MyBinMaker™ 8,760-Hour Meteorological Bin Calculation Engine

Comprehensive Engineering & Mathematical Reference Manual • Ver 2026-8

Executive Overview & Purpose

Temperature bin analysis is an essential thermal engineering method used to evaluate HVAC system performance, seasonal heat pump efficiency (SCOP), economizer operating hours, chiller/boiler part-load profiles, and building thermal energy consumption. By condensing 8,760 hourly meteorological observations into discrete temperature intervals paired with coincident psychrometric properties, engineers can perform rigorous annual energy calculations without the excessive overhead or obscurity of dynamic black-box simulation engines.

MyBinMaker™ is a cloud-based precision calculation engine that processes multi-decadal quality-controlled meteorological datasets into custom 1°F, 2°F, 5°F, or 1°C temperature bin distribution tables. It couples ambient dry-bulb intervals with exact Mean Coincident Wet-Bulb (MCWB), relative humidity, enthalpy, and commercial operating schedule matrices to deliver production-ready Excel engineering workbooks.

Core Capabilities & Technical Scope

Engine Feature	Specification / Range	Engineering Utility & Impact
Meteorological Backbone	21,000+ Quality-Controlled Global Stations	WMO, NOAA NCEI ISD, and ECMWF ERA5 ground + satellite solar datasets.
Bin Resolution Options	1°F, 2°F, 5°F, or 1°C Temperature Steps	High-precision heat pump sizing (1°F) to standard HVAC bin tables (5°F).
Psychrometric Synthesis	Mean Coincident Wet-Bulb (MCWB) & Enthalpy	Accurate latent load, cooling tower, and evaporative economizer analysis.
Schedule Time Masking	7-Day x 24-Hour Custom Binary Matrix	Isolate occupied commercial office hours, multi-shift plants, or weekend setbacks.
Thermal Operating Modes	Heating (<70°F), Cooling (>75°F), Economizer	Automatic bin classification for sensible heating, cooling, and free-cooling.
Export Workbooks	Native Microsoft Excel (.xlsx) & CSV	Audit-ready workbooks with formula transparency, monthly sheets, and charts.

1. Meteorological Data Provenance & Observational Backbone

All bin calculations in MyBinMaker™ are driven by authoritative 8,760-hour typical meteorological datasets constructed from global ground-based observation stations, calibrated satellite irradiance models, and atmospheric reanalysis.

• Primary Surface Observations: World Meteorological Organization (WMO) Global Telecommunication System and NOAA/NCEI Integrated Surface Database (ISD) stations covering over 21,000 locations worldwide.
• Solar Irradiance Integration: Satellite-derived Direct Normal (DNI), Diffuse Horizontal (DHI), and Global Horizontal (GHI) solar irradiance synthesized via ECMWF ERA5 reanalysis.
• Quality Assurance & Strict Conservation: Every annual dataset is verified to guarantee exactly 8,760 sequential hours (sum of all bin frequencies = 8,760 hours in standard years, 8,784 in leap years) with zero missing data gaps or unphysical thermodynamic anomalies.

2. Temperature Binning Mathematical Formulations

The fundamental objective of temperature binning is to transform an 8,760-hour continuous dry-bulb temperature vector T_db = [T_1, T_2, ..., T_8760] into a discrete frequency distribution over N temperature intervals (bins).

2.1 Bin Boundary & Midpoint Definitions

For a specified bin width ΔT (e.g. 5°F, 2°F, 1°F, or 1°C), each discrete bin i is bounded by a lower limit T_low,i and an upper limit T_high,i centered around midpoint T_mid,i:

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Bin Interval Definition:    T_low,i = T_mid,i - (ΔT / 2)
                           T_high,i = T_mid,i + (ΔT / 2)
Membership Criterion:      T_low,i ≤ T_db(t) < T_high,i
Total Bin Frequency:       H_i = ∑_{t=1}^{8760} I(T_low,i ≤ T_db(t) < T_high,i) • S(t)
Annual Conservation:       ∑_{i=1}^{N} H_i = H_total (8,760 hrs under 24/7 schedule)
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Where I(•) is the binary indicator function (1 if true, 0 if false), and S(t) ∈ {0, 1} is the schedule masking multiplier for hour t.

3. Mean Coincident Psychrometric Formulations

In HVAC engineering, knowing only the hours in a dry-bulb bin is insufficient because cooling coils, cooling towers, and economizers depend heavily on moisture content and wet-bulb temperature. MyBinMaker™ calculates the exact Mean Coincident Wet-Bulb (MCWB), Relative Humidity, and Specific Enthalpy for every bin.

3.1 Mean Coincident Wet-Bulb (MCWB)

For each hour t falling into bin i, the coincident wet-bulb temperature T_wb(t) is calculated from ambient dry-bulb T_db(t) and relative humidity RH(t) using the comprehensive Stull psychrometric formulation:

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T_wb = T_db • atan[0.151977 • (RH + 8.313659)^0.5] + atan(T_db + RH) - atan(RH - 1.676331)
       + 0.00391838 • (RH)^1.5 • atan(0.023101 • RH) - 4.686035

Mean Coincident Wet-Bulb for Bin i:
MCWB_i = (1 / H_i) • ∑_{t ∈ Bin_i} T_wb(t)
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3.2 Psychrometric Specific Enthalpy & Humidity Ratio

The humidity ratio W (mass of water vapor per unit mass of dry air) and specific enthalpy h (Btu/lb_da or kJ/kg_da) are calculated via ASHRAE Fundamentals formulation:

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Saturation Vapor Pressure (Magnus-Tetens):  P_ws = 0.61078 • exp[(17.27 • T_db) / (T_db + 237.3)] (kPa)
Actual Water Vapor Pressure:                P_w = (RH / 100) • P_ws
Humidity Ratio (W):                         W = 0.62198 • [P_w / (P_atm - P_w)] (kg_w / kg_da)
Specific Enthalpy (IP Units):               h = 0.240 • T_db(°F) + W • (1061 + 0.444 • T_db) (Btu/lb)
Specific Enthalpy (SI Units):               h = 1.006 • T_db(°C) + W • (2501 + 1.86 • T_db) (kJ/kg)
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4. Commercial Operating Schedule Matrices & Binary Time Masking

Most commercial and industrial HVAC equipment does not operate 24 hours a day, 365 days a year. Sizing equipment or calculating annual utility consumption using continuous 8,760-hour weather data produces severe overestimation. MyBinMaker™ incorporates a 7-Day by 24-Hour binary schedule matrix $S(d, h) \in \{0, 1\}$ to filter hours precisely.

Standard Schedule Profile	Active Hours / Week	Annual Operating Hours	Target Facility Application
24/7 Continuous Baseline	168 hrs / week	8,760 hrs (100.0%)	Hospitals, data centers, continuous process plants.
Standard Commercial Office	45 hrs / week (8am - 5pm, M-F)	2,340 hrs (26.7%)	Commercial office buildings, administrative suites.
Extended Commercial / Retail	65 hrs / week (8am - 9pm, M-F, Sat)	3,380 hrs (38.6%)	Retail stores, medical clinics, bank branches.
K-12 School / Educational	50 hrs / week (7am - 5pm, M-F)	2,600 hrs (29.7%)	Primary & secondary schools, university classrooms.
Two-Shift Industrial	80 hrs / week (6am - 10pm, M-F)	4,160 hrs (47.5%)	Manufacturing facilities, assembly plants, warehouses.

5. Thermal Operational Mode Classification

MyBinMaker™ automatically categorizes temperature bins into primary HVAC operational modes based on standard engineering balance point thresholds:

Operational Mode	Temperature Threshold	HVAC Thermodynamic Action & Sizing Impact
Sensible Heating Mode	T_db < 70°F (21.1°C)	Active building heating required. Quantifies heating degree-hours, heat pump compressor low-temperature cutoff hours, and auxiliary strip heating.
Sensible Cooling Mode	T_db > 75°F (23.9°C)	Active mechanical refrigeration required. Determines chiller part-load hours, DX rooftop unit runtime, and peak condenser heat rejection.
Neutral / Economizer Mode	70°F ≤ T_db ≤ 75°F (21.1°C - 23.9°C)	Free-cooling economizer window. Air handlers utilize 100% outdoor air to satisfy internal thermal loads with zero compressor runtime.

6. Production Excel Workbook Architecture & Model Structure

Exported Microsoft Excel workbooks (.xlsx) are engineered for professional audit compliance, containing transparent native formulas and zero proprietary locked macros.

Workbook Worksheet	Content Layout & Data Structure	Engineering Usage
Sheet 1: Annual Summary	Full 8,760-hour annual bin distribution table with bin range, midpoint, total hours, % annual hours, MCWB, coincident RH, specific enthalpy, and mode tags.	Primary annual HVAC energy calculations, heat pump bin models, and executive reports.
Sheets 2 - 13: Monthly Breakdowns	12 individual monthly tabs (January through December) containing month-specific bin hour distributions and coincident psychrometric properties.	Detailed monthly billing demand analysis, seasonal equipment staging, and chiller plant optimization.
Sheet 14: Histogram & Bell Curve	Visual frequency distribution chart plotting annual bin hours against ambient dry-bulb temperature, showing climate bell curves and extremes.	Visual presentations, engineering client reports, and climate zone comparison studies.

7. Engineering Standards & Methodological Compliance

MyBinMaker™ calculation algorithms adhere to the following internationally recognized engineering standards and guidelines:

Governing Standard	Publishing Authority	Technical Scope & Compliance
ASHRAE Fundamentals (Ch. 14)	ASHRAE	Climatic Design Information & statistical weather data processing.
ASHRAE Fundamentals (Ch. 19)	ASHRAE	Energy Estimating Methods & modified bin calculation procedures.
ASHRAE Guideline 14-2014	ASHRAE	Measurement of Energy, Demand, and Water Savings (M&V audit standard).
ISO 15927-4:2005	ISO	Hygrothermal performance of buildings — Calculation of hourly data for cooling and heating.
IPMVP Volume 1	EVO	International Performance Measurement and Verification Protocol (Option C & D).