Reference Implementation of DG-TEA v0.9 using NREL/TP-5100-92412

Version: v0.9 | Date: 2025-12-13
Statement: This document demonstrates compliance with DG-TEA v1.0 for the SAF benchmark case. It does not define the standard.

Conformance Statement

- This reference case conforms to DG-TEA v1.0, including Appendix A (Minimum Evidence Package) and Section 10 (Escalation, Amendments, and Version Integrity).
- Any pillar marked Review Required downgrades the entire study (no partial passes).
- Public framing is categorical only (Validated / Acceptable / Review Required); no validation percentages are published.

1. Scope & Intent

- Validated domain: Lignocellulosic SAF (NREL/TP-5100-92412 reference).
- Exclusions: Hydrogen, ammonia, other pathways (planned Q1-Q2 2025); no claims of certification/endorsement.
- Purpose: Show alignment and reproducibility against the published NREL benchmark using DG-TEA pillars.

2. DG-TEA Compliance Matrix (front-matter)

Pillar	Evidence location(s)	Status (Validated / Acceptable / Review Required)	Notes / Variances
Benchmark Anchoring	Sections 3-4 (benchmark inputs, cost baselines); Appendix A tables		
Scope Discipline	Section 2 (domain, exclusions); Section 7 (assumption bounds)		
Variance Classification	Section 5 (variance log), Appendix B (PASS/ACCEPTABLE/FAIL internal)		
Balance Closure & Internal Consistency	Section 6 (M&E closure), Section 8 (financial reconciliation)		
Auditability & Reproducibility	Section 1.4 (traceability), Appendices (inputs, versions, calculation steps)		

3. Artifact Index (per DG-TEA Appendix A)

Artifact ID	File	Version	Hash
A1	validation/NREL_metrics_audit.csv	v1.0	7C6FBA25E38336AAF6623ABBCE612C7FBA1CBEA84D3F5E6E4905F9CD2B59F0E1
A2	validation/Engine_Validation_White_Paper_v1_1.pdf	v1.1	13A90903E79317825907590ED2982F0FFDCF3A2A99AC56CF50AB27DFFD56710C
A3	validation/engineer_grade_report_20251213_1231.pdf	v1.0	77C99A647698643A4DE10AD6232DF69CD8FEAEE95C7E5153D2138D78632524D2
A4	validation/artifacts/CAPEX_breakdown_v1.0.csv	v1.0	47CC7CCD341D79639F7C3158D730B342F20E081C19C7FB53C4E402AE1C314DFF
A5	validation/artifacts/OPEX_breakdown_v1.0.csv	v1.0	657688CC5AD05C7359817A800565AC5452F4FA39916EBF4527E7A71CD3BB5792
A6	validation/artifacts/mass_balance_v1.0.csv	v1.0	A74DF74EA6500DF78C832E1B9F8B30094F2CA906AEAD9C527905368C168DA588
A7	validation/artifacts/energy_balance_v1.0.csv	v1.0	DE273C7CCC16B780A126A8247E35A23BE78FB9A9A63EB1EDF3FAC87280945E1D
A8	validation/artifacts/NREL_validation_matrix_v1.0.csv	v1.0	DC7EF9D6F602C54CBC77DEF042D9E58BCE5E04BDCD37C3EC959A8B46C1FDEF80
A9	validation/artifacts/sensitivity_analysis_v1.0.csv	v1.0	87794188FDC11FF8C2220327938EC26DFF5F75740ABA86C57C006F6E2D3CA54E
A10	validation/artifacts/variance_log_v1.0.csv	v1.0	D538CE4C3F7002151581F8802A3B1956A9D60C5746660ED1D9D17DCA6B68AE2F
A11	validation/artifacts/validation_traceability_v1.0.pdf	v1.0	041E02EDA200983CF61590548267E78EC820F1ED76484FA69C4C6EED2382A202
A12	validation/artifacts/balance_closure_v1.0.pdf	v1.0	D73F32F4502F4012DA0A6269ECDEADB87CC913B1FAA13E765885191CCE499D80

Artifact ID	File	Version	Hash
A13	validation/artifacts/data_quality_v1.0.pdf	v1.0	C2618A8EEA9F1A32330130154217499AD2A0A176FC5E1E35DC06A41F0B24B977
A14	validation/artifacts/attestation.json	v1.0	D005F3D298A1869DB7D972436C9420259891E6F41053BF3508610EB4CB2E9988
A15	validation/artifacts/metric_coverage.csv	v1.0	E0D2002AC38C1124D87A8B9C6AF8F0FC3938B48DF2EF844FD09952BBBDF2A3C1
A16	validation/DG_TEA_Validation_Workflow.ipynb	v1.0	D79CDA44094BC1261AAC3C03AE434F26880C20CFB7039D9F68EC533576A48503
A11	validation/artifacts/validation_traceability_v1.0.pdf	v1.0	041E02EDA200983CF61590548267E78EC820F1ED76484FA69C4C6EED2382A202
A12	validation/artifacts/balance_closure_v1.0.pdf	v1.0	D73F32F4502F4012DA0A6269ECDEADB87CC913B1FAA13E765885191CCE499D80
A13	validation/artifacts/data_quality_v1.0.pdf	v1.0	C2618A8EEA9F1A32330130154217499AD2A0A176FC5E1E35DC06A41F0B24B977
A14	validation/artifacts/attestation.json	v1.0	47FFB2D1595F2D70B012D456FD72C58D016436E6404BADE924D6373F41355155
A15	validation/artifacts/metric_coverage.csv	v1.0	E0D2002AC38C1124D87A8B9C6AF8F0FC3938B48DF2EF844FD09952BBBDF2A3C1
A16	validation/DG_TEA_Validation_Workflow.ipynb	v1.0	D79CDA44094BC1261AAC3C03AE434F26880C20CFB7039D9F68EC533576A48503
Add additional artifacts for inputs, calculation notebooks, exports, and variance logs. Every YES answer in the checklist must cite one or more Artifact IDs.			

4. Benchmark Metric Universe (NREL/TP-5100-92412)

Benchmark Metric	Included? (Y/N)	Rationale if excluded	Evidence Artifact ID(s)
MFSP (per gallon)	Y	-	A5, A8
Total CAPEX	Y	-	A4, A8
OPEX (fixed/variable)	Y	-	A5, A8
Throughput (annual)	Y	-	A6, A8
Yields (jet, diesel, naphtha)	Y	-	A6
Utility intensities (power, steam, water)	Y	-	A5, A7
Operating hours / capacity factor	Y	-	A8
Emissions factors (if benchmarked)	Y	-	A6
Expected: include all primary economics and benchmark-reported ratios unless explicitly justified. Document any exclusions.			

5. Public Communication Controls

- Replace "validated engine / proves / superiority" with "demonstrates compliance / aligns with / reproduces benchmark."
- Public framing uses categories (Validated / Acceptable / Review Required); no published "validation percentages."
- Internal variance handling retains PASS / ACCEPTABLE / FAIL for engineering review only.

6. Validation Outcomes (categorical)

- **Validated** where benchmark alignment is achieved within DG-TEA tolerances and variances are resolved/justified.
- **Acceptable** where within tolerances with documented variances and mitigations.
- **Review Required** where material gaps remain or evidence is incomplete.

7. Scope Discipline (explicit)

- Domain: SAF benchmark case (NREL/TP-5100-92412).
- Exclusions: Other fuels/chemistries; non-benchmark feedstocks; site-specific incentives.
- Assumption set: AACE Class 4 (+/-20-30%) unless otherwise stated; ASTM E3200 treatment for uncertainty.

8. Variance Treatment

- Variances classified as Data / Methodology / Implementation.
- Each variance has disposition: accept (document), remediate (fix), or investigate (open).
- Public reporting: category only; internal tables retain PASS/ACCEPTABLE/FAIL.
- Decision-impact tests: each Moderate/High variance must document a test against decision thresholds (e.g., +/-10% MFSP, +/-2% IRR, or scenario ranking change) and state whether the investment recommendation would change.
- Variance log: validation/artifacts/variance_log_v1.0.csv (A10) with 5 variances logged, including 1 HIGH variance (IRR +20%) with decision-impact test.
- Variance summary (current run): 1 HIGH (IRR +20%, DIT provided), 4 LOW/ACCEPTABLE (MFSP +7.5%, CAPEX +8.7%, OPEX +9.0%, Equipment +8.0%); compliance: COMPLIANT.

9. Balance Closure & Consistency

- Mass balance closure target >=98%; energy balance closure target >=99%.
- Financial statements reconcile CAPEX/OPEX/throughput/discount assumptions; cross-checked to benchmark baselines.
- Latest run: Mass balance 99.74% (PASS); Energy balance 100.00% (PASS). Evidence: A6, A7.

10. Auditability & Reproducibility

- Every reported figure traces to source data, calculation steps, and versioned assumptions.
- Inputs, calculation versions, and exhibits are preserved in appendices for independent reproduction.
- Reproduction attestation:
- Reproduced by: jrgom
- Date: 2025-12-20T13:07:00.000000+00:00 (UTC)
- Environment: Gomez | Windows-11-10.0.26200-SP0 | Python 3.12.10 | git 86d475e2ccaa5808d631fb0e54fe3663e89fa94f (branch tea-lca-os)
- Outcome: initial generation (not a reproduction)
- Evidence: validation/artifacts/attestation.json (hash D005F3D298A1869DB7D972436C9420259891E6F41053BF3508610EB4CB2E9988)

11. Section 10 Acknowledgement (Escalation & Version Integrity)

- Issues discovered during application: none logged beyond benchmark variances at time of release.
- No escalations deferred to v1.1+; if new material issues arise, they will be logged and handled via versioned amendment (no silent updates).

12. Relationship to Standard

- Aligns with DG-TEA v1.0 pillars; cites NREL/TP-5100-92412 as benchmark anchor.
- Intended to be reviewed independently of any tool or vendor implementation.
- No marketing language, calls to action, or product positioning included.

13. Appendices / Evidence Pointers

- Artifact index (CSV): validation/artifacts/artifact_index.csv (mirrors Section 3 table).
- Manifest (JSON): validation/artifacts/artifact_manifest.json (complete metadata).
- Metric coverage (CSV): validation/artifacts/metric_coverage.csv (DG-TEA Section 4 evidence).
- Attestation: validation/artifacts/attestation.json (reproduction/environment details).
- Variance log: validation/artifacts/variance_log_v1.0.csv (pending once real variances logged).

14. Variance Log Excerpt (A10)

Evidence: validation/artifacts/variance_log_v1.0.csv (hash D538CE4C3F7002151581F8802A3B1956A9D60C5746660ED1D9D17DCA6B68AE2F).

Metric	Δ%	Magnitude	Classification	Disposition	Impact on decision	DIT explanation
IRR	+20.0%	HIGH	Data	investigate (open)	material	DIT provided (IRR +20% test)
MFSP	+7.5%	LOW	Data	accept (document)	moderate	N/A (low)
Total CAPEX (TCI)	+8.7%	LOW	Data	accept (document)	moderate	N/A (low)
Total OPEX	+8.9%	LOW	Data	accept (document)	moderate	N/A (low)
Total Installed Equipment	+8.0%	LOW	Data	accept (document)	moderate	N/A (low)