paul, MN	Apartment/rental	23	1968	1 & 2 bed	one unit unoccupied
Site 2	St Paul, MN	Apartment/rental	17	1970	1 & 2 bed	fully occupied

SWH - Baseline Configurations

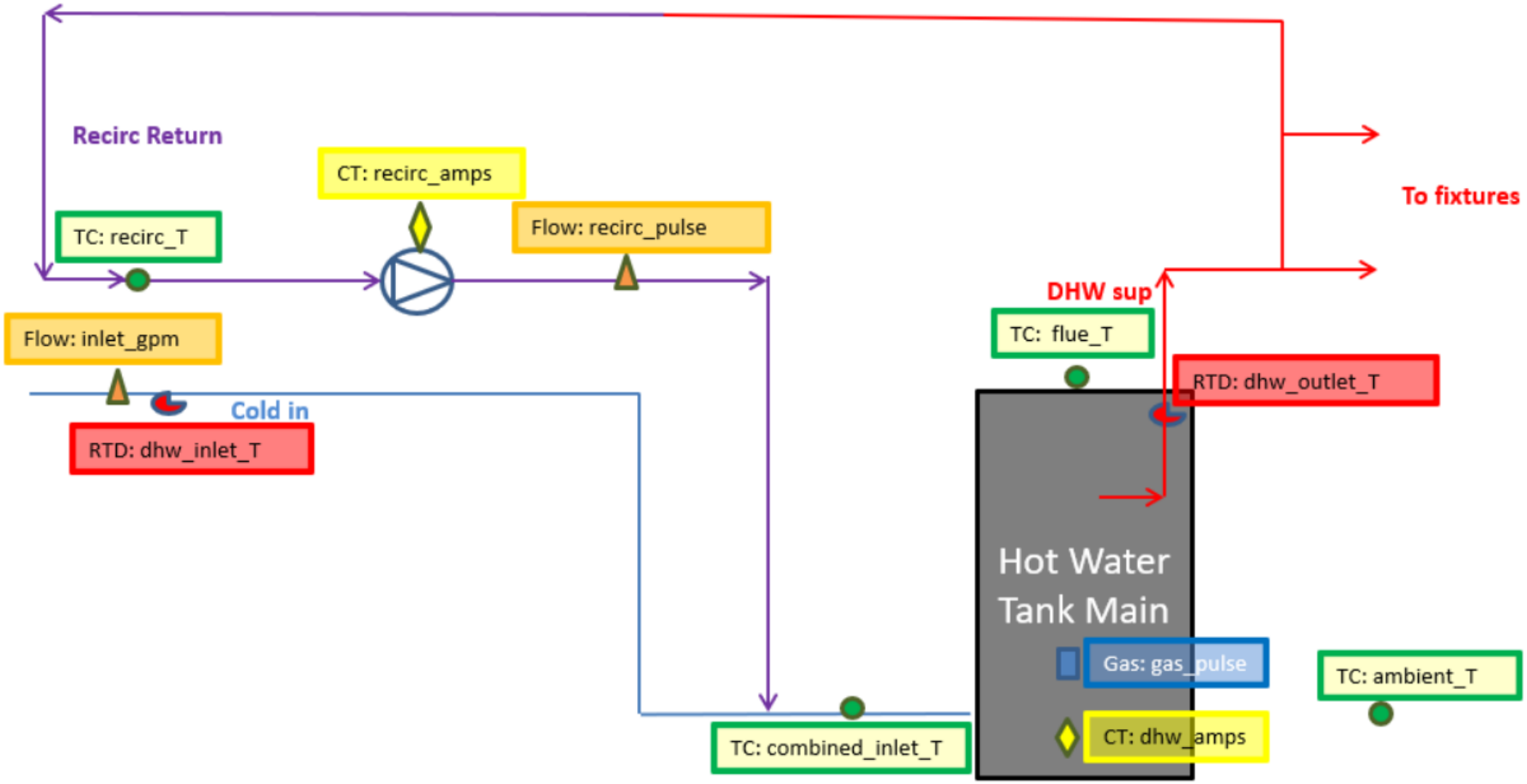
Site	Baseline SHW system	WH Make	WH Model	Input rate, Btu/hr	Recirc Loop present	Recirc Operation	Storage Volume, gallons
1	Single tank type water heater	A.O Smith	BTR 197 108	199,000	yes	Uncontrolled, on 24/7	100
2	Single tank type water heater	Rheem	RFD250-86	250,000	yes	Uncontrolled, on 24/7	86

SWH - CCTWH Configuration

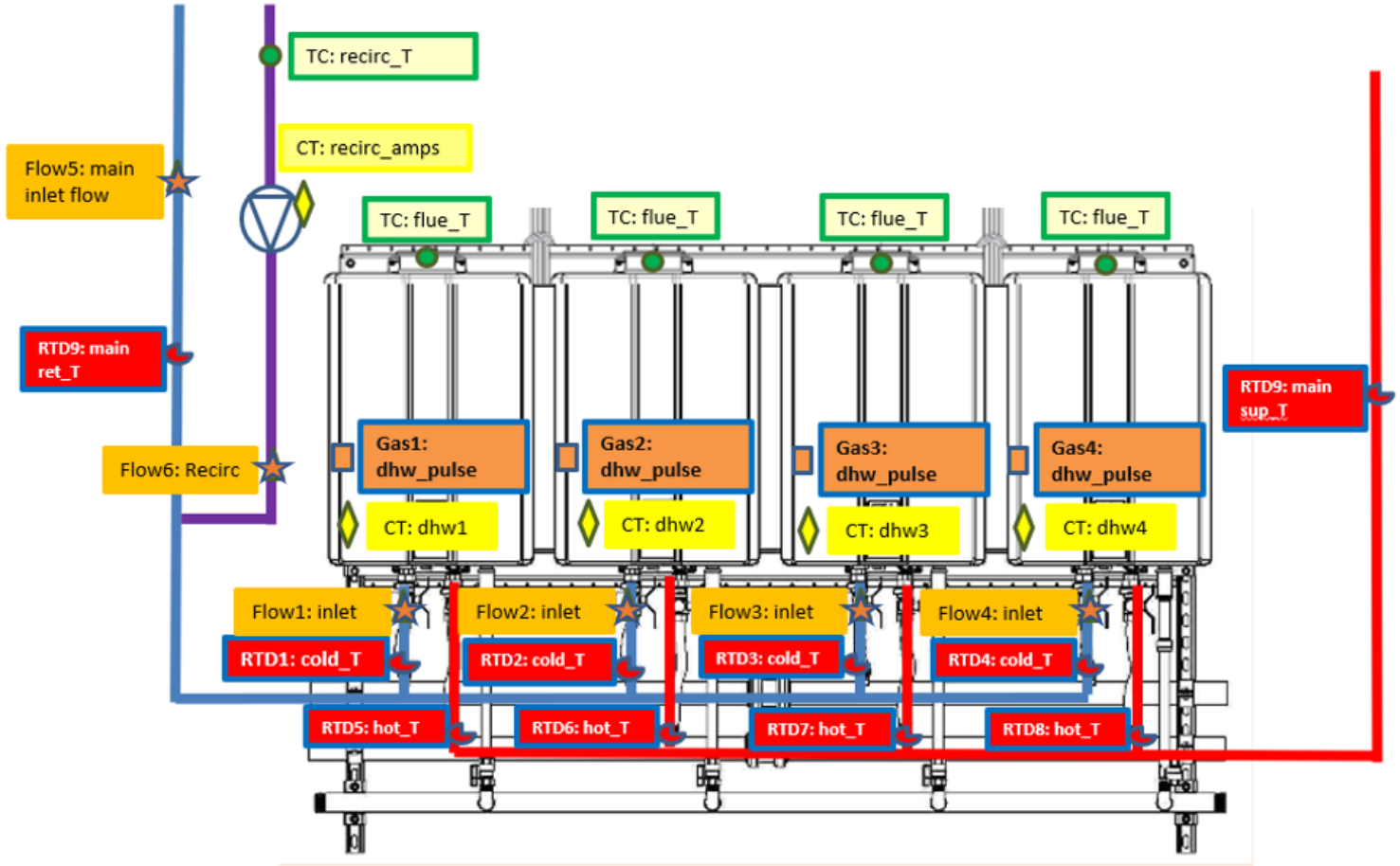
Site	CCTWH SHW system	TWH Make	TWH Model	Input rate range per unit, Btu/hr
1	Racked Tankless — 4 units	Rinnai	Cu199i	15,200–199,000
2	Racked Tankless — 3 units	Rinnai	Cu199i	15,200–199,000

Data Analyses and Results

Baseline Monitoring



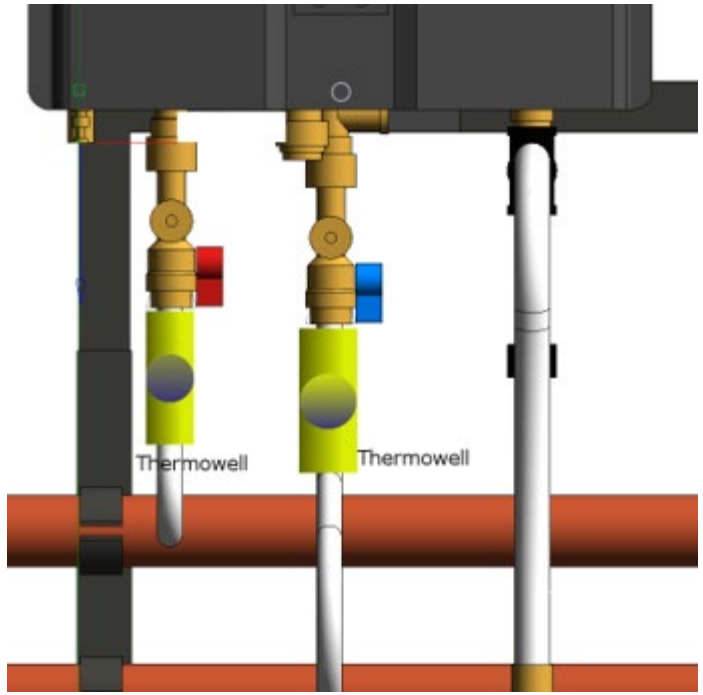
CCTWH Monitoring

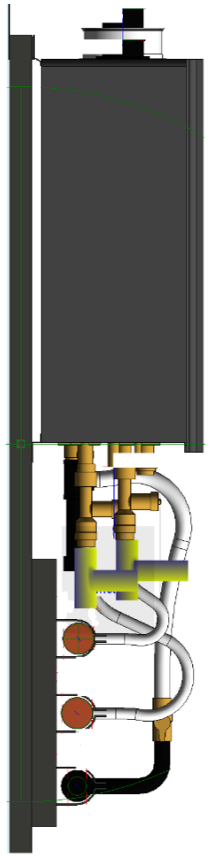


Racked Instrumentation

- RTD/TC for water
  - Each tankless inlet / outlet
  - Plumbed perpendicular Pete's plugs / thermowell, facing forward or out from rack
- TC for Flue Gas
  - ~6" from top of unit
  - ¼" NPT threaded port with 0.125" compression fitting.
- Gas Meter AC-250
  - Hard-piped, if necessary, in MN
- Water Meter Badger M25
  - Hot water capable >120°F
  - 10 ID upstream and 5 ID downstream straight pipe, facing forward or out from rack
  - Mounted horizontally

Racked System Instrumentation

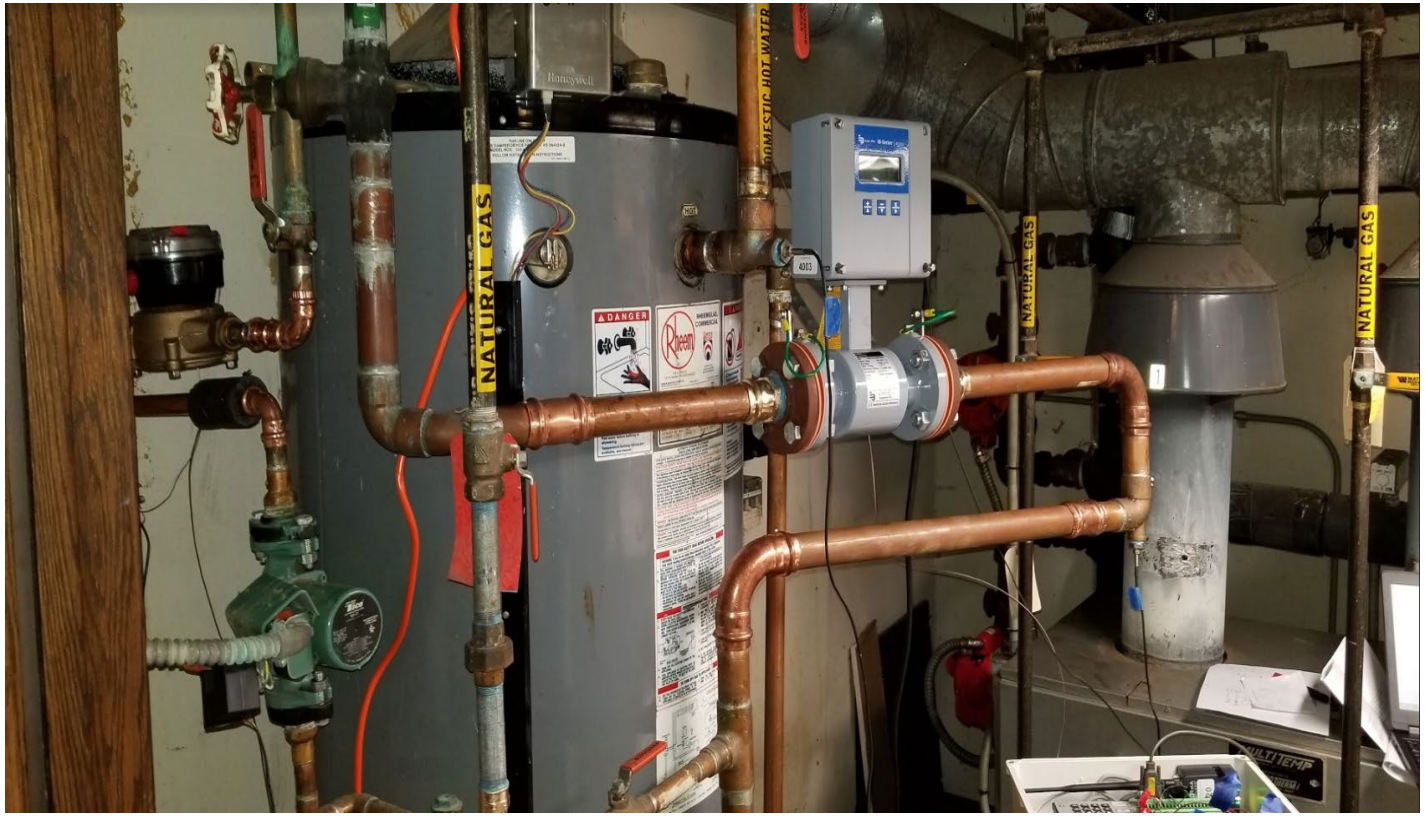




- Thermowells go here

Site 1

Site 2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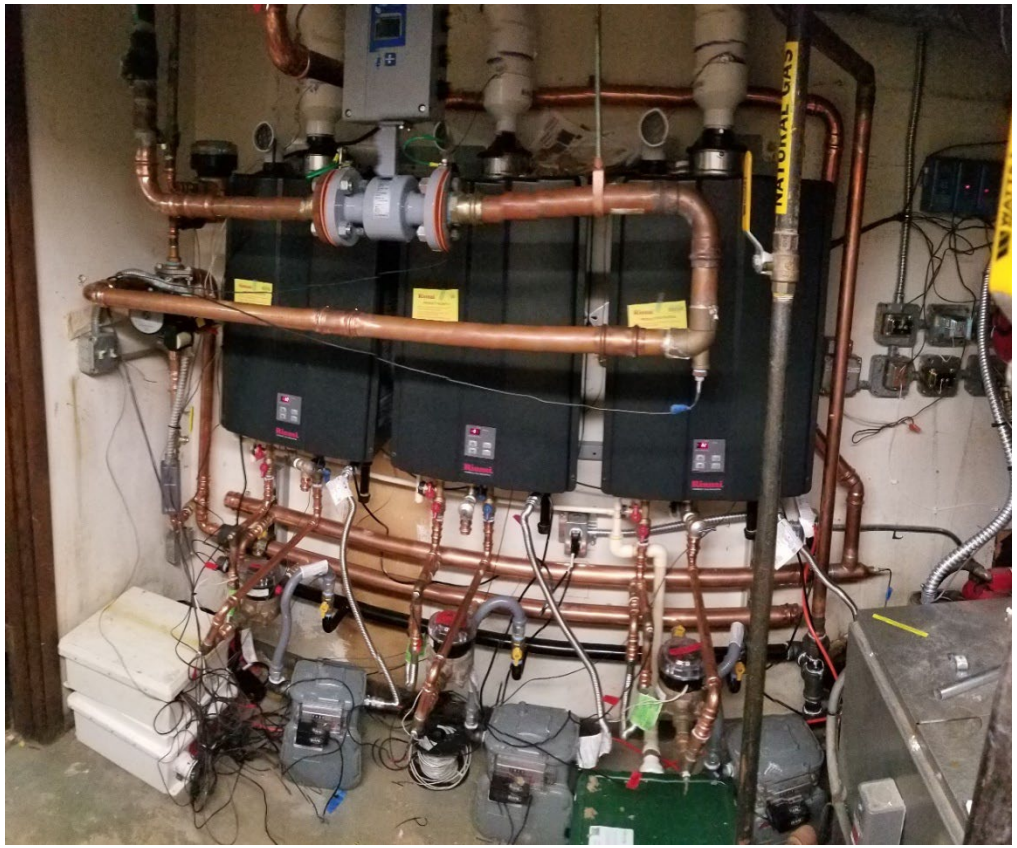
Rheem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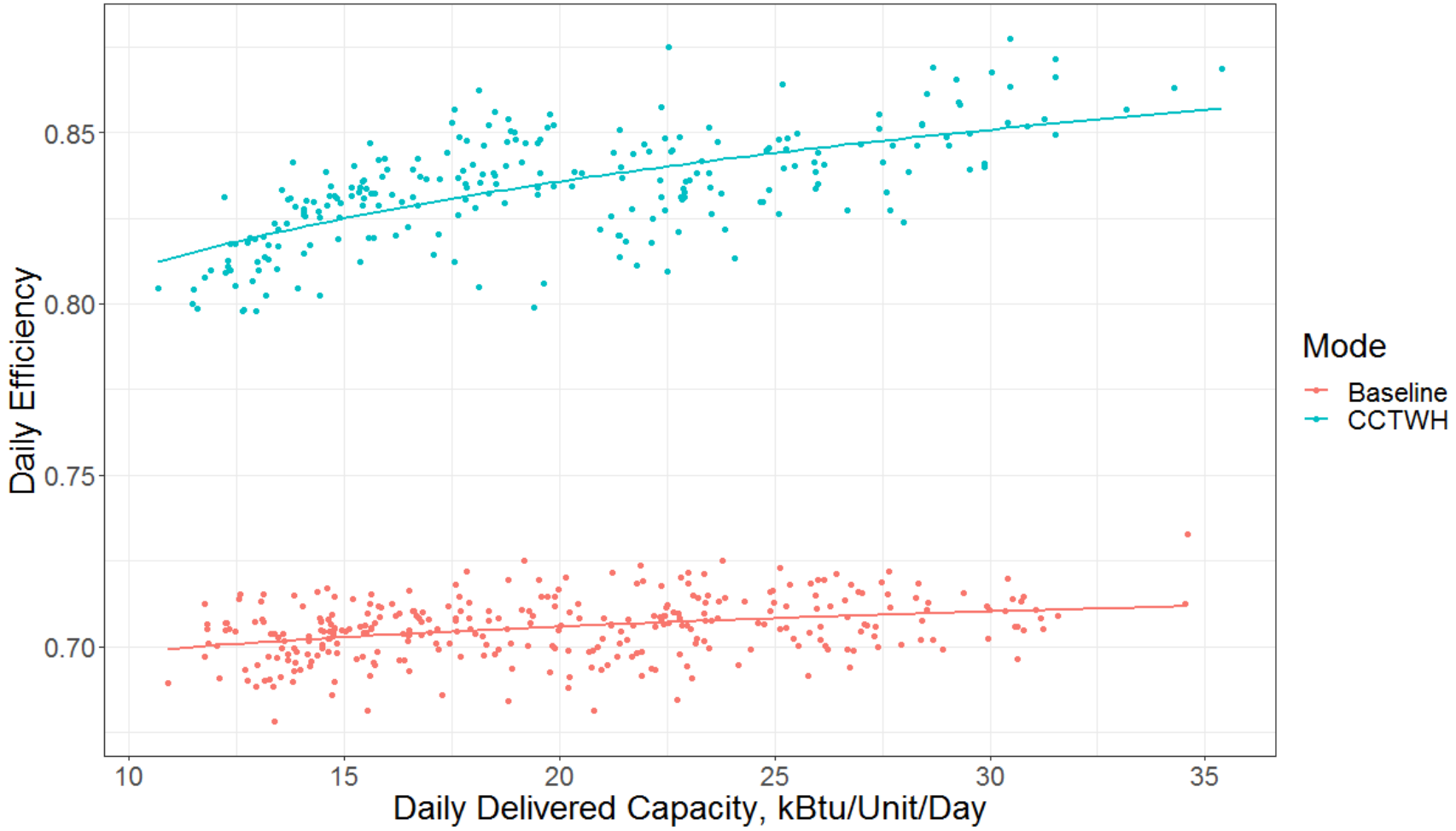
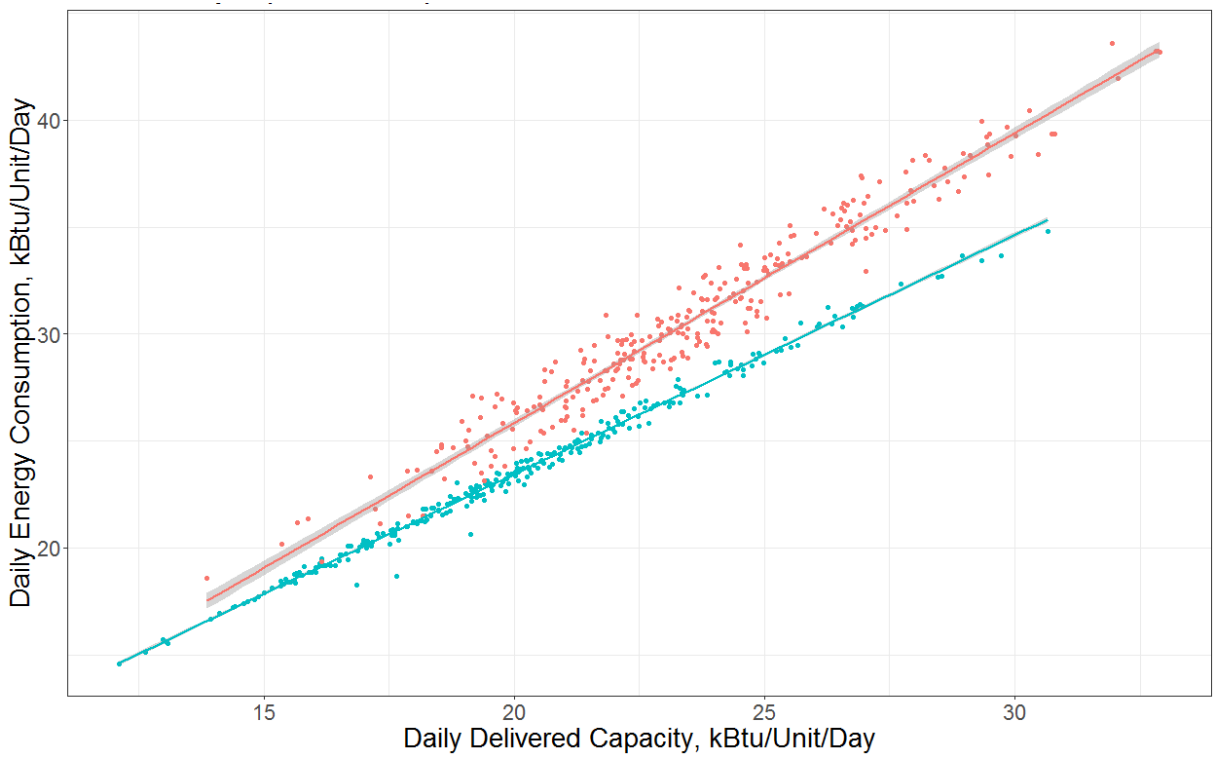
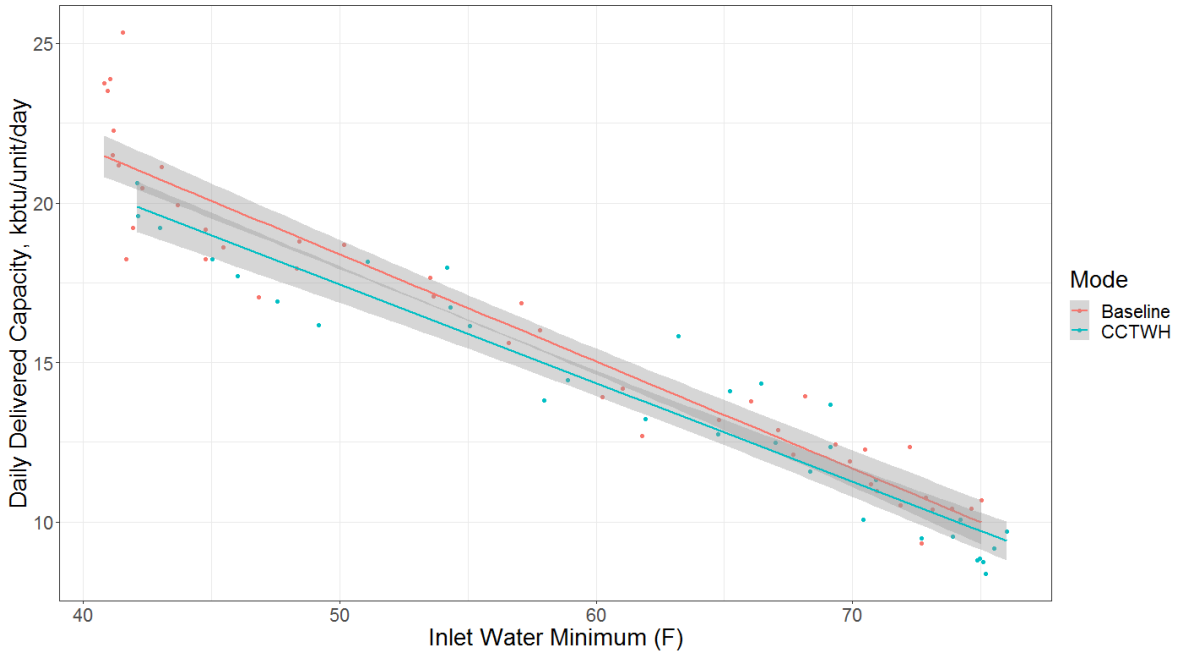
System Inlet Water Temperature Range

Efficiency Comparison



Analysis Method





Baseline vs. CCTWH – System

Testing period	Site	Q-out (kBtu/unit/day)	Q-in (kBtu/unit/day)	Efficiency	Annual Energy Use (Therms)	Energy Savings (Therms)	Percent Savings
Baseline	1	15.87	27.97	0.57	2348	—	—
	2	19.17	30.66	0.63	1903	—	—
CCTWH	1	15.14	25.82	0.59	2168	180	7.7%
	2	18.56	25.28	0.73	1569	334	18%

Baseline vs. CCTWH – Water Heater

Testing period	Site	Q-out (kBtu/unit/day)	Q-in (kBtu/unit/day)	Efficiency	Annual Energy Use (Therms)	Energy Savings (Therms)	Percent Savings
Baseline	1	19.71	28.02	0.70	2352	—	—
	2	23.58	30.69	0.77	1904	—	—
CCTWH	1	21.85	26.02	0.84	2184	168	7.2%
	2	21.52	25.14	0.86	1560	344	18.1%

Surveys

- Conducted interviews with building owners, occupants, and the contractor before and after CCTWH installation.
- Interviewees were asked about the following.
  - Comfort complaints (lack of hot water with each system)
  - Maintenance schedules
  - Overall impressions of each system
  - Importance of the CCTWH's non-energy benefits
  - Challenges and complexities of each system

Survey Results

Building Owners

- Main concern before installation was occupant complaints regarding lack of hot water.
- Energy savings, space savings, and redundancy were big factors in their decision.
- Overall were satisfied with the CCTWH's installation and performance.

Building Occupants

- No complaints were observed for lack of hot water during test period.

Survey Results

Contractors

- Had no experience with the CCTWH before the project.
- Potential issues were space constrictions and venting, both of which were easily addressed during the project.
- Came away with overall positive impressions of CCTWH.

CCTWH Assessment Tool

- Create a tool for use by a broad audience, including building owners, specifying engineers, contractors, and utilities to calculate costs and savings for multi-family units, hotels, schools, and universities.

CCTWH Assessment Tool

Building Description and Other Model Inputs

Building Type	Multifamily	*If "N/A" do not use*
# of dwelling units	80	*Number of Apartment or Hotel Units*
Avg bedrooms/dwelling unit	1	*Multifamily or Hospitality*
Estimated daily occupancy	200	*N/A*
Estimated Fixture Units	*240.0*	
OPTIONAL - Custom Fixture Units		link for resource, blank if unused
Hot Water Recirculation Efficiency	Default	
Recirculation Pump Size	0.33	hp
Apply Diversity Factor?	No	
Hot Water Characteristics		
Hot Water Usage Level	Default	
Thermostatic Temperature	140	F
Cold Water Mains Temperature	49.5	F ------>
Energy Prices		
	$ 0.67	per therm
	$ 0.10	per kWh

Typical Entering Cold Water Temperatures

	Min.	Avg.	Max.
7A - Int'l Falls, MN	34.7	43.9	53
6A - Rochester, MN	39.1	49.5	59.7
5A - Chicago, IL	44.7	54.1	63.5
4A - New York, NY	49.5	60.4	71.2
3A - Atlanta, GA	56.3	67.9	79.3
2A - Tampa, FL	68.7	85	77.3
1A - Miami, FL	80.3	82.9	85.4

Data from TMY3 - EnergyPlus

Outputs

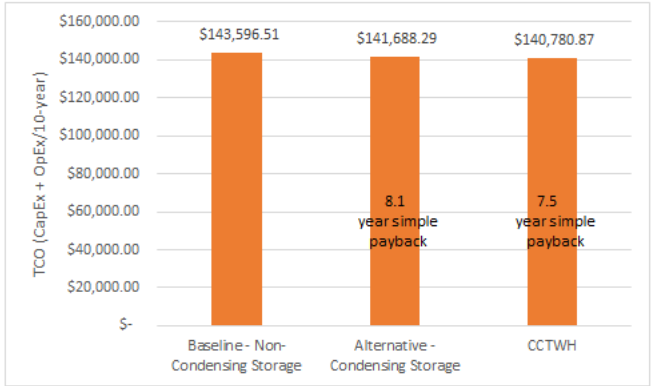
Hot Water Demand

Daily Draw	2268.3	Gal/day
Hot Water Energy Output	1.702	MMBtu/day
Design Output	1,738,201	Btu/hr

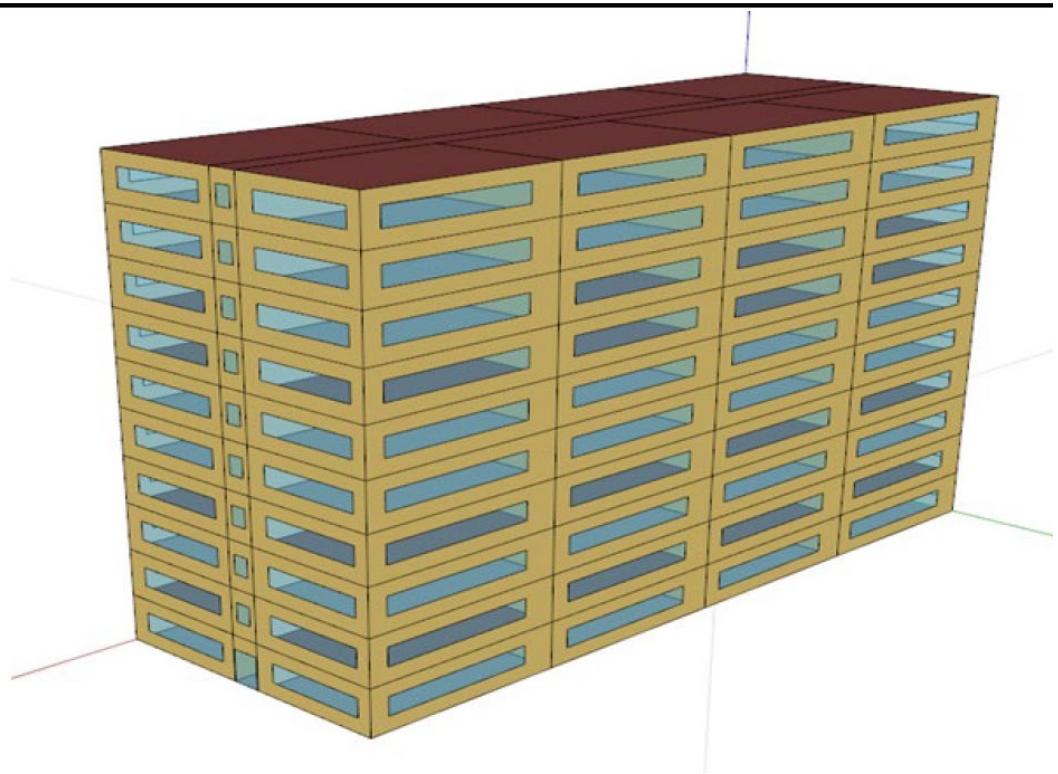
System Performance

			Annual Operating Costs
Baseline - Non-Condensing Storage	4.962	MMBtu gas/day	$ 12,349.34
Alternative - Condensing Storage	4.560	MMBtu gas/day	$ 11,366.61
CCTWH	4.492	MMBtu gas/day	$ 11,201.34
Recirculation Pump	5.91	kWh/day	

System Cost	Equipment Cost	10 year TCO (Equip + OpEx)	Simple Payback
Baseline - Non-Condensing Storage	$ 20,103.11	$ 143,596.51	
Alternative - Condensing Storage	$ 28,022.21	$ 141,688.29	8.1
CCTWH	$ 28,767.50	$ 140,780.87	7.5



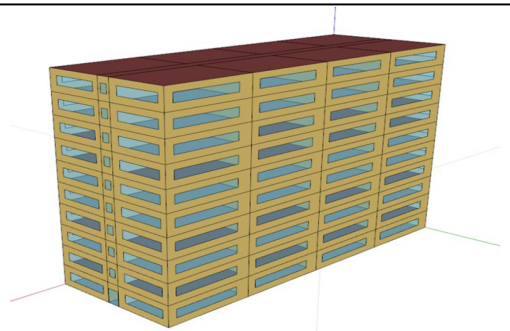
CCTWH Assessment Tool-Prototype Building Apartment Highrise



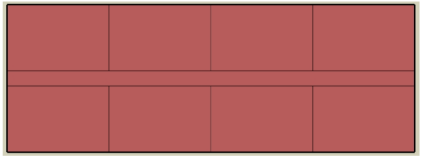
80 units-10 floors x 8 units per floor
950 sq ft per unit

Prototype Building Modeling Specifications

Pacific Northwest National Laboratory, updated on October 18, 2018

	Item	Descriptions			Data Source
Program					
	Vintage	NEW CONSTRUCTION			
	Location (Representing 8 Climate Zones)	Zone 1A: Honolulu, Hawaii (very hot, humid) Zone 1B: New Delhi, India (very hot, dry) Zone 2A: Tampa, Florida (hot, humid) Zone 2B: Tucson, Arizona (hot, dry) Zone 3A: Atlanta, Georgia (warm, humid) Zone 3B: El Paso, Texas (warm, dry) Zone 3C: San Diego, California (warm, marine)	Zone 4A: New York, New York (mixed, humid) Zone 4B: Albuquerque, New Mexico (mixed, dry) Zone 4C: Seattle, Washington (mixed, marine) Zone 5A: Buffalo, NY (cool, humid) Zone 5B: Denver, Colorado (cool, dry) Zone 5C: Port Angeles, Washington (cool, marine)	Zone 6A: Rochester, Minnesota (cold, humid) Zone 6B: Great Falls, Montana (cold, dry) Zone 7: International Falls, Minnesota (very cold) Zone 8: Fairbanks, Alaska (subarctic	Selection of representative climates based on ASHRAE Standard 169-2013
	Available fuel types	Gas, electricity			
	Building Type (Principal Building	**Multifamily**			
	Building Prototype	**High-Rise Apartment**			
Form					
	Total Floor Area (sq feet)	84,360 (152 ft x 55.5 ft)			*Reference: PNNL-16770: Analysis of Energy Saving Impacts of ASHRAE 90.1-2004 for the State of New York*
	Building shape				
	Aspect Ratio	2.75			
	Number of Floors	10			90.1 Envelope Subcommittee
	Window Fraction (Window-to-Wall Ratio)	South: 30%, east: 30%, north: 30%, west: 30% average total: 30%			Reference: Based on feedback from ASHRAE 90.1 SSPC established the Simulation Working Group
	Window Locations	See image			
	Shading Geometry	None			
	Azimuth	Non-directional			

CCTWH Assessment Tool-Prototype Building Apartment Highrise-Architecture

Thermal Zoning	Each floor has 8 apartments except ground floor (7 apartments and 1 office with equivalent apartment area) Total 8 apartments per floor with corridor in center. Zone depth is 25 ft for each apartment from side walls and each apt is 25' x 38' (950 ft²). 
Floor to floor height (ft)	10
Floor to ceiling height (ft)	10 (No drop-in ceiling plenum is modeled)
Glazing sill height (ft)	3 ft (4 ft high windows)

Architecture

Exterior walls	
Construction	Steel-frame walls (2X4 16 in o.c.) 0.4 in. stucco+5/8 in. gypsum board + wall Insulation+5/8 in. gypsum board
U-factor (Btu / h * ft^2 * °F) and/or R-value (h * ft^2 * °F / Btu)	Requirements in codes or standards
Dimensions	Based on floor area and aspect ratio
Tilts and orientations	Vertical
Roof	
Construction	Built-up roof: roof membrane+roof insulation+metal decking
U-factor (Btu / h * ft^2 * °F) and/or R-value (h * ft^2 * °F / Btu)	Requirements in codes or standards Residential; roofs, insulation entirely above deck
Dimensions	Based on floor area and aspect ratio
Tilts and orientations	Horizontal
Window	
Dimensions	Based on window fraction, location, glazing sill height, floor area and aspect ratio
Glass-Type and frame	Hypothetical window with a weighted U-factor and SHGC
U-factor (Btu / h * ft^2 * °F) SHGC (all)	Requirements in codes or standards Residential; vertical glazing
Visible transmittance	Same as above requirements
Operable area	100%

U-factor (Btu / h * ft^2 * °F) SHGC (all) Visible transmittance	NA
Foundation	
Foundation Type	Slab-on-grade floors (unheated)
Construction	8" concrete slab poured directly on to the earth
Slab on grade floor insulation Level	Requirements in codes or standards
Dimensions	Based on floor area and aspect ratio
Interior Partitions	
Construction	2 x 4 uninsulated stud wall
Dimensions	Based on floor plan and floor-to-floor height
Internal Mass	8 lbs/ft^2 of floor area
Air Barrier System	
Infiltration	Peak infiltration: 0.2016 cfm/sf of above grade exterior wall surface area, adjusted by wind Additional infiltration through building entrance

CCTWH Assessment Tool-Prototype Building Apartment Highrise-HVAC

HVAC		
	System Type	
	Heating type	Water source heat pumps
	Cooling type	
	Distribution and terminal units	Constant volume
	HVAC Sizing	
	Air Conditioning	Autosized to design day
	Heating	Autosized to design day
	HVAC Efficiency	
	Air Conditioning	Requirements in codes or standards
	Heating	Minimum equipment efficiency for electrically operated unitary and applied heat pumps
	HVAC Control	
	Thermostat Setpoint	75°F Cooling/70°F Heating
	Thermostat Setback	No setback for apartments
	Supply air temperature	
	Economizers	Requirements in codes or standards
	Ventilation	ASHRAE Standard 62.1 or International Mechanical Code See under **Outdoor Air**
	Demand Control Ventilation	Requirements in codes or standards
	Energy Recovery	Requirements in codes or standards
	Supply Fan	
	Fan schedules	See under **Schedules**
	Supply Fan Total Efficiency (%)	Depending on the fan motor size and requirements in codes or standards
	Supply Fan Pressure Drop	Depending on the fan supply air cfm
	Service Water Heating	
	SWH type	Central water heater with storage tank
	Fuel type	Natural gas
	Thermal efficiency (%)	Requirements in codes or standards
	Tank Volume (gal)	600 (central)
	Water temperature setpoint	140 F
	Water consumption	See under **Schedules**

CCTWH Assessment Tool-Prototype Building Apartment Highrise-Zone Summary

Zone Summary

Zone[1]	Area (ft²)	Conditioned (Y/N)	Volume (ft³)	Multipliers	Gross Wall Area (ft²)	Window Glass Area (ft²)	Lighting[4] (W/ft²)	People (ft²/person)	Number of People	Plug and Process (W/ft²)
G SW APARTMENT	950	Yes	9,499	1	630	189	1.34	380	2.5	0.62
G NW APARTMENT	950	Yes	9,499	1	630	189	1.34	380	2.5	0.62
OFFICE	950	Yes	9,499	1	630	189	1.10	950	1	0.62
G NE APARTMENT	950	Yes	9,499	1	630	189	1.34	380	2.5	0.62
G N1 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
G N2 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
G S1 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
G S2 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
M SW APARTMENT	950	Yes	9,499	8	630	189	1.34	380	2.5	0.62
M NW APARTMENT	950	Yes	9,499	8	630	189	1.34	380	2.5	0.62
M SE APARTMENT	950	Yes	9,499	8	630	189	1.34	380	2.5	0.62
M NE APARTMENT	950	Yes	9,499	8	630	189	1.34	380	2.5	0.62
M N1 APARTMENT	950	Yes	9,499	8	380	114	1.34	380	2.5	0.62
M N2 APARTMENT	950	Yes	9,499	8	380	114	1.34	380	2.5	0.62
M S1 APARTMENT	950	Yes	9,499	8	380	114	1.34	380	2.5	0.62
M S2 APARTMENT	950	Yes	9,499	8	380	114	1.34	380	2.5	0.62
T SW APARTMENT	950	Yes	9,499	1	630	189	1.34	380	2.5	0.62
T NW APARTMENT	950	Yes	9,499	1	630	189	1.34	380	2.5	0.62
T SE APARTMENT	950	Yes	9,499	1	630	189	1.34	380	2.5	0.62
T NE APARTMENT	950	Yes	9,499	1	630	189	1.34	380	2.5	0.62
T N1 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
T N2 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
T S1 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
T S2 APARTMENT	950	Yes	9,499	1	380	114	1.34	380	2.5	0.62
T CORRIDOR[2]	836	No	8,359	1	110	24	0.55	0	0	24.56
G CORRIDOR	836	No	8,359	1	110	24	0.55	0	0	0
M CORRIDOR	836	No	8,359	8	110	24	0.55	0	0	0
TOTAL[3]	**84,360**		**843,481**		**41,495**	**12,360**			**199**	
AREA WEIGHTED AVERAGE							**1.26**	**348.73**		**0.80**

1. Each apartment zone contains one apartment with one bedroom, living room and bathroom.
2. Elevator load is added in the top floor corridor zone.
3. Only volume, and gross wall area include unconditioned space.
4. Listed lighting power density is based on applicable requirements in ASHRAE Standard 90.1-2004. The actual inputs for the models are based on appliable codes and standards

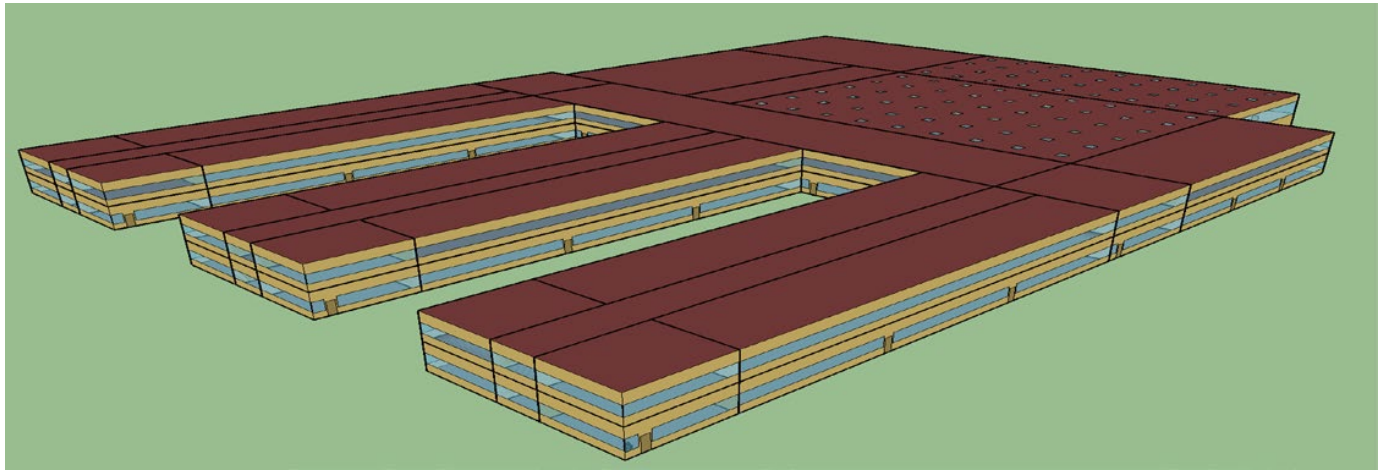
CCTWH Assessment Tool-Prototype Building Apartment Highrise-Minimum Outdoor Ventilation

Minimum Outdoor Ventilation Air Requirements

Zone	Area (ft^2)	Multipliers	Assumed Space Type	Total Occupants	Total OSA Ventilation (cfm/zone)			Total OSA Ventilation (cfm/ft2)		
				62.1-2004	90.1-2004 (62-1999)	90.1-2007 (62.1-2004)	90.1-2010 (62.1-2007)	90.1-2004 (62-1999)	90.1-2007 (62.1-2004)	90.1-2010 (62.1-2007)
G SW APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
G NW APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
OFFICE	950.0	1	Office space	5	95	81	81	0.10	0.09	0.09
G NE APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
G N1 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
G N2 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
G S1 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
G S2 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M SW APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M NW APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M SE APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M NE APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M N1 APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M N2 APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M S1 APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
M S2 APARTMENT	950.0	8	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T SW APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T NW APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T SE APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T NE APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T N1 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T N2 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T S1 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T S2 APARTMENT	950.0	1	Residential single bedroom apartment	2	55	55	55	0.06	0.06	0.06
T CORRIDOR	836.0	1	Corridors (public spaces)	0	42	50	50	0.05	0.06	0.06
G CORRIDOR	836.0	1	Corridors (public spaces)	0	42	50	50	0.05	0.06	0.06
M CORRIDOR	836.0	8	Corridors (public spaces)	0	42	50	50	0.05	0.06	0.06
TOTAL	**84,360**			**163**	**4,858**	**4,927**	**4,927**	**5.17**	**5.26**	**5.26**

1. Each apartment zone contains one apartment with one bedroom, living room and bathroom.
2. The ventilation requirements for other codes or standards are based on their reference ASHRAE Standard 62.1 or International Mechanical Code

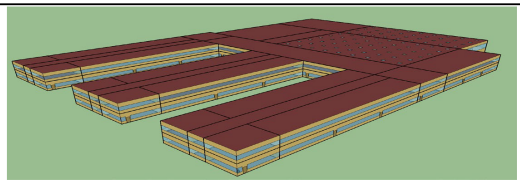
CCTWH Assessment Tool-Prototype Building School Secondary



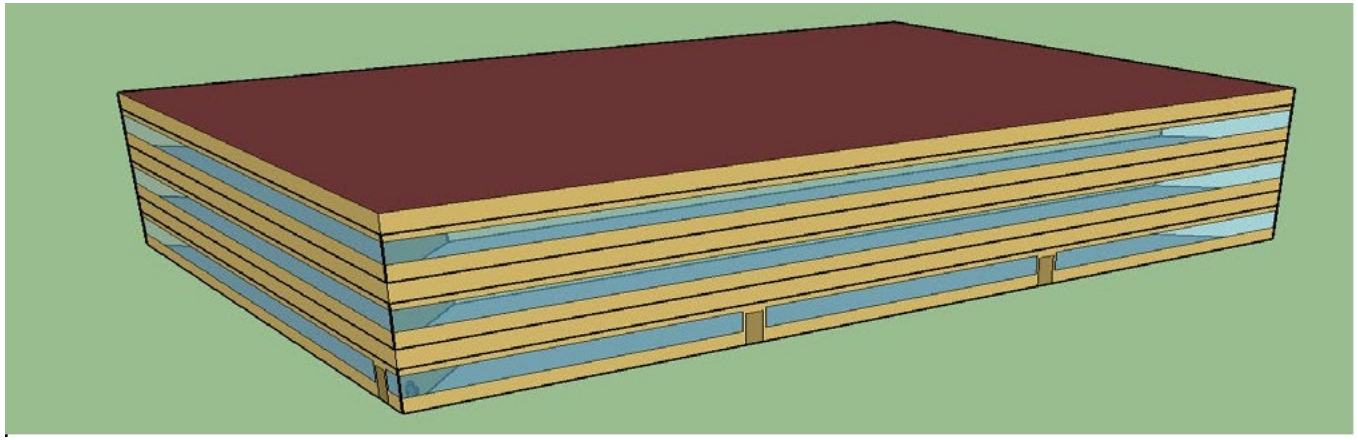
210,900 sqft – 2 floors
6,096 students

Prototype Building Modeling Specifications

Pacific Northwest National Laboratory, updated on October 18, 2018

	Item	Descriptions		
Program				
	Vintage	NEW CONSTRUCTION		
	Location (Representing 8 Climate Zones)	Zone 1A: Honolulu, Hawaii (very hot, humid) Zone 1B: New Delhi, India (very hot, dry) Zone 2A: Tampa, Florida (hot, humid) Zone 2B: Tucson, Arizona (hot, dry) Zone 3A: Atlanta, Georgia (warm, humid) Zone 3B: El Paso, Texas (warm, dry) Zone 3C: San Diego, California (warm, marine)	Zone 4A: New York, New York (mixed, humid) Zone 4B: Albuquerque, New Mexico (mixed, dry) Zone 4C: Seattle, Washington (mixed, marine) Zone 5A: Buffalo, NY (cool, humid) Zone 5B: Denver, Colorado (cool, dry) Zone 5C: Port Angeles, Washington (cool, marine)	Zone 6A: Rochester, Minnesota (cold, humid) Zone 6B: Great Falls, Montana (cold, dry) Zone 7: International Falls, Minnesota (very cold) Zone 8: Fairbanks, Alaska (subarctic
	Available fuel types	Gas, electricity		
	Building Type (Principal Building	**Education**		
	Building Prototype	**Secondary School**		
Form				
	Total Floor Area (sq feet)	210,900 (340 ft x 460 ft)		
	Building shape			
	Aspect Ratio	1.4		
	Number of Floors	2		
	Window Fraction (Window-to-Wall Ratio)	33% Ribbon window across all facades on both floors		
	Window Locations	Continuous Band		
	Shading Geometry	None		
	Azimuth	Non-directional		

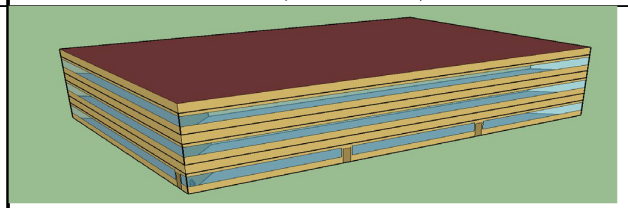
CCTWH Assessment Tool-Prototype Building Office Medium



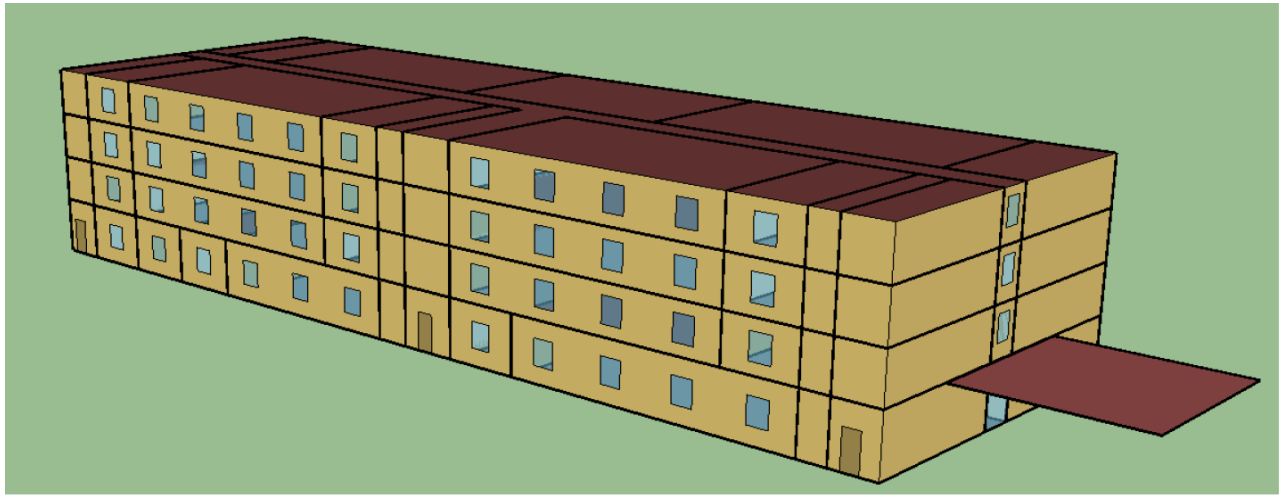
53,600 sqft – 3 floors
268 people

Prototype Building Modeling Specifications

Pacific Northwest National Laboratory, updated on October 18, 2018

	Item	Descriptions		
Program				
	Vintage	NEW CONSTRUCTION		
	Location (Representing 8 Climate Zones)	Zone 1A: Honolulu, Hawaii (very hot, humid) Zone 1B: New Delhi, India (very hot, dry) Zone 2A: Tampa, Florida (hot, humid) Zone 2B: Tucson, Arizona (hot, dry) Zone 3A: Atlanta, Georgia (warm, humid) Zone 3B: El Paso, Texas (warm, dry) Zone 3C: San Diego, California (warm, marine)	Zone 4A: New York, New York (mixed, humid) Zone 4B: Albuquerque, New Mexico (mixed, dry) Zone 4C: Seattle, Washington (mixed, marine) Zone 5A: Buffalo, NY (cool, humid) Zone 5B: Denver, Colorado (cool, dry) Zone 5C: Port Angeles, Washington (cool, marine)	Zone 6A: Rochester, Minnesota (cold, humid) Zone 6B: Great Falls, Montana (cold, dry) Zone 7: International Falls, Minnesota (very cold) Zone 8: Fairbanks, Alaska (subarctic
	Available fuel types	Gas, electricity		
	Building Type (Principal Building	**Office**		
	Building Prototype	**Medium Office**		
Form				
	Total Floor Area (sq feet)	53,600 (163.8 ft x 109.2 ft)		
	Building shape			
	Aspect Ratio	1.5		
	Number of Floors	3		

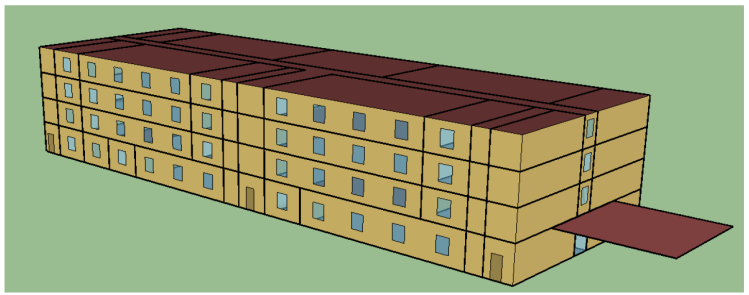
CCTWH Assessment Tool-Prototype Building Hotel Small



43,200 sqft – 4 floors
6,096 students

Prototype Building Modeling Specifications

Pacific Northwest National Laboratory, updated on October 18, 2018

Item	Descriptions		
Program			
Vintage	**NEW CONSTRUCTION**		
Location (Representing 8 Climate Zones)	Zone 1A: Honolulu, Hawaii (very hot, humid) Zone 1B: New Delhi, India (very hot, dry) Zone 2A: Tampa, Florida (hot, humid) Zone 2B: Tucson, Arizona (hot, dry) Zone 3A: Atlanta, Georgia (warm, humid) Zone 3B: El Paso, Texas (warm, dry) Zone 3C: San Diego, California (warm, marine)	Zone 4A: New York, New York (mixed, humid) Zone 4B: Albuquerque, New Mexico (mixed, dry) Zone 4C: Seattle, Washington (mixed, marine) Zone 5A: Buffalo, NY (cool, humid) Zone 5B: Denver, Colorado (cool, dry) Zone 5C: Port Angeles, Washington (cool, marine)	Zone 6A: Rochester, Minnesota (cold, humid) Zone 6B: Great Falls, Montana (cold, dry) Zone 7: International Falls, Minnesota (very cold) Zone 8: Fairbanks, Alaska (subarctic
Available fuel types	Gas, electricity		
Building Type (Principal Building	**Lodging**		
Building Prototype	**Small Hotel**		
Form			
Total Floor Area (sq feet)	43200 (180 ft x 60 ft)		
Building shape			
Aspect Ratio	3		
Number of Floors	4		

CCTWH Assessment Tool - Outputs Apartment Highrise

Building Description and Other Model Inputs

Building Type	Multifamily	*If "N/A" do not use*
# of dwelling units	80	*Number of Apartment or Hotel Units*
Avg bedrooms/dwelling unit	1	*Multifamily or Hospitality*
Estimated daily occupancy	200	*N/A*
Estimated Fixture Units	*240.0*	
OPTIONAL - Custom Fixture Units		link for resource, blank if unused
Hot Water Recirculation Efficiency	Default	
Recirculation Pump Size	0.33	hp
Apply Diversity Factor?	No	
Hot Water Characteristics		
Hot Water Usage Level	Default	
Thermostatic Temperature	140	F
Cold Water Mains Temperature	49.5	F ------>
Energy Prices		
	$ 0.67	per therm
	$ 0.10	per kWh

Typical Entering Cold Water Temperatures

	Min.	Avg.	Max.
7A - Int'l Falls, MN	34.7	43.9	53
6A - Rochester, MN	39.1	49.5	59.7
5A - Chicago, IL	44.7	54.1	63.5
4A - New York, NY	49.5	60.4	71.2
3A - Atlanta, GA	56.3	67.9	79.3
2A - Tampa, FL	68.7	85	77.3
1A - Miami, FL	80.3	82.9	85.4

Data from TMY3 - EnergyPlus

Outputs

Hot Water Demand

Daily Draw	2268.3	Gal/day
Hot Water Energy Output	1.702	MMBtu/day
Design Output	1,738,201	Btu/hr

System Performance

			Annual Operating Costs
Baseline - Non-Condensing Storage	4.962	MMBtu gas/day	$ 12,349.34
Alternative - Condensing Storage	4.560	MMBtu gas/day	$ 11,366.61
CCTWH	4.492	MMBtu gas/day	$ 11,201.34
Recirculation Pump	5.91	kWh/day	

System Cost	Equipment Cost	10 year TCO (Equip + OpEx)	Simple Payback
Baseline - Non-Condensing Storage	$ 20,103.11	$ 143,596.51	
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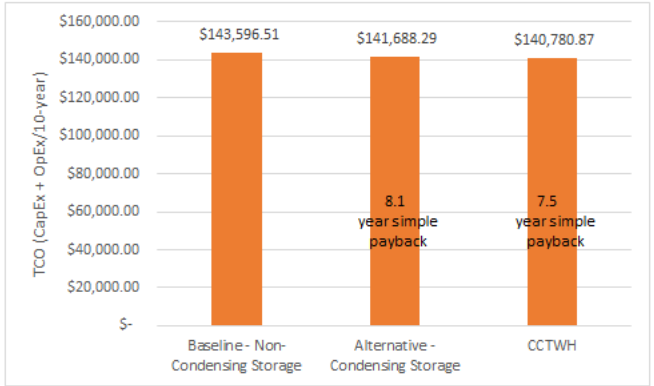


CCTWH Assessment Tool-Outputs
School Secondary

Building Description and Other Model Inputs

Building Type	School	*If "N/A" do not use*
# of dwelling units	200	*N/A*
Avg bedrooms/dwelling unit	1	*N/A*
Estimated daily occupancy	6100	*Students or Office Workers*
Estimated Fixture Units	*2013.0*	
OPTIONAL - Custom Fixture Units		link for resource, blank if unused
Hot Water Recirculation Efficiency	Default	
Recirculation Pump Size	0.33	hp
Apply Diversity Factor?	No	
Hot Water Characteristics		
Hot Water Usage Level	Default	
Thermostatic Temperature	140	F
Cold Water Mains Temperature	49.5	F ------>
Energy Prices		
	$ 0.67	per therm
	$ 0.10	per kWh

Typical Entering Cold Water Temperatures

	Min.	Avg.	Max.
7A - Int'l Falls, MN	34.7	43.9	53
6A - Rochester, MN	39.1	49.5	59.7
5A - Chicago, IL	44.7	54.1	63.5
4A - New York, NY	49.5	60.4	71.2
3A - Atlanta, GA	56.3	67.9	79.3
2A - Tampa, FL	68.7	85	77.3
1A - Miami, FL	80.3	82.9	85.4

Data from TMY3 - EnergyPlus

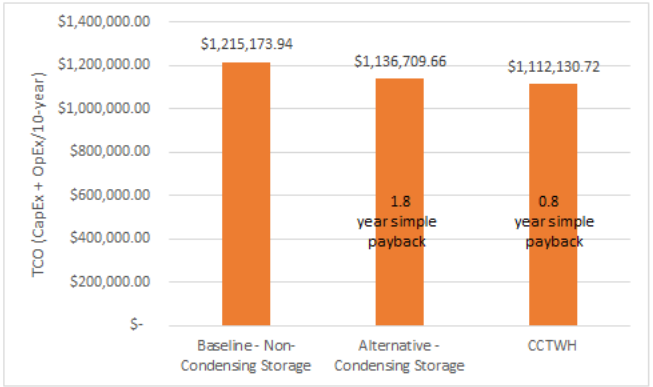
Outputs

Hot Water Demand

Daily Draw	21960.0	Gal/day
Hot Water Energy Output	16.475	MMBtu/day
Design Output	3,171,230	Btu/hr

System Performance			Annual Operating Costs
Baseline - Non-Condensing Storage	47.984	MMBtu gas/day	$ 117,560.94
Alternative - Condensing Storage	44.080	MMBtu gas/day	$ 108,012.44
CCTWH	43.389	MMBtu gas/day	$ 106,322.60
Recirculation Pump	5.91	kWh/day	

System Cost	Equipment Cost	10 year TCO (Equip + OpEx)	Simple Payback
Baseline - Non-Condensing Storage	$ 39,564.56	$ 1,215,173.94	
Alternative - Condensing Storage	$ 56,585.28	$ 1,136,709.66	1.8
CCTWH	$ 48,904.75	$ 1,112,130.72	0.8



CCTWH Assessment Tool-Outputs
Office Medium

Building Description and Other Model Inputs

Building Type	Offices	*If "N/A" do not use*
# of dwelling units	270	*N/A*
Avg bedrooms/dwelling unit	1	*N/A*
Estimated daily occupancy	270	*Students or Office Workers*
Estimated Fixture Units	*40.5*	
OPTIONAL - Custom Fixture Units		link for resource, blank if unused
Hot Water Recirculation Efficiency	Default	
Recirculation Pump Size	0.33	hp
Apply Diversity Factor?	No	
Hot Water Characteristics		
Hot Water Usage Level	Default	
Thermostatic Temperature	140	F
Cold Water Mains Temperature	49.5	F ------>
Energy Prices		
	$ 0.67	per therm
	$ 0.10	per kWh

Typical Entering Cold Water Temperatures

	Min.	Avg.	Max.
7A - Int'l Falls, MN	34.7	43.9	53
6A - Rochester, MN	39.1	49.5	59.7
5A - Chicago, IL	44.7	54.1	63.5
4A - New York, NY	49.5	60.4	71.2
3A - Atlanta, GA	56.3	67.9	79.3
2A - Tampa, FL	68.7	85	77.3
1A - Miami, FL	80.3	82.9	85.4

Data from TMY3 - EnergyPlus

Outputs

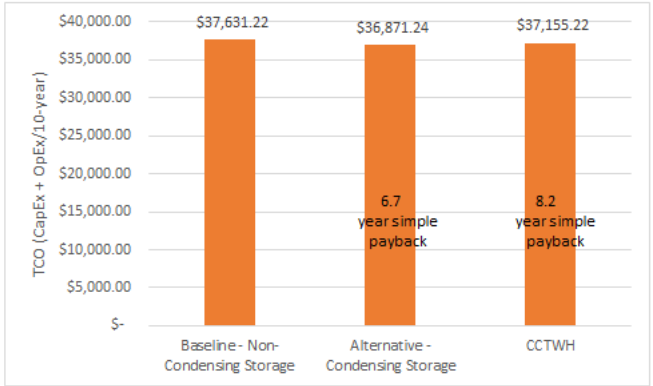
Hot Water Demand

Daily Draw	540.0	Gal/day
Hot Water Energy Output	0.405	MMBtu/day
Design Output	484,080	Btu/hr

System Performance

			Annual Operating Costs
Baseline - Non-Condensing Storage	1.186	MMBtu gas/day	$ 3,114.87
Alternative - Condensing Storage	1.091	MMBtu gas/day	$ 2,883.96
CCTWH	1.078	MMBtu gas/day	$ 2,852.50
Recirculation Pump	5.91	kWh/day	

System Cost	Equipment Cost	10 year TCO (Equip + OpEx)	Simple Payback
Baseline - Non-Condensing Storage	$ 6,482.55	$ 37,631.22	
Alternative - Condensing Storage	$ 8,031.68	$ 36,871.24	6.7
CCTWH	$ 8,630.25	$ 37,155.22	8.2



Conclusions

- The comparison of the systems at the two sites during the twenty-two-month field test period found that CCTWHs systems can be successfully installed and operated in multi-unit applications in Northern Midwest climates.
    - CCTWHs provided this energy savings with no significant change in hot water delivery.
- The CCTWH systems can save energy over tanked storage systems. CCTWHs saved an average of 12.7% of site energy consumed for water heating, 18.1% at the first site and 7.2% at the second site. The annual energy savings were 344 and 168 therms per building, respectively.
- The system efficiencies, which included the recirculation loop, for the first site were 0.57 in baseline and 0.59 in CCTWH mode, while the second site's efficiencies were 0.63 in baseline and 0.73 in CCTWH mode.
- The measured water heaters efficiencies were lower than rated efficiencies, as rated efficiencies are rarely seen in practice. The efficiency of the CCTWH at the first site was 0.84 compared to 0.70 for baseline. The efficiency for the CCTWH at the second site was 0.86 compared to 0.77 for baseline.

Conclusions

- The CCTWH results were compared to the existing baseline equipment and findings were extrapolated to other building types and loading patterns. Since the energy savings from the CCTWH are influenced by installed conditions and building type, a sizing and assessment tool was developed and applied to multifamily housing, hospitality, and schools.
    - The energy and cost outputs from the tool were compared for different building types, and it was found, in general, that paybacks were shortest in scenarios where usage is highest. The modelling showed that mid-rise multi-unit family, secondary schools, and large offices benefit by their high demand.
- By applying the Assessment Tool model, it was found that replacing a baseline tank system with a CCTWH in a 32 multi-unit family building could save 720 therms annually. However, by upgrading the recirculation loop, and by adding demand control to the recirculation loop the savings was 2,020 therms annually over the baseline system.

Recommendations

- Initial cost will be a significant hurdle for many properties. Rebates can help address this barrier, but further market transformation and increased contractor familiarity will be necessary to fully eliminate this barrier.
  - New construction offers an opportunity to lower incremental cost of racked systems. A considerable portion of the cost in the two retrofit applications was used to remove the existing equipment and modify the existing plumbing and mechanical spaces to fit the new water heater type. These costs would be avoided in new construction.
- Paybacks are shortest in scenarios where usage is highest. The modelling showed that mid-rise multi-unit family, secondary schools, and large offices benefit by their high demand.
- In residential applications of instantaneous water heating systems, non-energy benefits helped grow the market, such as
  - Reduced footprint of a residential tankless system was a frequently cited reason for increased market share.
  - Smaller footprint would benefit both new construction and retrofit applications by fitting into mechanical spaces that are typically too small for tank systems.
  - Operation and maintenance, the control sequence that cycles through the racked units add life and reduce maintenance costs.

Questions?

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Thanks for Attending!