Ontoly

Weather Normalization Methodology

IPMVP Option C — Avoided Energy Use (simplified)

Date:	2 November 2026
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Status:	Version 2.0 — Final — replaces v1.1. Aligned with the Existing Building Methodology v1.3, Appendix 2, and the GHG Actuals model v4.0.

1. Overview

This is the backend specification for weather normalization of **ex-post (actual)** savings under the Existing Building Methodology. Projected (ex-ante) credits are not weather normalized: they use the average annual baseline and the forecast consumption as they are.

Ontoly uses the avoided energy use approach of IPMVP Option C and ASHRAE Guideline 14-2023. One regression is fitted for each fuel from the baseline period, at validation, and then frozen. In every monitoring month it predicts what the building would have used under that month's actual weather. Savings are that prediction minus the meter reading. In the Existing Building Methodology, the summed monthly baseline is EC_BL,j for electricity and FCF_BL,f,j for other fuels, and the summed meter readings are EC_metered,j,y and FCF_metered,f,j,y (Equations 1 to 3). The meter readings are not weather-adjusted.

Where a fuel shows no significant relationship with weather, there is nothing to normalize: the baseline is the average baseline month and no weather adjustment is made. The ratio method, the post-retrofit regression and Typical Meteorological Year (TMY) data are not used.

2. Process Steps

Step	Action	Details
1	Collect baseline data	The 36 months immediately before the Project Start Date (all consecutive months available if fewer, minimum 12), fixed before any test is run; the window cannot be chosen to improve a result (EBM §5.3). Bills that straddle months are split across calendar months in proportion to days, as in ENERGY STAR Portfolio Manager. Plus monthly HDD and CDD (base 18 °C) from the nearest weather station, fixed at validation.
2	Fit the baseline regression	Heating fuels: $E = \alpha + \beta \cdot HDD$. Electricity: $E = \alpha + \beta_1 \cdot HDD + \beta_2 \cdot CDD$. For heating fuels, the HDD term is kept only if it is positive and

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Step	Action	Details
		significant. For electricity, if either term fails in the two-term model, the HDD-only and CDD-only models are each tested and a passing one is kept (the lower CV(RMSE) if both pass). If no term survives, E = α (the average month).
3	Run Tests 1–3 and freeze	At validation. Sets the pathway for each fuel (A weather-adjusted / B no adjustment) and whether positive savings are creditable. The model is then fixed for the crediting period.
4	Predict each monitoring month	Pathway A: baseline = $\alpha + \beta \cdot HDD$ ($+ \beta_2 \cdot CDD$) at the month's actual weather. Pathway B: baseline = α. Where occupancy or, for commercial and institutional buildings, operating hours fall below the baseline, the base load of the monthly baseline (the larger of α and the mean of the two mildest baseline months; all of α under Pathway B) is reduced by the lower of the occupancy and operating-hours factors before savings are calculated. An occupancy increase of more than 10% is handled only as a non-routine adjustment, and Ontoly makes a non-routine adjustment itself where a disclosed change lowers consumption (EBM §A2.2 and §A2.3).
5	Calculate savings	Savings = Σ (baseline − metered) over months with usable or substituted data. A missing month is substituted from the same calendar month of a prior monitoring year, adjusted for degree days (EBM §8.6.3(a); not available in the first monitoring year). Otherwise it adds no savings, and a net increase is scaled up to 12 months (§8.6.3(b)). Positive savings need at least 9 measured months; substituted months do not count.
6	Run Test 4 and credit	Positive savings are credited if Tests 1, 3 and 4 pass. An increase in a fuel's consumption is always counted in full.

3. Tests

Four tests replace the nine in v1.1. Tests 1–3 run once, at validation. Test 4 runs each monitoring year.

Test	Rule	Source	If it fails
1 Data sufficiency	≥12 consecutive baseline months; ≥75% of them usable and never fewer than 9, with at least 2 usable in each calendar quarter. A month is usable if metered, its weather covers ≥90% of days, and it was not excluded for a documented	EBM §A2.1.4; ASHRAE G14 (one full annual cycle; documented exclusions)	Add any baseline-period months not yet submitted and re-run; the period cannot be shortened or moved. Otherwise

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Test	Rule	Source	If it fails
	physical cause. Never exclude a month for being an outlier alone. Record the cause of every exclusion. Substituted baseline months only complete the baseline-year totals used for ex-ante quantification; they are not used in the regression or counted in the tests.		positive savings are not credited for the crediting period, unless the baseline is re-established (EBM §A2.3).
2 Weather relationship	Each degree-day coefficient kept is positive with $p < 0.05$.	EBM §A2.1.4; ENERGY STAR (adjust only where a fit exists)	Not a failure: selects Pathway B, no weather adjustment.
3 Model fit	CV(RMSE) of the model used ≤ 25%.	ASHRAE G14 (≤25% for 12–60 months of reporting data)	Add any baseline-period months not yet submitted and re-run; the period cannot be shortened or moved. Otherwise positive savings are not credited for the crediting period, unless the baseline is re-established (EBM §A2.3).
4 Savings uncertainty	FSU = $t \times 1.26 \times \text{CV(RMSE)} \times \sqrt{((n/n')\cdot(1 + 2/n')/m)} \div F \leq 50\%$ at 90% confidence, where $n' = n(1 - \rho)/(1 + \rho)$ if ρ, the lag-1 autocorrelation of the baseline residuals, is positive, and $n' = n$ otherwise. Run only where savings are positive. m counts measured monitoring months only (substituted months excluded).	ASHRAE G14 (<50%; 68% confidence minimum)	Positive savings for that fuel are not credited that year.

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4. What Was Removed, and Why

Removed	From v1.1	Why
Ratio method	Fallback whenever a test failed, plus the regression-vs-ratio QA check.	It assumes consumption is proportional to HDD without testing that any relationship exists. Where no relationship exists there is nothing to adjust, so v2.0 makes no adjustment.
Post-retrofit regression and TMY	A new regression each monitoring year, evaluated with the baseline at TMY.	One frozen baseline regression is enough under the avoided energy approach, and credits then reflect the year's actual reductions. Removes a fragile 12-point fit each year and the 15-year TMY dataset.
|NMBE| ≤ 5%	Test 4.	With least squares and an intercept, NMBE is zero by construction on the baseline data. It could never fail.
Weather range check	Test 7 (TMY within 90–110% of the baseline range).	No TMY is used, and 12+ baseline months with at least 2 usable months in each calendar quarter span the full annual weather range.
Separate sign, significance, cap and point tests	Tests 1, 2, 5 and 6.	Merged into Test 1 (data) and Test 2 (weather relationship).
Gap Coverage Factor	Pro-rata reduction using TMY monthly savings.	Replaced by a missing-month rule: an excluded month adds no savings; an increase is scaled up to 12 months.

5. Automation

5.1 Decision tree (per fuel)

Step	Check	Action
1	Weather coverage ≥90% of days for each month	Otherwise the month is not usable.
2	Test 1 on the baseline	FAIL → tag NOT_CREDITED_DATA (positive savings); ask for any baseline-period months not yet submitted.
3	Fit the regression; apply Test 2 (for electricity, test the HDD-only and CDD-only	PASS → Pathway A. FAIL → Pathway B (E = α).

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Step	Check	Action
	models if a term fails)	
4	Test 3 on the model used	FAIL → tag NOT_CREDITED_FIT (positive savings).
5	Each monitoring year: monthly baseline (with the occupancy or operating-hours factor where triggered), substitution or missing-month rule, savings	Savings < 0 → tag INCREASE_COUNTED and count in full. Fewer than 9 measured months → NOT_CREDITED_DATA for that year.
6	Test 4 (savings > 0)	PASS → CREDITED_A or CREDITED_B. FAIL → NOT_CREDITED_UNCERTAINTY for that year.

5.2 Output tags

Tag	Meaning	Credited amount
CREDITED_A	Weather-adjusted baseline (Pathway A); Tests 1, 3 and 4 passed.	Savings
CREDITED_B	No weather relationship (Pathway B); Tests 1, 3 and 4 passed.	Savings
INCREASE_COUNTED	Consumption rose against the baseline.	The increase, in full (negative savings)
NOT_CREDITED_DATA	Test 1 failed at validation, or fewer than 9 measured months in the monitoring year.	0 for positive savings
NOT_CREDITED_FIT	Test 3 failed at validation.	0 for positive savings
NOT_CREDITED_UNCERTAINTY	Test 4 failed this monitoring year.	0 for that year
NO_DATA	No usable monitoring months.	0

6. Data

- Weather: NOAA Climate Data Online (US) and Environment and Climate Change Canada (Canada), daily mean temperature, nearest station within 50 km (100 km if none), fixed at validation.
- Degree days: HDD = max(0, 18 − daily mean °C); CDD = max(0, daily mean °C − 18); summed by calendar month.
- Utility data: monthly metered consumption uploaded through the Ontoly Portal, converted to a common unit per fuel. Bills that straddle months are converted to calendar months by

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allocating each bill's consumption in proportion to the days falling in each month (EBM §A2.1.2). Each fuel is modelled separately and the results summed after emission factors.

- TMY and climate normals are no longer required.

Records: for each fuel, the test results, the pathway, the residual autocorrelation ρ and the cause of every excluded or substituted month are kept in the project file for the Validation and Verification Body and disclosed in the Annual Monitoring Report and BERU Issuance Report (EBM §8.6.4).

7. Script Specification

Function	Input	Output
load_utility_data(csv)	Bills (any billing period), converted to calendar months	DataFrame: month, fuel, consumption, status
get_degree_days(station, start, end)	Fixed station, date range	Monthly HDD, CDD, coverage
fit_baseline(df, fuel)	Baseline months	α, β (β_1, β_2), model form, pathway, CV(RMSE), n, p, ρ, Tests 1–3
predict_baseline(model, weather)	Frozen model, monitoring weather, occupancy factor	Monthly baseline
annual_savings(baseline, metered)	Monthly values	Savings after substitution and the missing-month rule
fsu(model, m, savings, baseline)	n, n′, p, CV(RMSE), m, F	Fractional savings uncertainty, Test 4
result(fuel)	All of the above	Credited savings and output tag

Statistics: ordinary least squares (statsmodels OLS) gives coefficients and p-values. CV(RMSE) = √(SSE ÷ (n − p)) ÷ mean; t = Student's t, two-tailed 90%, n − p degrees of freedom; ρ = correlation of each residual with the previous month's, consecutive usable months only.

8. Worked Example and Correction

Test building (GHG Actuals model v4.0 sample data, monitoring year 2024): gas β = 9.43 m³/HDD, α = 1,218 m³/month, CV(RMSE) 2.8% → Pathway A. Adjusted baseline 40,521 m³, metered 31,603 m³, savings 8,918 m³ (22.0%), ρ 0.05, FSU 8.4% → credited. Electricity (HDD + CDD), CV(RMSE) 1.3% → savings 46,823 kWh (8.6%), ρ 0.23, FSU 12.5% → credited.

Correction to v1.1 §4A.4: the illustration used √(24/12) in place of √((n+2)/(n·m)) (the v2.0 formula with no autocorrelation) and so overstated uncertainty about fourfold. For

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CV(RMSE) 12%, n = 24, m = 12 and 10% savings, the correct FSU (with the 1.26 factor, 90% confidence) is about 78%, which fails; at 30% savings it is about 26%, which passes (v1.1 said 93%, failing).

9. References

- ASHRAE Guideline 14-2023, Measurement of Energy, Demand, and Water Savings.
- IPMVP Core Concepts, Efficiency Valuation Organization (EVO), 2022 — Option C, avoided energy use.
- ENERGY STAR Portfolio Manager Technical Reference: Climate and Weather.
- Ontoly, Existing Building Methodology v1.3, Appendix 2 and Section 8.6.3.
- NOAA Climate Data Online; Environment and Climate Change Canada historical climate data.

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