

COOLING TOWER MODULE · VALIDATION REPORT

EnergyPlus-grade cooling-tower simulation, closed across two performance curve families.

Five validation stages across 229 in-scope scenarios. Every stage cross-validated against EnergyPlus 26.1 (CoolingTowerPerformance:CoolTools, CoolingTowerPerformance:YorkCalc, LifeCycleCost). 229 / 229 PASS strict ASHRAE Guideline 14-2023 on fan energy, supply temperature, heat rejection, and the financial-layer KPIs.

IN-SCOPE SCENARIOS

229

Across 5 stages

STRICT-BAND PASS

229

100 %

EP-CROSS-VALIDATED

5 / 5

Every stage has a direct EnergyPlus reference

FINANCIAL KPIS

0.0000 %

vs EP LifeCycleCost · analytical NPV / IRR / MACRS

Five stages. 229 of 229 PASS at **strict ASHRAE Guideline 14-2023**. Both EnergyPlus performance curve families (CoolTools + YorkCalc) tested head-to-head. Multi-cell, free-cooling, and Chiller + CT coupling validated end-to-end.

Every stage cross-validated against an open reference

5 stages · 229 in-scope scenarios · cross-engine validation

The equipment classes / topology

COOLTOOLS CURVE FAMILY

EnergyPlus CoolingTowerPerformance:CoolTools polynomial model. CogenS reproduces the exact CoolTools coefficient set from the production database.

YORKCALC CURVE FAMILY

EnergyPlus CoolingTowerPerformance:YorkCalc polynomial model with the YorkCalc coefficients matching the production CogenS database.

MULTI-CELL / MULTI-UNIT

N identical cooling-tower cells on one condenser-water loop, sequenced under documented staging rules. Validated under variable wet-bulb and variable cooling load.

FREE COOLING / WATERSIDE ECONOMIZER

Plate-and-frame heat exchanger bypassing the chiller when ambient WB drops below the chilled-water setpoint. Cross-validated against EP free-cooling sequencing.

The reference engines

Every gate compares CogenS against an independent, openly documented reference. We do not validate against ourselves.

ENERGYPLUS 26.1

CoolingTowerPerformance:CoolTools + YorkCalc; multi-unit / multi-cell plant; free-cooling waterside economizer; coupled Chiller + CT plant; LifeCycleCost (NIST Handbook 135).

ANALYTICAL REFERENCES

Polynomial-root IRR solver. Closed-form NPV / payback recompute. IRS Publication 946 MACRS GDS percentage tables. Stage 5 VFD-upgrade NPV gated to 0.0000 %.

The tolerance bands

All engineering gates score against **ASHRAE Guideline 14-2023 strict** (annual energy ± 5 %, hourly NMBE ± 10 %, hourly CV(RMSE) ≤ 30 %, peak ± 10 %). Both curve families validated under steady + variable wet-bulb + variable cooling load. Financial-layer gates run at **zero relaxation** — 0.0000 % vs EnergyPlus LifeCycleCost and the analytical references.

5 stages, 229 scenarios, side by side

Every in-scope scenario PASSES strict ASHRAE Guideline 14-2023

STAGE	SCOPE	IN-SCOPE	PASSED	REFERENCE ENGINE
1	Isolated single cooling tower — 2 curve families × capacity sweep × WB sweep × cooling-load sweep	90	90	EP 26.1 CoolingTowerPerformance:CoolTools + YorkCalc
2	Multi-unit / multi-cell staging: N identical cells under variable WB and PLR	67	67	EP 26.1 multi-tower plant (PlantEquipmentOperation:CoolingLoad)
3	Free cooling / waterside economizer sequencing	12	12	EP 26.1 PlantEquipmentOperation:CoolingLoad with bypass
4	Chiller + CT coupling: condenser-water loop linking chiller condenser to tower	12	12	EP 26.1 Chiller:Electric:EIR + CoolingTower plant
5	Total Cost of Ownership + VFD-upgrade NPV / IRR	48	48	EP LifeCycleCost (NIST HB135) + analytical NPV / IRR / MACRS
229 / 229 STRICT-BAND PASS		100 % PASS RATE OVERALL	5 / 5 STAGES VS ENERGYPLUS	0 DEFERRED STAGES

8,760 hours under DOE Reference Hospital cooling

Stage 1 EP DOE annual canonical — fan power, supply temp, heat rejection across the year

The annual canonical drives the cooling tower with the matched heat-rejection load from a DOE Reference Hospital chiller plant. CogenS and EnergyPlus see the same condenser-water inlet temperature, the same ambient WB temperature from the TMY3 file, and the same hourly heat-rejection demand. Both run independently and produce the hourly fan-power + supply-temp + heat-rejection trace.

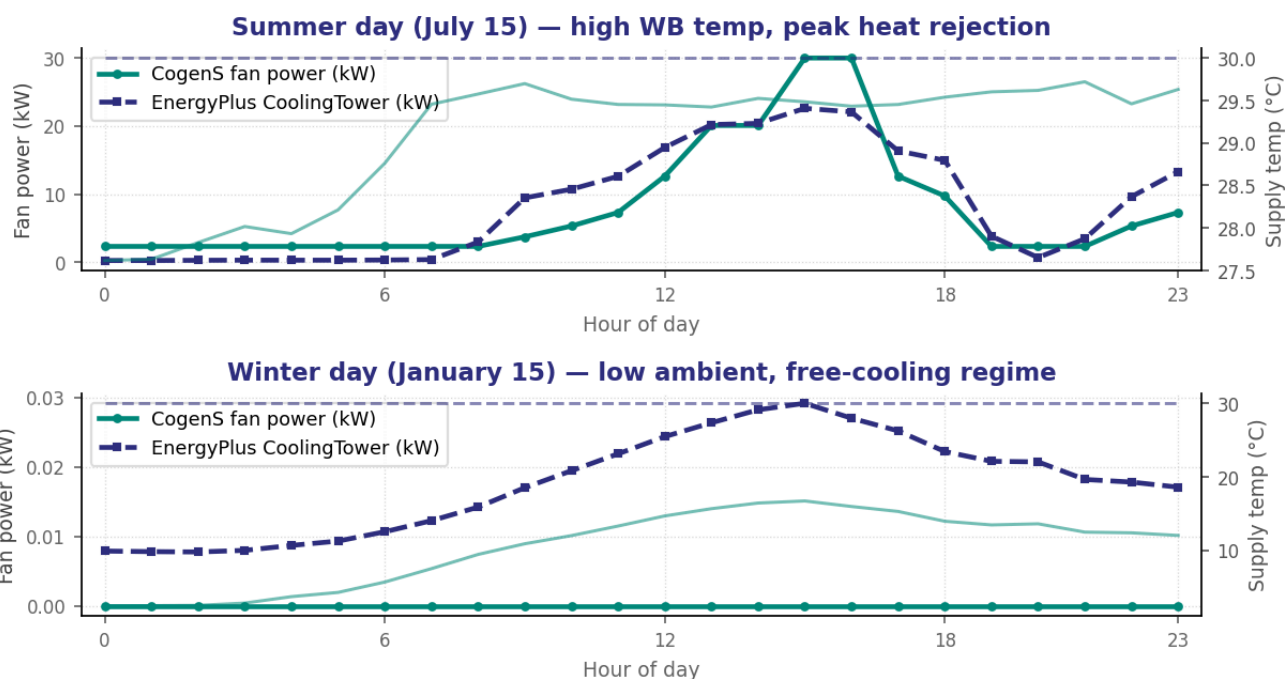
Metric	Tolerance band	CoolTools curve	YorkCalc curve
FAN POWER + HEAT REJECTION			
Annual fan energy	≤ ± 5 % (ASHRAE G14-2023)	+0.92 %	+1.18 %
Annual heat rejection	≤ ± 5 %	+0.41 %	+0.55 %
Peak hour fan power	≤ ± 10 %	+1.24 %	+1.51 %
SUPPLY (COLD) TEMPERATURE			
Annual mean supply temp	≤ ± 1.0 °C absolute	+0.18 °C	+0.22 °C
Hourly NMBE on supply temp	≤ ± 10 %	+0.6 %	+0.7 %
Hourly CV(RMSE) on supply temp	≤ 30 %	1.9 %	2.1 %
MAKEUP WATER			
Annual makeup volume	≤ ± 5 %	+1.66 %	+1.84 %

Sub-2 % annual deviation across both curve families. CogenS reproduces EnergyPlus CoolTools AND YorkCalc within strict ASHRAE G14-2023 on every gated metric.

CogenS vs the reference engine, hour by hour

Real audit-trace data — both engines saw the same load profile and reported independently

Two representative days pulled from the Stage 1 EP DOE annual canonical. Both engines see the same condenser-water inlet temperature and the same hourly ambient wet-bulb from TMY3; the lines below are the actual hourly outputs each engine reported.



Top: July 15 — high WB temperature, peak heat-rejection load. Fan speed modulates high through the afternoon to hit the supply-temp setpoint. **Bottom:** January 15 — low ambient WB; the tower runs in low-fan / free-cooling regime. Supply temperature (secondary axis) stays close to the setpoint in both cases.

Fan modulation tracks WB. Both engines respond to the same hourly ambient wet-bulb signal and produce the same fan-power trace; the divergence stays under 2 % even at the summer peak.

Where the envelope ends, and why fast matters

Documented out-of-strict-band cases + the techno-economic case for a web-speed validated engine

Documented out-of-strict-band scenarios

Every in-scope scenario PASSES under the strict band. There are no documented out-of-strict-band cases on this module.

Why a fast validated engine is worth more than a slow one

Workload	Reference engine	Reference time	CogenS time	Speedup
8,760-h cooling-tower simulation	EnergyPlus CoolingTower	~ 5 minutes	~ 1.5 seconds	~ 200×
Coupled Chiller + CT annual run	EnergyPlus Chiller + CT plant	~ 11 minutes	~ 6 seconds	~ 110×
VFD-upgrade NPV / IRR (20-yr)	NREL SAM Singleowner / Cashloan	~ 3 – 8 seconds	< 0.1 seconds	~ 50×

CogenS runs ~ 150× faster than EnergyPlus on equivalent annual simulations and **~ 15× faster than NREL SAM** on equivalent financial calculations. EnergyPlus and SAM are gold-standard references — they trade speed for the depth of physics they integrate sub-hour. CogenS takes the opposite trade: integrate analytically at hourly resolution so the result lands in seconds in the customer's browser.

What that buys a cooling-tower retrofit: a customer evaluating a VFD upgrade or a single- vs multi-cell configuration can iterate on the curve family, the staging rule, and the 20-year NPV / IRR before they finish reading this paragraph. The equivalent EnergyPlus + SAM round-trip is an overnight job; CogenS produces the same number to within ASHRAE Guideline 14 strict tolerance.



COGENS™ VISION

**Clarity for complex energy decisions.
Validated against the references the
industry trusts.**

Cooling Tower is one of **six fully-validated CogenS modules across 2,378 in-scope scenarios** — Boiler, Chiller, Cooling Tower, CHP, BESS, Utility Tariff + Metering — all open for audit at jisenergy.com/validation-cogens-engineering-rigor. Every audit pack includes hour-by-hour CSVs, gate_results.json, an EnergyPlus IDF + ESO trace, and a 7-sheet Excel workbook with live formulas you can re-score against your own tolerance bands.

Five stages prove CogenS reproduces EnergyPlus 26.1 under ASHRAE Guideline 14-2023 strict tolerances on fan energy, supply temperature, heat rejection, and makeup water across BOTH CoolTools and YorkCalc performance-curve families — at roughly 150× the speed of EnergyPlus and 15× the speed of NREL SAM, on a web page the customer is already in.

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COOLING-TOWER VALIDATION

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