NY STATEWIDE CLEAN HEAT CALCULATOR HEAT RECOVERY CHILLERS (HRC) Version 1.0 USER GUIDE September 1, 2023

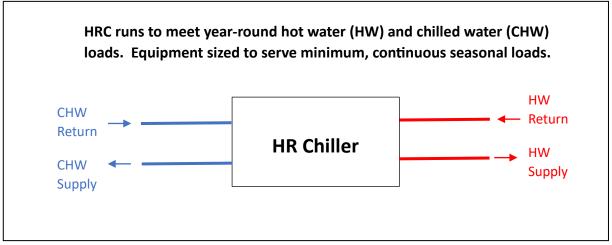
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Summary

The Statewide Clean Heat Program Heat Recovery Chiller (HRC) Savings Calculator (Clean Heat HRC Calculator) is an excel based tool that is being developed to assist participating contractors applying to the New York State Clean Heat Program (Clean Heat Program) with calculating custom energy savings for the following heat recovery chiller technologies:

Heat Recovery Chiller (HRC) – chiller operating in mode where heat is moved between HW and CHW loops within the thermal envelope in buildings requiring simultaneous cooling and heating. Unit provides heating and cooling at the same time. Note: exempt from minimum annual heating thresholds applicable to each program.



This initial version enables users to quantify savings for specific HRC applications **ONLY** as indicated below. It also allows users to get a rough estimate of the savings for projects in the early stages to get a feasibility check on pursuing the project further.

When to Use this Calculator:

The Clean Heat HRC Calculator should be used as the default method to calculate energy savings for the technologies mentioned above if one or more of the following statements are true:

- The project involves installing water-source HRCs that meet or exceed the applicable minimum efficiency requirements in Table 6.8.1-16 of ASHRAE 90.1 2022.
- The Operating Mode for the HRC is: Simultaneous Heating and Cooling.
- The project building or facility operating conditions allows for a <u>potential minimum of 6,000</u> <u>equivalent full load hours (EFLH) of the HRC.</u>
- For EFLH values lower than 8,760, the user has the option to enter the value manually.

In addition, the Version 1.0 Clean Heat HRC Calculator must be used for projects that have not yet received a **Preliminary Incentive Offer Letter** before September 1, 2023, superseding previously approved calculation results.

Revisions and Updates:

The following are the summary of updates from the last version of the Statewide Clean Heat HRC calculator:

Tab	Section	Summary of Revisions

Exceptions to Using Calculator:

Under certain circumstances, applicants may bypass this calculator, opting instead to calculate savings using their own custom approach, even when one of the above statements is true. Justifiable reasons for doing so include, but are not limited to:

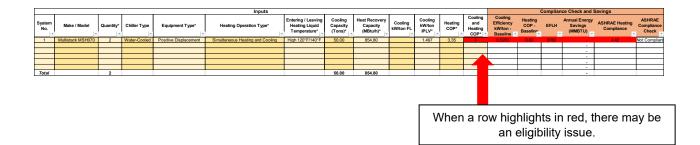
- The applicant has prepared a whole building energy model using one approved modeling software listed in the Clean Heat Program Guide.
- The project proposes installing an HRC/HPC technology that does not fall into one of the above applicable categories available in the clean heat calculator and no prescriptive TRM methodology is available for calculating savings.

All calculation approaches must use NYS ECC code minimum efficiencies and minimum efficiency requirements in Table 6.8.1-16 of ASHRAE 90.1 – 2022 for baseline HRC/HPC systems.

General

Users shall review the 'Project Information, and 'Equipment Information' tabs and input project-specific details where needed. Cells requiring user input are highlighted in <u>yello</u>w. Cells in white will auto-populate based on the inputs the user enters. Red cells indicate there may be an issue with project or equipment eligibility. Users can fill in the costs and related data in the 'Results Summary **Fab**'





Tabs should be completed in the following order:

- 1. Project Information (Info) (highlighted cells only)
- 2. Equipment Information (highlighted cells only)
- 3. Results Summary (highlighted cells only)

Tab: Project Information SECTION 1: Building Characteristics	Yellow shaded cells indicate user input is required.
Project De	tails
Program Name	
Tool Generation Date	
Estimated Installation Date	
Utility Name*	Con Edison
Program Type*	Commercial and Industrial

- Program Name Clean Heat Program
- Tool Generation Date current date
- Estimated Installation Date enter projected installation date
- Utility Name chose from dropdown menu
- Program Type Commercial & Industrial (default)

SECTION 2: Building Characteristics

Building Characteristics						
Building Type	Office - Large					
Heating System Type	Steam Boiler					
Cooling System Type	Electric Chiller					
Heating Fuel Type	Gas					
Distribution System Type	VAV with Economizer					
Construction Type*	Existing Building - Retrofit					
Year of Construction/ Renovation	1995					
Gross Building Area Impacted by SOW (SF)	35,000					
Billing Data: Annual Cooling Energy Use (kWh)						
Billing Data: Annual Heating Energy Use (MMBtu)*	20,000					
Scope of Work*	Category 4 - Custom Full Load Space Heating Applications					

- Building Type Select the appropriate building type from the drop-down menu. Selection should correspond to the building type that the HRC will be serve. Building profiles have been derived from ASHRAE 90.1 Typical Occupancy Schedule and the New York State Technical Reference Manual Appendix A for several building types.
- Heating System Type Select current heating system utilized from the drop-down menu.
- Cooling System Type Select current cooling system utilized from the drop-down menu.
- Heating Fuel Type Select current fuel type utilized from the drop-down menu.
- Distribution System Type Not Applicable
- Construction Type Select from the following drop-down options depending on the project facility application:
 - 1) New Construction (not applicable)
 - 2) Existing Building -Retrofit
 - 3) Gut Renovation¹

¹Gut renovation is any renovation that removes material down to structural load-bearing beams.

• Year of Construction / Renovation

- Gross Building Area Impacted by SOW (SF) area (square feet) impacted by measure
- Billing Data –
- Annual Cooling Energy Use (kWh)
- Billing Data Annual Heating Energy Use (MMBtu)
- Scope of Work chose the Clean Heat Program Incentive Category applicable to the project:
 - Category 4 Custom Full Load Space Heating Applications
 - Category 4a Custom Full Load Space Heating Applications + Envelope
 - Category 6 Custom Hot Water Heating Applications
 - Category 10 C&I Custom Partial Load Space Heating Applications

SECTION 3: System Characteristics

System Characteristics						
Facility Type (Applicable to Existing Only)						
BCL (MBtu/h)						
BHL (MBtu/h)						
Minimum CHW Demand (MBtu/h)*	1,258					
Minimum Heating Demand (MBtu/h)*	6,824					
Annual Baseline Heating or Domestic Hot Water (DHW) (MMBtu)						
Annual Baseline CHW (MMBtu)						
Annual Equivalent Full Load Hours (EFLH)*	8,760					

- Facility Type (Applicable to Existing Only)
- BCL (MBtu/hr)
- BHL (MBtu/hr)
- Minimum CHW Demand (MBtu/hr) enter minimum historic, calculated or modeled chilled water load required for the space being conditioned by the measure.
- Minimum Heating / DHW Demand (MBtu/hr) enter minimum historic, calculated or modeled heating or domestic hot water loads required for the space being conditioned or serviced by the measure.
- Annual Baseline Heating / DHW (MMBtu) enter the annual historic, calculated or modeled heating or domestic hot water consumption required for the space being conditioned or serviced by the measure.
- Annual Baseline CHW (MMBtu) enter annual historic, calculated or modeled chilled water load required for the space being conditioned by the measure.
- Annual Equivalent Full Load Operating Hours (EFLH) enter the calculated or proposed EFLH. If equipment capacity is less than minimum CHW and heating/DHW demand – 8,760 EFLH is the default.

SECTION 4: Account Holder Information

Account Holder Information							
Account Name							
Account Number (15 Digits)							
Title							
Mailing Address							
Unit Number							
City							
Zip							
Contact Person							
Phone							
Email							

• Please complete all fields highlighted in yellow prior to submittal for review.

SECTION 5: Contractor Information

Contractor Information							
Installation Completed By							
Company Name							
Contact Name							
Title							
Tax ID							
Mailing Address							
Phone							
Email							

• Please complete all fields highlighted in yellow prior to submittal for review.

Tab: Equipment Information

This tab is utilized to enter equipment information, checks availability and displays the anticipated energy savings for the proposed project based on inputs entered by the user on this and previous tabs.

Section 1 – Inputs

System No.	Make / Model	Quantity*	Chiller Type	Equipment Type*	Heating Operation Type*
1	Multistack MSH070	2	Water-Cooled	Positive Displacement	Simultaneous Heating and Cooling
Total		2			

- System Number enter each equipment / measure.
- Make / Model enter full make and model number.
- Quantity quantity of identical equipment to be installed.
- Chiller Type drop-down menu: air/water cooled (only water-cooled is applicable for this calculator)
- Equipment Type compressor type drop-down menu: Positive Displacement or Centrifugal
- Heating Operation Type drop-down menu: Heat Pump Heating/Simultaneous Cooling and Heating/Heat Recovery Heating (only Simultaneous Cooling and Heating operation is applicable to this version of the calculator).

Entering / Leaving Heating Liquid Temperature*	Cooling Capacity (Tons)*	Heat Recovery Capacity (MBtu/h)*	Cooling kW/ton IPLV	Cooling kW/ton FL*	Heating COP*	Simultaneous Cooling and Heating COP*		
High 120°F/140°F	50.00	854.80		1.497	3.35	5.7		
					When this	s value highlights	in red there	
					may be an inconsistent cooling heating COP value entered or th equipment is not eligible (not comp with ASHRAE Standards).			
	50.00	854.80						

- Entering / Leaving Heating Liquid Temperature drop-down menu
 - Low (95F/105F)
 - o Medium (105F/120F)
 - High (120F/140F)
 - o Boost (120F/140F)
- Cooling Capacity (tons) enter cooling capacity of each equipment unit.
- Heat Recovery Capacity (MBtu/hr or 1,000 Btu/hr) enter hourly maximum heat output capacity.
- Cooling (kW/ton) enter cooling efficiency at full load.
- Heating COP enter heating COP at full load.
- Simultaneous Cooling and Heating COP enter COP in specific heat recovery operating mode (only simultaneous cooling and heating operation mode is active in the current version of the calculator).

Please note sample manufacturer's specification sheet for values referenced in above calculator.

JLTIST Mechan Accesso	ical Mod		1) MSH0	70XNHCIE	AAE				nits sh	n sheet – iould read			
						SUM	MMARY PERF	ORMANCE D	ATA				
							EV	APORATOR			CONDEN	SER	
Load C	apacity	kW	THR	kW/Ton	EER	COP	Flow Rate	Leaving	ΔP (ft	Cond Flow	Entering	Leaving	ΔP (ft
	(tons)		(MBtu/h		(Btu/ Wh)	(kW/k W)	(GPM)	Temp. °F	H2O)	(GPM)	Temp. °F	Temp. °F	H2O)
100%	49.95	74.82	0.8548	1.498	8.012	2.350	85.60	42.00	6.039	85.48	120.0	140.0	4.653
75%	37.47	56.12	0.6411	1.498	8.012	2.350	85.60	42.00	6.039	85.48	125.0	140.0	4.653
50%	24.98	37.67	0.4283	1.508	7.956	2.330	85.60	42.00	6.039	85.48	130.0	140.0	4.653
25%	12.49	20.06	0.2183	1.606	7.470	2.190	85.60	42.00	6.039	85.48	135.0	140.1	4.653
The 25, 50) % points	have inco	orporated a	cycling penal	ty per AHF	RI 550/590).						
Cooling COP						Heating COP Heating a					Heating a <mark>nd (</mark>	Cooling COP	
2.350					3.350					5.7	00		

Section 2 – Compliance Check and Savings

	Compliance Check and Savings										
Cooling Efficiency kW/ton - Baseline	Heating COP - Baseline	EFLH	kWh Savings	kW Savings	Therm Savings	Savings (MMBTU)	ASHRAE Simultaneous Heating and Cooling Load Efficiency COP per AHRI 920	ASHRAE Compliance Check			
0.5263	0.80	8760	(673,526.77)	(85.43)	168,481	14,549.94	4.42	Compliant			
			-	-	-	-					
			-	-	-	-					
			-	-	-	-					
			-	-	-	-					
			-	-	-	-					
			(673,526.77)	(85.43)	168,481	14,549.94					

- <u>Cooling Efficiency kW/ton Baseline</u> automatically populates based on:
 - Equipment Type
 - Cooling Capacity
 - Path B IPLV (from ASHRAE 90.1–2022–Attachment B)
- <u>Heating COP Baseline automatically populates based on:</u>
 - Equipment Type
 - Cooling Capacity
 - Heating Operation Type
 - Entering / Leaving Heating Liquid Temperature
- <u>EFLH automatically populates based on:</u>
 - Equipment capacity
 - Minimum building/space heating and cooling loads
 - Manual Override Option Available
- <u>kWh Savings</u> calculations described in Attachment C
- <u>kW Savings</u> calculations described in Attachment C
- <u>Therm Savings</u> calculations described in Attachment C
- Annual Energy Savings (MMBtu) calculations described in Attachment C
- <u>ASHRAE Cooling Compliance (IPLV) from ASHRAE 90.1–2022</u>–Attachment B
- ASHRAE Heating Compliance from ASHRAE 90.1–2022–Attachment B
- <u>ASHRAE Compliance Check automatically</u> populated based on eligibility criteria. If equipment is deemed "Not Compliant" Annual Energy Savings are not catculated.

Tab: Results Summary

Technology	Material Cost	Labor Cost	Total Cost
Heat Recovery Chiller			\$-

• Enter Material and Labor Costs for each Measure.

• <u>Total Cost</u> = Material + Labor Costs

Net MMBtu Savings	Heating Electrification Savings (kWh)	Cooling Savings (kWh)	Net kWh savings	kW Savings	Therms Savings
14,549.9	-	(673,526.8)	(673,526.77)	(85.4)	168,481.1

- <u>Net MMBtu Savings = Annual Energy Savings (MMBtu)</u> calculations described in Attachment C
- <u>Heating Electrification Savings (kWh)</u> = HRC Heating Energy = Zero (0) Free Heating calculations described in Attachment C
- <u>Cooling Savings (kWh)</u> calculations described in Attachment C
- <u>kW Savings</u> calculations described in Attachment C
- Therm Savings calculations described in Attachment C

Effective Useful Life (years)	Lifetime Net MMBtu Savings	Un	capped Incentive	
15	218,249.1	\$	1,454,994.0	

- Effective Useful Life (years) Source NYS TRM Version 10 Appendix P
- Lifetime Net MMBtu Savings Net MMBtu Savings x Effective Useful Life
- <u>Uncapped Incentive</u> Incentive Calculation automatically populates for each compliant measure based on calculated Net MMBtu Annual Savings, project information and location.
- <u>The Uncapped Incentive value should not be construed as a Preliminary Incentive</u> <u>Offer Letter (PIOL). A PIOL will be offered after the project is reviewed by the</u> <u>participating utility.</u>

Appendices

A. Definitions

- Air-Conditioning, Heating, and Refrigeration Institute (AHRI): A trade association representing manufacturers of heating, ventilation, air-conditioning, refrigeration, and water heating equipment. AHRI provides the database of equipment performance specifications, which is used in this program to determine the rebate amount.
- Building Heating Load (BHL): Building heat loss in British Thermal Units per hour (Btu/h). For residential buildings, BHL shall be calculated using ACCA Manual J or another code-approved methodology. For commercial buildings, BHL shall be calculated following ANSI/ASHRAE/ACCA Standard 183-2007(RA2017), or other code-approved equivalent computational procedure. Calculation of the building's design heating load shall be at the 99% dry bulb heating design temperature for the most relevant ASHRAE 2017 location.
- Building Cooling Load (BCL): Building total sensible and latent heat gain in British Thermal Units per hour (Btu/h). For residential buildings, BCL shall be calculated using ACCA Manual J or another code-approved methodology. For commercial buildings, BHL shall be calculated following ANSI/ASHRAE/ACCA Standard 183-2007 (RA2017), or other code-approved equivalent computational procedure. Calculation of the building's design cooling load shall be at the 1% dry bulb cooling design temperature for the most relevant ASHRAE 2017 location.
- **Coefficient of performance (COP)**: COP is the ratio of work or useful energy output of a system versus the work or energy input, measured in the same units. It is a measure of performance often used for electrically powered heating and cooling equipment, with the higher the system COP corresponding to the more efficient operation.
- Energy Efficiency Ratio (EER): A measure of how efficiently a cooling system will operate when the outdoor temperature is 95 degrees Fahrenheit. It is calculated by dividing the rated cooling output at 95 degrees Fahrenheit by the watts used by the AC/HP system. A higher EER means the system is more efficient. It is an instantaneous measure of electrical efficiency, unlike SEER (Seasonal Energy Efficiency Rating), which is an averaged value of efficiency. This is a term applied to air conditioning equipment.
- **Full Load Heating System**: A system installed as a building's primary heating source, with a total system heating capacity that satisfies a minimum of 90% of building heating load (BHL).
- Heat Pump Chiller (HPC) chiller operating in mode where heat sink or source is outside of the building (i.e., well field, air or chilled water loop as source of hot or cold water for the building). Unit provides either heating or cooling but not at the same time. This calculator does not currently have the capability to calculate savings for HPCs. Savings from HPC projects will be evaluated on a case-by-case basis as part of the review of the custom project under the purview of the Program Administrator.
- Heat Recovery Chiller (HRC) chiller operating in mode where heat is moved between HW and CHW loops within the thermal envelope in buildings requiring simultaneous cooling and heating. Unit provides heating and cooling at the same time. Note: HRC are exempt from minimum annual baseline heating consumption displacement thresholds applicable to each program. This calculator may be utilized for HRC projects as described in the schematic below. The project would still retain the option to be evaluated on a case-by-case basis as part of the review of the custom project under the purview of the Program Administrator.
- Heat Pump Chiller/ Heat Recovery Chiller (HPC+HRC) chiller that will operate in both of the above modes for a project. This calculator does not currently have the capability to calculate savings for HPC+HRC projects. Savings from HPC+HRC projects will be evaluated on a case-by-case basis as part of the review of the custom project under the purview of the Program Administrator.

B. Applicable ASHRAE 90.1 – 2022 Efficiency Requirements

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(P _H) ^{f,h} , W/V | leating
 | Sim | ation Efficien
ultaneous Co
oad Efficienc | oling and He | |
 | Recovery H
fficiency (CO | | |
 |
| = | | Size Category | Air Source EER (
Liquid-Source Pow | ion Efficiency ^{a,d,e,j}
FL/IPLV), Btu/W·h
er Input per Capacity
'), kW/tong

 | Heating Source | | eaving Heati
Medium | |
 | | Leaving Heat
Medium | | |
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Hot- | emperature
Hot- |
 |
| | Equipment | Refrigerating
Capacity ⁿ , | | Path B

 | Conditions
(leaving liquid) or | 95.00°F/
105.00°F | 105.00°F/ | 120.00°F/ | 120.00°F/
 | 95.00°F/ | 105.00°F/ | 120.00°F/
140.00°F | 120.00°F/
140.00°F | 95.00°F/
 | 105.00°F/ | Water 1
90.00°F/ | Water 2
120.00°F/ | Test
 |
| = | Type
Air source | <150.0 | Path A
≥9.595 FL | >9.215 FI

 | OAT (db/wb) ^g , °F
47.00 db | 23.290 | 120.00°F
≥2.770 | 140.00°F
≥2.310 | 140.00°F
NA ^p
 | 105.00°F
NA ^p | 120.00°F
NA ^p | 140.00°F | NA P | 105.00°F
NA ^P
 | 120.00°F
NA ^p | 140.00°F
NA ^p | 140.00°F
NA ^p | AHRI
 |
| | | | ≥13.02 <i>IPLV</i> .IP | ≥15.01 <i>IPLV</i> .IP

 | 43.00 wb ¹
17.00 db. | >2.029 | ≥1.775 | ≥1.483 | NAP
 | NA ^p | NA ^p | NA ^p | NA ^p | NAP
 | NA ^p | NAP | NAP | 550/590
 |
| | | ≥150.0 | ≥9.595 FL | ≥9.215 FL

 | 15.00 wb ¹
47.00 db. | >3.290 | >2.770 | >2.310 | NAP
 | NAP | NAP | NAP | NAP | NAP
 | NAP | NAP | NAP |
 |
| | | | ≥13.30 <i>IPLV</i> IP | ≥9.215 FL
≥15.30 <i>IPLV</i> .IP

 | 43.00 wb ¹
17.00 db, | ≥2.029 | ≥1.775 | ≥1.483 | NAP
 | NAP | NAP | NAP | NAP | NAP
 | NAP | NAP | NAP |
 |
| - | Liquid | ≥11.25 ^q and | ≤ 0.7895 FL | <0 \$21157

 | 17.00 db
15.00 wb ¹
44.00 ^m | ≥2.029 | ≥1.775 | ≥2.680 | NAP
 | ≥8.330 | ≥6.410 | ≥4.420 | NA.P | ≥8.330
 | ≥6.410 | ≥4.862 | ≥4.420 | AHPT
 |
| | Liquid-
source
electrically | ≥11.25 ⁴ and
<150.00 | ≤ 0.7895 FL
≤0.6316 <i>IPLV</i> .IP | ≤0.8211FL
≤0.5263
<i>IPLV</i> .IP

 | 44.00 ^m
65.00 ^m | ≥4.640
NA ^P | ≥3.680
NA ^P | ≥2.680
NA ^P | NA ^p
≥3.550
 | ≥8.330
NA ^P | ≥6.410
NA ^P | ≥4.420
NA ^P | NA ^p
≥6.150 | ≥8.330
NA ^P
 | ≥6.410
NA ^P | ≥4.862
NA ^P | ≥4.420
NA ^P | AHRI
550/590
 |
| | operated
positive
displacement | ≥150.0 and
<300.0 | ≤0.7579 FL
≤0.5895 <i>IPLV</i> .IP | ≤0.7895 FL
≤0.5158

 | 44.00 ^m | ≥4.640 | ≥3.680 | ≥2.680 | NAP
 | ≥8.330 | ≥6.410 | ≥4.420 | NA ^p | ≥8.330
 | ≥6.410 | ≥4.862 | ≥4.420 |
 |
| | uspiacement | ≥300.0 and | <0.6947 FL | <0.5158
<i>IPLV</i> .IP
<0.7158 FL

 | 65.00 m
44.00 ^m | NA P
>4.640 | NA ^P
≥3.680 | NA ^p
≥2.680 | ≥3.550
NA ^P
 | NA ^p
≥8.330 | NA ^p
≥6.410 | NA ^p
≥4.420 | ≥6.150
NA ^p | NA P
>8.330
 | NA ^p
≥6.410 | NA ^p
≥4.862 | NA ^p
≥4.420 |
 |
| | | <400.0 | ≤0.5684 <i>IPLV</i> .IP | ≤0.7158 PL
≤0.4632
IPLV.IP

 | 65.00 m | 24.040
NA ^P | 25.080
NA P | 22.080
NA P | ≥3.550
 | 28.330
NA ^p | NA ^p | 24.420
NA ^p | ≥6.150 | ≥a.330
NA ^P
 | 20.410
NA P | 24.802
NA ^P | 24.420
NA P |
 |
| | | ≥400.0 and
<600.0 | ≤0.6421 FL
≤0.5474 <i>IPLV</i> .IP | ≤0.6579 FL
≤0.4316

 | 44.00 ^m | ≥4.930 | ≥3.960 | ≥2.970 | NAP
 | ≥8.900 | ≥6.980 | ≥5.000 | NA ^p | ≥8.900
 | ≥6.980 | ≥5.500 | ≥5.000 |
 |
| | | ≥600.0 | ≤0.5895 FL | <i>IPLV</i> .IP
≤0.6158 FL

 | 65.00 ^m
44.00 ^m | NA ^P
≥4.930 | NA ^p
≥3.960 | NA. ^p
≥2.970 | ≥3.900
NA ^P
 | NA ^p
≥8.900 | NA ^P
≥6.980 | NA ^p
≥5.000 | ≥6.850
NA ^p | NA ^p
≥8.900
 | NA ^p
≥6.980 | NA ^p
≥5.500 | NA ^p
≥5.000 |
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C. Sample Calculations and Formulas

Calculations for Annual Energy Use for the Proposed HRC

Inputs:

- Condenser Leaving Water Temperature
- Simultaneous Cooling & Heating COP
- COPcooling (kW/ton Full Load & IPLV)
- Heating COP COPheating
- Max. HRC Capacity -Tons (@ Max. Operating Conditions)
- Heat Recovery Capacity/ Heating Output (MBtu/hr)
- EFLH (hours) defaults to 8,760 but user should enter actual calculated EFLH if available

Outputs:

- Cooling Output MMBtu/hr = Max Tons x 12,000 Btu/Ton / 1,000,000 Btu / MMBtu
- **Cooling Input MMBtu/hr** = Output / COPcooling
- Heating Input MMBtu = 0 (Free)
- Energy Use MMBtu/yr = (Cooling Input + Heating Input) * EFLH

Simultaneous Cooling & Heating COP Check:

Cooling Output + Heating Output) / Cooling Input = Heating and Cooling COP (mfg. specs.)

Calculations for Annual Energy Use for Baseline System @ Code Efficiency

Inputs:

- Simultaneous Cooling & Heating COP
- COPcooling (kW/ton) Path B IPLV
- COPheating = code compliant baseline heating system efficiency

Outputs:

- Cooling Output MMBtu/hr = HRC Max Tons x 12,000 / 1,000,000
- Cooling Input MMBtu/hr = Output / COP @ Code
- **Heating Output MMBtu/hr** = HRC Heating Capacity (BTU/hr) / 1,000,000
- Heating Input MMBtu/hr = Heating Output / COP @ Code

Assumptions and Standards:

- Boiler HW Pump Input = HW Loop Pump Input (assumed negligible not included)
- Chilled Water Pump Baseline = HRC CHW Pump Input (assumed negligible not included)
- Cooling Tower Energy Standard = 38.2 gpm/hp (ASHRAE 90.1-2022 Appendix G)
- Note: Cooling Tower Ton = 15,000 Btu Chiller Ton = 12,000 Btu
- Cooling tower GPM = 15,000 Btu / 500 x 10 delta T = 3 gpm/ton
- Cooling Tower Energy (kW/ton) = 1/38.2 gpm/hp x 3 gpm/ton x 0.7457 kW/hp) = .059 kW/ton

- <u>Condenser Water Pump Energy Standard = 19 W/gpm (ASHRAE 90.1-2022 Appendix G)</u>
- Condenser Water Energy (kW/ton) = (19 W/gpm x 3 gpm/ton) / 1000 watts/kW = 0.057 kW/ton
- Baseline Energy MMBtu/yr = (Cooling Input + Heating Input + Cooling Tower Input + Condenser Water Pump Input) * EFLH

Results Summary Calculations:

	Net MMBtu Savings	Heating Electrification Savings (kWh)	Cooling Savings (kWh)	Net kWh savings	kW Savings	Therms Savings	Effective Useful Life (years)	Lifetime Net MMBtu Savings
l	14,549.9	-	(673,526.8)	(673,526.77)	(85.4)	168,481.1	20	290,998.8

<u>Net MMBtu Savings (Annual Energy Savings)</u> = (Baseline Energy - Proposed Energy) x Safety Factor (0.9)

Heating Electrification Savings (kWh) = Zero (Free Heating)

Cooling Savings (kWh) = [Cooling Input Energy @ Code (Path B IPLV) (kW/ton) + Cooling Tower Energy (kW/ton) + Condenser Water Energy (kW/ton) - HRC Cooling Energy (kW/ton @ Full Load)] x Capacity (ton) x (# of units) x EFLH x Safety Factor (0.9)

<u>Net kWh Savings</u> = Heating Electrification Savings + Cooling Savings

<u>kW Savings</u> = [Cooling Input Energy @ Code (Path B IPLV) (kW/ton) + Cooling Tower Energy (kW/ton) + Condenser Water Energy (kW/ton) - HRC Cooling Energy (kW/ton @ Full Load)] x Capacity (ton) x (# of units)

<u>Therms Savings</u> = [(Heat Recovery Capacity (MBtu/hr) / 1,000 MBtu/MMBtu / Heating COP @Code * 10 Therms/MMBtu] x EFLH x Safety Factor (0.9)

<u>Effective Useful Life (years)</u> – Source NYS TRM Version 10 – Appendix P – 20 Years for Air- or Water-Cooled Chillers

<u>Lifetime Net MMBtu Savings</u> = Net MMBtu Savings x Effective Useful Life