Decision-Grade TEA Validation Standard (DG-TEA v1.0)

Developed by Jamie Gomez, Ph.D. (2025) Version: v1.0 | Date: 2025-12-13

1. Scope & Intent

- Governs capital-relevant techno-economic analysis (TEA) decisions in the ~$10M–$1B+ range.
- Defines what qualifies as "decision-grade" TEA; this is a methodology standard, not a tool, model, or software.
- Enables third parties to understand, implement, and evaluate compliance independently of any vendor.

2. Definition of "Decision-Grade"

Decision-grade TEA provides auditable, benchmark-anchored, and reproducible economics suitable for capital allocation decisions. Non-compliance implies elevated decision risk, limited defensibility, and increased rework cost.

3. DG-TEA Pillars (mandatory)

1) **Benchmark Anchoring** — Primary economics and key ratios must be anchored to authoritative benchmarks (e.g., NREL/DOE) with transparent provenance.
2) **Scope Discipline** — Validated domain, feedstocks, pathways, and scenarios must be explicitly bounded; exclusions and assumptions are stated.
3) **Variance Classification** — Deviations are classified (e.g., Data / Methodology / Implementation) with justification and disposition (accept, remediate, investigate).
4) **Balance Closure & Internal Consistency** — Mass and energy balances must close within stated tolerances; financials must reconcile across statements and assumptions.
5) **Auditability & Reproducibility** — Every reported figure must trace to source data, calculation steps, and versioned assumptions; results must be reproducible from provided inputs.

4. Validation Outcomes (categorical)

- **VALIDATED** — Meets benchmark-anchored criteria across pillars; variances resolved or justified.
- **ACCEPTABLE** — Within defined tolerances with documented variances and mitigations.
- **REVIEW REQUIRED** — Material gaps or unresolved variances; additional evidence or remediation needed.
  Publication of "validation percentages" is prohibited; use categorical outcomes only.

Failure handling: A "Review Required" status on any pillar downgrades the overall study to "Review Required" until evidence is supplied or the variance is remediated. Pillar-level acceptance cannot be used to assert overall validation when any pillar remains open.

Adversarial stance: Assume the reviewer does not trust narrative explanations. Only artifacts, tables, and traceability will be evaluated.

5. Relationship to Existing Standards

- **ASTM E3200** — Aligns with E3200 requirements for process design, cost estimation, and uncertainty treatment.
- **AACE Class 4** — Assumes conceptual-level maturity (±20–30%) unless stated otherwise.
- **NREL / DOE Reference Studies** — Benchmarks and anchor data must cite specific reports (e.g., NREL/TP-5100-92412) and publication years.

6. Intended Use & Limitations

- **Governs:** Benchmark-anchored TEA for capital decisions, diligence, grant applications, and regulatory-facing analyses where defensibility is required.
- **Does not claim:** Certification, endorsement, or approval by any agency; superiority over benchmark sources; universal validity across all technologies.
- **Requires:** Explicit statement of validated domain and exclusions; transparent assumption sets; versioned data and code where applicable.

7. Compliance Matrix (template)

Map each DG-TEA pillar to evidence locations. Example template:

Pillar	Evidence location(s)	Status (Validated / Acceptable / Review Required)	Notes / Variances
Benchmark Anchoring	Section X.Y, Appendix A tables, cited benchmark IDs		
Scope Discipline	Section X.Y (scope), Section X.Z (exclusions)		
Variance Classification	Section X.Y (variance log), Appendix B		
Balance Closure & Internal Consistency	Section X.Y (M&E closure), Section X.Z (financial reconciliation)		
Auditability & Reproducibility	Section X.Y (traceability), appendix with inputs/versions		

8. Formal Citation (examples)

- **APA:** Gomez, J. (2025). *Decision-Grade TEA Validation Standard (DG-TEA v1.0)*.
- **IEEE:** J. Gomez, "Decision-Grade TEA Validation Standard (DG-TEA v1.0)," 2025.
- **DOE/report style:** Gomez, J., 2025. *Decision-Grade TEA Validation Standard (DG-TEA v1.0)*. Internal methodology standard, v1.0, 13 Dec 2025.

9. Governance

- Stewardship: Maintained by the DG-TEA Working Group; originating author listed for provenance only.
- Change control: Versioned releases with date stamps; material changes require a change log and backward compatibility note.
- Evidence: All assumptions, data sources, and calculations must be traceable to versioned artifacts.
- Ambiguity: Defaults to conservative interpretation of benchmarks and tolerances.

10. Escalation, Amendments, and Version Integrity

- Material ambiguities or deficiencies discovered during application must be logged (issue, impact, proposed resolution).
- Resolutions occur via versioned amendments (v1.1+) rather than ad-hoc interpretation.
- v1.0 results remain valid under v1.0 unless explicitly reclassified by a subsequent version.
- Clarifications that change required behavior trigger a new minor/major version; no silent updates.

Appendix A: Minimum Evidence Package (MEP)

Purpose: Define minimum acceptable artifacts to satisfy "traceable" requirements.

Baseline artifacts (all pillars): - Artifact index (required): table with columns `Artifact ID | File | Version | Hash | Pillar | Evidence Type | Upstream Dependency (Artifact IDs)` . - Traceability map (required): machine-readable linkage of inputs → calculations → outputs; references artifact IDs. - Source benchmarks: cited reports with ID/year (e.g., NREL/TP-5100-92412); include file names and access paths. - Input datasets: versioned file names (e.g., `inputs_v1.0_2025-12-13.xlsx`), checksum/hash recommended. - Assumption log: AACE class, discount rate, pricing bases, escalation; versioned. - Calculation versions: code/notebook/worksheet ID and version/date; change log of material updates; execution environment noted if applicable. - Exhibits/tables: labeled with section/table numbers, units, data source references, and dated. - Storage: Archive location recorded (e.g., `./artifacts/<date>_<case>.zip`) with hash and access method.

Benchmark Anchoring: - Benchmark comparison tables with columns: metric, benchmark value, model value, variance, variance class, disposition. - Provenance note per benchmark (cite report section/page if available). - Benchmark metric universe declared up front; coverage table with columns `Benchmark Metric | Included (Y/N) | Reason if Excluded` . Omission without rationale defaults to Review Required. - Expected scope: include all primary economics and key ratios reported in the reference benchmark unless explicitly justified; burden of proof is on any exclusion.

Scope Discipline: - Domain statement, exclusions, and scenario bounds in a dedicated section. - List of out-of-scope technologies/geos/incentives. - Acceptance note: Missing exclusions or bounds defaults the pillar to Review Required.

Variance Classification: - Variance log with class (Data/Method/Implementation), impact, and disposition (Accept/Remediate/Investigate). - Evidence of remediation or rationale for acceptance. - Decision-impact test required for Moderate/High variances: "If this variance moved ±X%, would the investment recommendation change?" Unanswered defaults to Review Required. - X must be justified against a decision threshold (e.g., ±10% MFSP, ±2% IRR, or change in scenario ranking); hand-waving responses are non-compliant. - Acceptance note: Any variance without class + disposition defaults to Review Required.

Balance Closure & Internal Consistency: - Mass/energy balance closure table with targets and achieved values. - Financial reconciliation showing CAPEX/OPEX/throughput/discount alignment across statements. - Acceptance note: Missing closure evidence defaults to Review Required.

Auditability & Reproducibility: - Reproduction steps: required inputs, tools, versions, and commands/workflow to rerun results. - Location of archived inputs/outputs (e.g., `./artifacts/2025-12-13_dg-tea_saf_case.zip`), with version/date. - Reproduction attestation required: who reran, when, environment, and result. "No rerun performed" defaults to Review Required. Fresh-environment rerun preferred/expected. - Reproduction outcomes (internal): Reproduced identically / Reproduced within tolerance / Reproduced with deviations (explain) / Not reproducible. - Acceptance note: Absence of a runnable reproduction path defaults to Review Required. - Final language is subject to approval by Dr. Jamie Gomez, Ph.D.