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RESEARCH & DECISION STUDIO

Making transition investable

Physical energy and emissions balances must precede marginal abatement economics.

Energy, industrial efficiency and decarbonisation

METHODS / EVIDENCE / WORKED STUDIES

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THE DECISION

Making transition investable

A transition investment combines a physical intervention, an emissions claim and a financial commitment. Those propositions can support each other while retaining different boundaries and evidence requirements. This methodological study begins with a defined service and an energy balance, then develops counterfactual emissions, sequential measure interactions, annualised abatement economics and decision-directed verification. Explicitly illustrative studies reproduce the annual electricity Transition lab engine. They expose added-demand effects, tariff dependence, small and zero abatement denominators, annual renewable curtailment and the difference between changing marginal attribution and changing a final package. The study supplies completed records for baseline definition, factor selection, operating envelopes, measurement planning, investment challenge and continuing oversight. It distinguishes a screening calculation from a full industrial electrification appraisal, recognised emissions reporting, verified savings and finance approval. Its conditional thesis is that a physical balance makes a defined transition proposition assessable; neither the balance nor an attractive cost per tonne establishes investability on its own.

Questions this study answers

- What service, baseline and electricity boundary make the proposed energy and emissions comparison valid?
- How do supplied tariffs, factors, operating demand and interacting measures change the annual cash and abatement results?
- When should a favourable annual screening result be held because service readiness, the emissions counterfactual or surplus use lacks support?
- Which verification responsibilities, protected events and stop authority make the next transition commitment and continuing claims defensible?

Scope and limits

Illustrative inputs explain mechanisms and are not actual project data or empirical estimates.

A deterministic model cannot establish implementation feasibility, legal effect, lender acceptance or future outcomes.

Cited public guidance is used only within explicitly stated source scope; institutional frameworks require local adaptation.

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DECISION ARCHITECTURE

01 Investability begins with a physical balance

A transition appraisal charter

Define the claim and the commitment

A transition proposal can sound coherent while making incompatible promises. A supplier may describe lower energy consumption, a sponsor may announce lower emissions, and finance may expect lower operating expenditure. Each proposition refers to a different quantity. Consuming less electricity does not necessarily lower the relevant emissions claim if production or the accounting boundary changes. Lower attributed emissions do not necessarily lower the bill. Lower annual expenditure does not necessarily repay the capital commitment within its useful life. An investment dossier becomes assessable when it makes these relationships explicit, beginning with what changes physically and what service remains comparable.

The opening decision is therefore a charter for the appraisal. The charter identifies the intervention, the service it must deliver, the alternative against which it will be assessed and the commitment currently requested. It also separates claims that the organisation intends to make. A statement about electricity bought by a facility belongs to a different evidential chain from a statement about avoided system emissions. A statement about a screening net present value belongs to a different decision stage from an offer of committed financing. The charter prevents a favourable result in one chain from quietly standing in for missing evidence in another.

Consider a fictional industrial facility investigating demand reduction and an additional supply arrangement. The engineering question concerns how demand changes while the required production service continues. The accounting question concerns how supplied energy and emission factors should be attributed within a declared boundary. The commercial question concerns the expenditure that disappears and the expenditure that is introduced. The finance question concerns capital, timing, contingencies and obligations. These questions share information but cannot be collapsed into a single attractive adjective. Describing the proposal as efficient or green does not identify which proposition has been established.

The energy identities, discounting convention and recognised accounting-method distinctions are not presented as discoveries of this paper. The retained primary material supplies narrow guidance on boundaries, verification and appraisal, and the canonical app supplies the reproducible numerical instrument. The original

contribution is a decision protocol connecting a defined service, a physical comparison, cash terms, claim scope and the authority to make the next commitment. The protocol is demonstrated rather than asserted: the fictional Aster Works case sends computed alternatives through a cash condition, a provisional climate mandate and an unresolved-surplus constraint, then records a different accountable action at each failure. The resulting dispositions cannot be recovered by sorting cost per tonne alone.

The fictional roles are introduced here so the chapter records can be read independently. Idris Ko chairs the decision and stops commitments beyond the authorised scope. Mara Sene owns service and operating interfaces, Nora Vale owns measurement, Owen Diallo owns commercial terms, Leila Chen owns cash and funding interpretation, and Safia Bello owns reporting. All names and delegations are authored teaching conditions. Existing-staff evidence preparation returns at the diligence review before the maintenance-plan freeze. Supply terms and external wording have separate precommitment gates. These event deadlines do not assert a real project calendar, and the recorded evidence gaps do not become verified facts through assignment.

A physical balance provides the first discipline because it requires the proposal to name its inputs and outputs. Electricity demand has to be met by sources that fall within the calculation's boundary. A decrease in an input must correspond to less waste, changed conversion, changed operating duty or changed service. Additional supply has to serve demand, be stored, exported or curtailed according to a stated model. None of those outcomes can be assigned by enthusiasm. A balance also exposes missing carriers. A calculation that records added electricity but omits displaced fuel cannot establish the complete climate effect of electrification.

The boundary is a decision instrument, not a claim that the wider system is irrelevant. A facility calculation can be useful precisely because its limits are manageable. It becomes misleading when the facility result is presented as the consequence for an entire power system or product chain without additional analysis. The analyst should state what crosses the perimeter and what is held outside it. The committee can then decide whether the missing mechanisms could alter the proposed commitment or the intended claim. A narrow model earns credibility through a narrow interpretation.

Evidence and scope

Industrial efficiency and carrier switching depend on process and supply conditions.

Evidence: Climate Change 2022: Mitigation of Climate Change, Chapter 11 Industry

The charter proposed here begins with a service statement. The facility might need a specified product quality, a stable thermal condition or dependable mechanical output. The statement matters because a cheap energy outcome can be achieved by reducing useful service. Such a change may be a legitimate commercial option,

but it should be appraised as a changed production choice. It should not be reported as a technical improvement on an unchanged service. A service boundary also prevents the appraisal from treating unlike energy carriers as interchangeable merely because their consumption is recorded in energy units.

The next element is a credible alternative. Continuing current operation is convenient, but it is not always the action the organisation would take without the proposed investment. Existing equipment may require replacement, regulations may change permissible operation, or a production plan may alter duty. A sponsor who assigns all future improvement to the proposal may overstate its additional contribution. A sponsor who compares it with an impossible continuation may exaggerate both cost savings and abatement. The charter records the decision that the alternative represents and the evidence needed to sustain it.

The intervention must then be decomposed into mechanisms. A motor upgrade, a control change, reduced leakage and a new supply contract can affect different terms in the balance. Their effects may overlap. If a supply arrangement already serves nearly all remaining demand, further efficiency may reduce the amount of supplied energy used rather than the grid energy originally expected. If a demand increase precedes an efficiency measure, the assumed efficiency scope may apply to the added load. A package description should therefore explain which loads each measure affects and how the sequence is interpreted.

Economics follows the same decomposition. Energy charges, demand charges, maintenance, consumables and operating labour do not respond identically to a reduction in annual electricity use. A contract can preserve a fixed payment even when physical consumption falls. A control measure can save electricity while requiring additional maintenance. A new process can change product value or downtime, effects absent from a simple energy-price comparison. The charter should distinguish the cash terms included in the screening model from those still requiring a fuller business case. A preliminary benefit estimate is useful when its perimeter is explicit.

The time basis must also be declared. Annual totals are sufficient for some initial questions and insufficient for others. A calculation can balance annual electricity demand and annual supplied energy without establishing that supply is available when the process needs it. The same calculation can assign constant yearly savings without representing commissioning, degradation or an interruption. The committee should identify which time-dependent questions are material to the proposed decision stage. A concept screen may tolerate an annual approximation; a supply contract or production conversion can require a much more resolved operating case.

A claim-specific appraisal charter

The sponsor names the service, intervention and commitment. Engineering records the physical boundary and the mechanism that changes each input. The emissions reviewer selects the reporting question and factor basis. Commercial staff identify which bill components and operating costs respond to the change. Finance identifies capital timing, cash obligations and conditions outside the screening result. The chair records the evidence gaps that prevent the next commitment and assigns an owner to each. A proposal advances only when the evidence is proportionate to the commitment requested. A missing physical term calls for model development; a disputed claim boundary calls for reporting clarification; a missing contract term calls for commercial investigation.

Separate the propositions before accepting the package

Read each row as a distinct proposition and a distinct route to challenge. This original map does not certify a proposal; it makes the required evidence visible.

Separate the propositions before accepting the package		
Proposition	Evidence record	Unresolved consequence
Useful service is maintained	Production, quality and operating requirements	The apparent saving may result from diminished service.
Energy inputs change as described	Carrier and equipment balance with measure scope	A missing or overlapping input can distort the intervention.
The emissions statement is appropriate	Boundary, factor basis and reporting purpose	A facility attribution may be presented as a system consequence.
Cash expenditure responds	Tariff, contract and maintenance records	Physical savings may not release the assumed cash.
The investment is executable	Connection, downtime, procurement and operating ownership	An attractive screen may describe an unavailable operating state.
The commitment is affordable	Capital timing and obligations in a fuller finance case	A positive screen may leave funding and liquidity unresolved.

Original appraisal architecture. A result in one row does not establish the proposition in another.

The study uses the Transition lab as a disciplined but deliberately narrow numerical companion. It begins with annual electricity demand, applies supplied demand-reduction percentages and added loads sequentially, caps additional annual renewable energy used at remaining demand, and assigns supplied factors and flat energy prices. It annualises upfront capital across a supplied constant horizon and discounts constant annual cash savings. That calculation can expose arithmetic and interaction problems within its boundary. It does not model fuel displacement, useful heat, hourly dispatch, contractual emissions attributes or debt service. Those omissions govern what the examples can establish.

A completed appraisal charter should state what the screening output will be used for. It might support a request for engineering study, identify which tariff term needs confirmation or show that a package deserves comparison with a simpler alternative. It should not default to implementation approval simply because the output has the precision of a financial model. Precision records an arithmetic result conditional on inputs. The authority to commit capital requires a separate judgement about evidence, feasibility and obligations. The charter ties the calculation to that judgement instead of allowing the screen to set its own decision stage.

The charter can also preserve a justified exception. A project with unattractive energy savings might be necessary to meet a service obligation, protect product quality or enable a later conversion. A proposal with an attractive abatement cost might create an unacceptable outage. The committee can recognise such considerations without forcing them into an energy metric. The stronger record states the screening result and the independent reason for the disposition. It also states whether the climate claim remains valid when the investment proceeds for another purpose. A legitimate investment rationale does not repair an inaccurate emissions statement.

Challenge should be directed at the mechanism most likely to change the decision. If the demand response is unsupported, improve measurement or engineering scope. If the result depends on a disputed factor basis, separate the relevant accounting perspectives. If the financial benefit depends on a contractual payment disappearing, inspect the contract rather than refine the discount rate. If sequencing changes the actual final demand, develop the operating envelope. Analytical effort is scarce. Its value lies in resolving a consequential uncertainty, rather than adding detail to assumptions that already have little influence on the disposition.

The charter remains useful after approval because it records the conditions under which the recommendation was made. A change in production, connection terms, operating scope or reporting requirements can invalidate a particular proposition without invalidating every aspect of the investment. Keeping the chains distinct helps the organisation respond proportionately. It may need to revise the claim, renegotiate the contract, repair performance or reopen the capital decision. The purpose of the physical-first architecture is to make these responses traceable, from the service and energy balance to the financial commitment and the public statement.

A screen must be inexpensive enough to use

A sponsor can reasonably object that a full engineering and accounting dossier is excessive before a promising concept has earned investigation. The charter permits incomplete evidence at a preliminary stage. It requires the incompleteness to be connected to the action requested: a concept may justify a measurement campaign or supplier discussion while remaining unsuitable for an irreversible production conversion. The proportionality test concerns commitment as well as analytical effort. A lightweight calculation remains useful when it states its boundary, provisional inputs and intended next action. Requiring final proof at inception would impede exploration; treating exploration as final proof would expose the organisation to unsupported obligations.

A balance is necessary for a defined claim, not sufficient for investability

The charter cannot establish a field service, accounting eligibility or funding source. Its decisive falsifier is a material proposition for which the annual electrical perimeter is inadequate. The committee must adopt the appropriate method or narrow the statement before authorising reliance.

Decision implications

- Separate useful service, energy, emissions, cash and finance propositions.
- Use the boundary to explain what the calculation can establish.
- Direct the next investigation at the uncertainty that could change the commitment.

DECISION ARCHITECTURE

02

The baseline is a model of normal operation

A baseline evidence and measurement worksheet

Make the reference operation auditable

A baseline is a representation of how the relevant system would operate without the proposed measure. It is not merely the oldest bill available or the largest consumption total that can be found. A bill records energy delivered within a billing boundary during particular conditions. The baseline needs to explain the conditions that make that record relevant to the decision. Production, operating hours, product mix, weather, maintenance and shutdowns can change consumption without any technical efficiency improvement. A defensible baseline makes those influences visible before assigning an expected saving.

The first task is to define normal operation for the decision being considered. Normal does not mean perfectly stable or free from unusual events. It means that the operating conditions represented by the baseline correspond to the service and horizon used in the appraisal. A facility planning an expansion should not treat an old low-output year as the counterfactual for a larger future operation. A facility reducing production should not assign the resulting lower energy use entirely to new equipment. The evidence record should explain the reference operation and the reason it represents the relevant alternative.

Equipment boundaries help turn a facility total into a testable mechanism. A measure targeting compressed air should identify the compressors, treatment equipment, distribution losses and users included in its saving claim. If a meter captures other loads, the analyst needs a way to distinguish the targeted service from those loads. Conversely, an equipment meter can omit a supporting system whose demand rises after the intervention. The boundary should follow the causal mechanism rather than stop wherever metering happens to be convenient. The analyst may need an explicitly incomplete record while the missing measurement is commissioned.

Rated power alone is a poor substitute for operating evidence. Equipment can spend much of its available time idle, run at variable load or operate below its design condition. Multiplying a nameplate by an assumed duty can produce a plausible annual total while concealing the very behaviour a control measure is intended to change. The baseline record should distinguish measured consumption, measured operating state and inferred demand. An inference can be useful when its basis is transparent. It should not acquire the status of measurement because it appears in the same worksheet.

Production is especially important when the saving mechanism concerns intensity. A lower energy requirement per useful output can coexist with higher total energy use if output increases. A lower total can coexist with worse intensity if the facility runs at inefficient low load. Neither finding is contradictory. They answer different questions. The baseline should retain the service denominator and the absolute carrier balance where both matter. An investment committee may value increased production, but the resulting demand must remain in the emissions and commercial assessment rather than disappear behind an intensity improvement.

Evidence and scope

A measurement plan documents baseline conditions, savings methods and responsibilities.

Evidence: Measurement and Verification Activities Required in the Energy Savings Performance Contract Process

A useful evidence record distinguishes provenance from confidence. Provenance states where a reading, contract term or engineering estimate came from. Confidence states the reason it is adequate for the intended decision. A meter

record can have clear provenance but weak confidence because its calibration, completeness or boundary is unresolved. A supplier estimate can be clearly attributable but unsuitable for a commitment because it assumes a duty the operator cannot maintain. Keeping these fields separate prevents a document reference from being mistaken for assurance.

The record should also preserve exclusions. A planned shutdown, temporary product trial or meter failure may warrant excluding a period from a normal-operation baseline. That choice needs an explanation of the event and its consequence. Excluding only high-consumption periods can understate normal demand; excluding only low-consumption periods can overstate the saving opportunity. The issue is the coherence of the operating representation. An exclusion should be justified by the reference operation and applied consistently, rather than selected because it improves the investment result.

Where adjustments are necessary, the adjustment rule should be declared before evaluating savings. Routine changes might be associated with production or ambient conditions within an established operating range. A structural change, such as adding a process line, can require a separate treatment. The analyst should avoid allowing an adjustment to absorb every disappointing outcome. If the rule is chosen after the performance result is known, it can become an explanation that cannot be falsified. A baseline plan should state how change will be detected, who authorises the adjustment and which evidence supports it.

Uncertainty should be attached to the relevant baseline term rather than expressed as a general feeling about the project. Missing production records affect the ability to distinguish intensity from output changes. Uncertain meter coverage affects the relation between the reported total and the targeted load. An unresolved operating plan affects the future reference case. Those uncertainties call for different actions. Adding a contingency to capital does not repair an ambiguous load boundary. Reducing the saving assumption does not establish whether the same service is delivered. The evidence gap determines the next investigation.

The annual electricity engine uses a supplied baseline demand rather than estimating one from raw operating records. This is an important interface choice. It allows the numerical study to focus on how measures transform an explicit annual demand, but it places the burden of baseline selection outside the computation. A user must not infer that the calculator validated meter quality, production comparability or normal conditions. The completed illustrative record below makes that limitation visible instead of leaving the supplied demand as an unexplained number at the top of a form.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Completed Aster Works baseline scoping decision

The fictional facility record is intentionally incomplete as a diligence record. It supplies an assumption for a reproducible screen, assigns the missing evidence and identifies the commitment that remains unavailable. No equipment, meter or production history is represented as measured.

Completed Aster Works baseline scoping decision		
Record field	Completed entry	Decision consequence
Service perimeter	Existing production service retained as a conceptual assumption; equipment duty not supplied	Confirm product and operating requirements before equipment selection.
Annual electricity demand	10,000.00 MWh/year, illustrative supplied total	The calculation transforms this annual total; it does not validate its provenance.
Meter and period evidence	No actual readings, calibration or operating period supplied	Commission baseline evidence before guaranteeing savings.
Production comparability	No actual output, quality or product-mix series supplied	A measured intensity claim cannot yet be made.
Adjustment responsibility	Fictional operator to define production and structural-change rules before commitment	Do not choose a correction after seeing the saving result.
Permitted next action	Use the screen to scope engineering and measurement work	Implementation and verified-savings claims remain conditional.
Accountable evidence	Nora Vale owns EW-METER, currently absent raw readings; Mara Sene owns EW-SERVICE, currently an unchanged-service assumption	Prepare meter boundary and logging specification before the maintenance-plan freeze.
Authorised commitment	Existing-staff baseline scoping only; no performance guarantee or meter installation	Idris Ko retains implementation hold until a relevant measured reference and service record exist.
Stop authority	Mara Sene stops any task that interrupts accepted production; Nora stops a baseline presented as measured without readings	Return the gap and permitted scope at the diligence review.

Original completed record for the foundation study. All numerical inputs are illustrative; an empty evidence proposition is not a zero value.

Match baseline confidence to the next commitment

The reviewer identifies the service and the load targeted by the measure, then maps each supplied baseline term to a measurement or explicit assumption. The operating owner confirms that the represented duty matches the relevant alternative. The measurement lead records exclusions, gaps and adjustment rules. If the baseline supports only a concept screen, the recommendation names the engineering or measurement action that would upgrade it. A guarantee, public saving claim or irreversible conversion needs evidence appropriate to that obligation. The review should close a specific missing proposition rather than request indiscriminate additional data.

A baseline can be reproducible without being representative. Another analyst might follow the same extraction rules and obtain the same annual total from a retained dataset. That is useful for detecting arithmetic or selection errors. It does not prove that the chosen period corresponds to the relevant future operation. Reproducibility and representativeness should therefore be reviewed separately. The former concerns whether the record can be reconstructed; the latter concerns whether the reconstructed record answers the intended decision question. A retained dataset helps both reviews but does not settle either by itself.

The baseline should contain an account of deterioration and replacement. If existing equipment is near the end of its usable life, continuing present operation indefinitely may be an inappropriate alternative. The comparison may need to distinguish ordinary replacement from the incremental transition feature. Conversely, assigning improvement from an already committed maintenance programme to a new proposal can double count its contribution. The operator should identify which actions are discretionary, which are already planned and which are necessary to maintain service. This turns the baseline into a decision alternative rather than a frozen photograph.

A baseline does not have to contain every possible future condition. It should contain enough information to test conditions that can materially change the measure's effect. An annual estimate might be adequate to reject an obviously uneconomic concept before expensive instrumentation. A load-shifting proposal may require temporal records from the outset because its mechanism depends on timing. A process conversion may require quality and temperature evidence because total energy alone cannot establish comparable service. Proportionality concerns the causal question, not a universal amount of data to collect for every proposal.

The evidence record can support useful disagreement. Engineering may regard a supplier's duty assumption as technically plausible, while operations knows that production constraints prevent that duty. Finance may prefer a conservative baseline, while the measurement team warns that an arbitrary reduction

undermines the adjustment method. The record should capture the disputed proposition and the evidence that could resolve it. Averaging opinions does not necessarily produce a defensible operating case. Where an unresolved alternative is plausible, retain separate cases and show how the commitment depends on the choice.

After commissioning, the baseline becomes part of a continuing comparison. The organisation should retain the original service perimeter, adjustment rules and reasons for exclusions, alongside any authorised revision. Otherwise a later analyst can report a change in consumption without knowing whether it represents savings, a production change or a new boundary. A transparent baseline history supports learning when a measure underperforms. It also protects a valid performance result from being dismissed merely because operating conditions have changed. The record gives both success and failure an interpretable reference.

Imperfect evidence need not prevent investigation

A small facility may lack detailed meters or a stable production history. Refusing all preliminary comparison would deny useful improvements to precisely the sites with weak information. The proposed record permits engineering estimates and temporary measurement, provided their status is explicit and the authorised action remains proportionate. The counterargument becomes decisive when the cost of better information exceeds its likely decision value. In that situation the committee can accept a bounded uncertainty or choose a reversible trial. It should record the risk it accepts rather than present an inferred baseline as verified operating evidence.

The screen does not estimate a baseline from operations

An annual input can be reproducible yet unrepresentative. Missing calibration, meter coverage or service history keeps EW-METER at assumption status. A compulsory replacement or structural production change would require Nora Vale to revise the without-project reference before a performance obligation is accepted.

Decision implications

- A reproducible baseline can still be unrepresentative.
- Keep provenance, adequacy, exclusions and adjustment rules distinct.
- The annual demand input transfers baseline responsibility to the user.

DECISION ARCHITECTURE

03 Energy units carry different physical meanings

A unit dictionary and conservation check

Keep quantities, stages and periods distinct

An energy balance can fail before its arithmetic begins if the quantities being combined have different meanings. Power describes a rate of energy transfer. Energy describes a quantity accumulated over an interval. An equipment rating is therefore not an annual consumption record, and an annual consumption record does not establish peak demand. A proposal that lowers annual electricity use can still increase the capacity needed at a critical moment. A proposal that reduces a peak can leave annual consumption largely unchanged. The unit dictionary should preserve these distinctions because different engineering and commercial decisions depend on them.

Units also have boundaries. Electricity at the facility meter, fuel energy entering a furnace and useful heat reaching a material can all be expressed as energy while referring to different stages of conversion. Adding them without identifying the stage can double count an input or confuse useful service with purchased energy. A furnace consumes fuel to deliver thermal service through a process with losses. An electrical process consumes electricity to deliver service through its own conversion and control arrangement. Comparing the purchased energy totals alone does not establish whether the same service is provided.

The analyst should write the physical quantity before choosing the unit. A field labelled consumption is ambiguous if it could mean fuel volume, electrical input, delivered heat or a bill amount. A field labelled capacity is ambiguous if it could mean rated power, process throughput, grid connection or energy storage. Naming the quantity disciplines both data collection and later interpretation. The unit then provides a consistency check. A cost per unit of purchased electricity cannot be multiplied by useful heat without a conversion relation that describes the actual equipment and operating state.

Conversion efficiency is a relationship between specified inputs and outputs. Its meaning depends on the boundary and the operating conditions. An equipment efficiency stated at a design point may not represent the annual duty. An efficiency improvement can reduce losses while leaving an important operating constraint unchanged. A service improvement can require a different quality of output that changes the appropriate comparison. The dictionary should record what enters the denominator, what enters the numerator and which operating envelope makes the ratio relevant. The word efficient is insufficient without that record.

Useful heat introduces a quality question as well as an energy quantity. A process can need a temperature, distribution pattern or response that a proposed technology cannot deliver reliably. Recoverable heat may be available at a condition unsuitable for the required service. Treating all thermal energy as fully interchangeable can create an apparent saving that the production process cannot use. This study does not supply a thermal engineering model. It uses the heat example to show why energy units alone do not establish service equivalence, and why a broader electrification appraisal needs an operating specification.

Evidence and scope

Energy and power are distinct physical quantities with distinct SI units.

Evidence: *The International System of Units (SI)*, NIST Special Publication 330

A practical dictionary should distinguish physical units from reporting conventions. Electricity demand is an energy quantity over the declared period. A supplied emission factor links a specified energy basis to an attributed emissions quantity. A price links an energy quantity to a particular commercial charge. An efficiency percentage expresses a proportional change in the particular demand to which it applies. An annual cost and an upfront capital cost have different time bases. Keeping these fields separate prevents a technically valid multiplication from answering the wrong accounting or financial question.

The renewable supply field requires particular care. In the annual electricity engine it represents an additional annual quantity available within the illustrative balance. The quantity actually used cannot exceed the remaining annual demand. Any supplied quantity beyond that cap is labelled curtailed in the simplified annual model. This convention does not represent a storage asset, an export agreement or hourly coincidence. It prevents the screen from assigning negative grid demand or unlimited savings to excess supply. It also tells the user which more detailed questions the annual cap cannot resolve.

The cost per tonne field combines another set of bases. The numerator is an annualised net cost within the supplied horizon and discount convention. The denominator is annual modelled abatement within the supplied emissions boundary. The result is meaningful only when the abatement denominator is positive and the numerator and denominator describe the same package and period. A raw capital amount divided by annual abatement would have a different interpretation. A discounted lifetime financial amount divided by an annual emissions quantity would also require explicit treatment. The dictionary should prevent those bases from drifting between tables.

Currency units need an economic convention as well as a label. A flat supplied energy price says nothing by itself about escalation, tax, foreign-exchange exposure or the distinction between real and nominal analysis. The illustrative engine uses constant supplied prices and constant annual savings. A user who intends a real project appraisal should choose a coherent price and discount basis in a fuller

model. Relabelling a currency amount cannot make incompatible bases consistent. The limitation is especially important when a long-lived physical intervention is compared with commercial terms that can change during its life.

A unit check should be paired with a conservation check. The first asks whether each operation combines compatible quantities. The second asks whether the resulting physical state has accounted for its inputs and outputs within the boundary. A calculation can pass a unit check while losing an energy source, because omitted energy still has compatible units. It can pass a simple total while counting the same supplied energy under overlapping measures. The reviewer should therefore ask both whether the arithmetic is dimensionally meaningful and whether the state it describes can be reconciled to the measure scopes.

A quantity dictionary for the annual electricity screen

The dictionary states the physical and decision meaning of each quantity. Fields outside the schema are included as boundary questions rather than represented as hidden model outputs.

A quantity dictionary for the annual electricity screen			
Quantity	Unit or basis	Meaning to preserve	Boundary question
Electricity demand	MWh/year	Annual electrical input within the supplied perimeter	Does this include every load affected by the measures?
Power or connection need	Rate of energy transfer; outside the schema	Instantaneous or capacity requirement	Can the connection and equipment meet the operating peak?
Useful thermal service	Thermal output with process conditions; outside the schema	Heat reaching the required material and condition	Does the alternative deliver equivalent usable service?
Emission factor	tCO ₂ e/MWh on a declared attribution basis	Emissions assigned to a specified supplied quantity	Is the factor appropriate to the reporting question?
Energy price	USD/MWh in the illustrative screen	Flat variable charge applied to energy used	Which demand, fixed or contractual charges remain?
Abatement cost	USD/tCO ₂ e using annualised net cost	Package or incremental cost per positive annual reduction	Are the numerator and denominator aligned and stable?

Original unit architecture. Supplied factors, prices and efficiencies are assumptions; the dictionary does not validate them.

The final annual supply reconciliation

$E_{\text{final}} = E_{\text{grid}} + E_{\text{renewable_used}}$. $E_{\text{renewable_used}}$ does not exceed E_{final} . $E_{\text{renewable_curtailed}}$ is supply outside the used annual cap.

Canonical annual electricity balance expressed symbolically. No storage, export or hourly dispatch is represented.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Completed Aster Works annual reconciliation record

The supplied foundation case can be reconciled directly from its canonical output.
The check concerns the annual electricity state, not evidence of a physical installation or hourly operability.

Completed Aster Works annual reconciliation record		
Check field	Frozen value	Interpretation
Final demand	8,000.00 MWh/year	The demand after the supplied sequential measures.
Grid energy used	3,500.00 MWh/year	The remaining annual supply requirement.
Additional renewable energy used	4,500.00 MWh/year	The annual supplied energy admitted within demand.
Additional renewable energy curtailed	0.00 MWh/year	Annual supplied excess under the simplified cap.
Temporal validation	Not represented	Matching annual totals does not establish availability at operating times.
Accountable evidence	Leila Chen owns EW-CALC; canonical annual fields reconcile, with no hourly or thermal evidence	Retain the scalar ledger before circulation of the diligence brief.
Authorised use	Internal numerical reconciliation of the supplied annual electricity case only	No grid-capacity or service-availability conclusion is released.
Stop authority	Leila Chen stops circulation if units, stages or pointer identities differ from EW-CALC	Resolve the discrepancy before the briefing-signature gate.

Canonical foundation output pointers. This is an illustrative conservation receipt with an explicit scope.

Reject a quantity substitution before refining the result

The reviewer traces each reported benefit to a named physical or economic quantity, its unit, its time basis and its boundary. A proposed substitution is accepted only when an explicit relation connects the quantities under relevant operating conditions. Rated power does not become annual consumption without duty; purchased energy does not become useful service without conversion; annual supply does not become hourly availability without timing; an attributed emissions factor does not become a marginal consequence without a compatible method. If the relation is missing, the model must be expanded or the claim narrowed before the result is used.

The dictionary should remain stable across scenarios. If a favourable case interprets efficiency as a reduction in total facility demand while an adverse case applies it only to a targeted subsystem, the comparison changes more than the parameter. If a supply quantity means generated energy in one case and delivered usable energy in another, losses and curtailment have moved outside the record. Sensitivity is interpretable when the meaning of each field remains fixed while an explicitly stated assumption changes. Where the meaning must change, define a different model or study rather than silently reusing the same label.

A conservation failure can have a useful diagnostic consequence. Negative grid demand indicates that supply has exceeded a permitted demand cap without an explicit export or storage treatment. A missing carrier indicates that the calculation is incomplete for the intended intervention. A discrepancy between equipment and facility totals can reveal loads, losses or metering boundaries requiring investigation. The reviewer should use the discrepancy to identify the missing mechanism. Forcing the totals to agree with an unexplained adjustment would remove the diagnostic value while leaving the actual operating question unresolved.

Finally, numerical precision should reflect the distinction between computation and evidence. The engine can carry detailed arithmetic from supplied values, and the ledger retains exact results for replication. The manuscript displays quantities at an appropriate readable precision. Neither practice establishes that a demand, price or factor is known with the same confidence. The unit dictionary and evidence record should travel with the result so the reader can distinguish an exact conditional calculation from an uncertain input. A polished number becomes useful when its meaning and evidential basis remain visible.

Annual totals can be the right first abstraction

A full temporal and thermodynamic model is unnecessary for every early decision. Annual electrical inputs can be sufficient to reveal a weak concept, compare bounded packages or specify the next measurement need. The abstraction is legitimate when the question can be answered at that resolution and when omitted timing or service quality is unlikely to change the preliminary action. The objection to unnecessary complexity should therefore guide method selection. It should not turn an annual screen into proof of peak capacity, process suitability or marginal system emissions. The boundary gives the simple model its appropriate use.

Units do not validate service or factors

A reconciled annual electrical state does not establish capacity, thermal quality or availability during production. A measured mismatch between the declared stages or carriers would require a wider balance. The curtailment cap is a screening convention, not an operating or purchase-right determination.

Decision implications

- Dimensional consistency and physical completeness are separate checks.
- Energy quantities at different conversion stages require explicit relations.
- Annual renewable matching has no inherent hourly or contractual meaning.

DECISION ARCHITECTURE

04

Accounting boundaries change the emissions result

An emissions boundary decision framework

Route each emissions proposition to its evidence

The same physical intervention can support different emissions questions. An organisation may need to account for emissions assigned to its operations, estimate how a project changes emissions relative to an alternative, or explain a comparative impact associated with a product or service. These questions can use overlapping energy information while differing in boundaries, factors and counterfactuals. A single emissions total cannot answer all of them simply because it is expressed in tonnes. The reviewer should identify the statement being made before choosing the accounting method or interpreting the numerical result.

An inventory statement is tied to a reporting entity and a defined accounting perimeter. A project-change statement is tied to an intervention and an alternative that would occur without it. A comparative product statement is tied to a specified function and a comparison. Confusing those purposes can create a claim that appears to cancel one kind of emissions with another. An improvement estimated beyond the inventory boundary should not be silently deducted from an inventory figure. The organisation can communicate distinct statements, but each needs its own method and a clear relation to the underlying physical activity.

The practical consequence appears in a supply-switch example. A facility can record the same annual electricity demand after changing its supply arrangement. Its attributed purchased-energy emissions might change under an appropriate accounting basis. A separate estimate of the consequence for generators would require a counterfactual power-system question. The physical demand at the facility has not disappeared, and the procurement statement alone does not identify which generation changed. An analyst should not use the contract's label to infer an unmodelled system response or use a system estimate to bypass contractual reporting requirements.

An efficiency example raises another boundary issue. Lower electricity input for the same facility service can reduce energy associated with that operation. If production moves elsewhere, a facility reduction may coexist with emissions outside the chosen perimeter. If demand increases because the process becomes cheaper or supports expansion, the total consequence may differ from the fixed-service case. The paper does not assume that every such effect occurs. It requires the analyst to identify which effects are material to the intended statement and whether the selected boundary captures them.

A boundary also determines ownership of the evidence. The operator may hold meter and production records, the supplier may hold generation and contractual attributes, and a reporting programme may specify the conditions for recognised statements. A project analyst can combine public guidance with retained records, but cannot establish another party's attributes by assumption. The claim map should show which propositions depend on third-party evidence and which require an authorised interpretation. Missing ownership or eligibility information should remain a gap, rather than being converted into a convenient emission factor.

Evidence and scope

Corporate inventory guidance differs from quantifying project reductions for credits.

Evidence: Corporate Accounting and Reporting Standard

Evidence and scope

Project assessment specifies its boundary, baseline procedure and monitoring.

Evidence: The GHG Protocol for Project Accounting

The original decision map proposed here starts with the audience and use of the statement. An internal investment committee may need a bounded physical comparison to decide whether to fund investigation. A public inventory needs the applicable reporting rules and complete perimeter. A contractual performance obligation needs a measurement and attribution rule that the parties can administer. A credit application needs the relevant programme conditions. These uses may all concern the same asset, but they do not share an automatic evidential threshold. The audience matters because it determines which claim is being relied upon.

The map next identifies the functional comparison. A reduction should not be credited merely because the project delivers less of the required service. If a product comparison is intended, the service and relevant lifecycle perimeter need to make the alternatives meaningfully comparable. If a project counterfactual is intended, the alternative should be credible for the decision context. If an

inventory statement is intended, the reporting perimeter should remain coherent under the applicable rules. The analyst should write the comparison in plain language so reviewers can challenge it before reviewing the calculation.

The factor basis follows the question. A factor associated with annual average generation describes a different relationship from an estimate of the generation response to a change in load. A contractual attribution can differ again. These differences do not make every factor wrong. They make interchangeable use wrong when the basis changes the meaning of the statement. The reviewer should identify the energy quantity the factor applies to, its geographical and temporal scope, its treatment of upstream effects and the reporting purpose for which it is being used. The resulting uncertainty belongs in the claim record.

Completeness needs to be assessed in relation to the chosen boundary. A facility electricity screen can be complete for its annual electrical terms while incomplete for an industrial fuel switch. A project assessment may require secondary effects beyond the immediate equipment. An inventory may require other activities that are irrelevant to a narrow concept comparison. The analyst should resist a generic assertion of completeness. The appropriate statement names the terms included, the relevant excluded effects and the reason the exclusions do or do not prevent the intended next action.

The distinction between attribution and consequence should survive executive reporting. A short summary can state that a supplied-factor annual electricity comparison indicates lower attributed emissions under the illustrative assumptions. It can separately state that contractual eligibility and system effects remain unassessed. Shortening the report should not broaden the claim. The committee needs enough precision to know whether it is considering an internal screen, a recognised inventory statement or a consequential reduction estimate. That precision protects both a legitimate investment and the credibility of its public description.

Evidence and scope

Comparative emissions statements require a defined equivalent function and separate method.

Evidence: Estimating and Reporting the Comparative Emissions Impacts of Products

Separate statements can expose apparent disagreement that is actually a difference in purpose. An accounting reviewer may reject a contractual attribution while engineering still expects lower physical demand. A power-system analyst may question marginal benefit while the facility inventory follows a recognised reporting basis. The organisation should not resolve that disagreement by selecting whichever total is smaller. It should identify which statement each

method supports and why the methods differ. The audience can then evaluate the relevant result without being invited to mistake different quantities for competing measurements of the same thing.

The map also supports disciplined revision. Reporting standards, contractual instruments or baseline evidence can change after the physical asset is installed. The organisation may need to revise a statement without undoing the investment. Conversely, if a credit or incentive is essential to the business case, a claim revision can require a financial reassessment. The appraisal should record this dependence from the outset. That record distinguishes a disclosure adjustment from a failure of physical performance and from a material change in the investment rationale.

A narrow claim can be more useful than an expansive but unsupported one. Saying that the annual electricity balance falls under specified assumptions identifies a proposition another analyst can reproduce and challenge. Saying that the project decarbonises the entire production system invites questions the screen cannot answer. The discipline is to use language that follows the method and evidence. This does not diminish the opportunity. It clarifies what has been established and directs the additional work needed before the organisation relies on a broader transition statement.

Select the statement before selecting the method

This original claim map separates uses that can coexist in the same investment dossier. It states the record needed for each use rather than treating one calculation as a universal accounting certificate.

Select the statement before selecting the method			
Intended statement	Comparison or perimeter	Evidence to establish	Common category error
Internal electricity screen	Annual demand and supplied energy assumptions	Explicit input and factor bases	The screen is described as verified corporate reporting.
Corporate inventory	Reporting entity and applicable accounting perimeter	Inventory data and applicable reporting treatment	An external comparative benefit is netted into the inventory.
Project change	Credible alternative and intervention effects	Baseline, boundary and monitoring design	A historical total is treated as the complete counterfactual.
Comparative service impact	Comparable useful function and declared system perimeter	Equivalent-function evidence and appropriate comparison	Reduced service is presented as a technical emissions improvement.
Contractual performance or credit	Applicable agreement or programme conditions	Accepted attribution, eligibility and verification records	A favourable model result is treated as ownership or acceptance.

Original boundary synthesis. Published guidance retains its own applicability; this table is an analytical routing record.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Completed Aster Works statement-scope decision

The foundation study is retained as an internal annual electricity screen. It does not become an inventory, a recognised credit or a power-system estimate through the precision of its output.

Completed Aster Works statement-scope decision		
Claim field	Completed record	Excluded inference
Reported quantity	2,190.00 tCO2e/year final attributed electricity emissions	No full facility inventory is supplied.
Comparison result	3,810.00 tCO2e/year reduction from the supplied baseline	No displaced fuel or system dispatch consequence is computed.
Factor basis	Supplied illustrative grid and renewable factors on a common declared screening basis	No regional, contractual or lifecycle factor is verified by the input.
Permitted use	Scope engineering and accounting investigation	Do not claim programme acceptance or ownership of a credit.
Next evidence owner	Operator for demand; reporting reviewer for basis; supplier for relevant attributes	The calculator cannot attest to third-party evidence.
Accountable evidence	Safia Bello owns EW-CLAIM and EW-FACTOR; the statement is an illustrative annual attribution	Retain the exact internal wording before the claim-signature gate.
Authorised use	Reader learning and internal development; recognised inventory, credit and system claims withheld	Idris Ko permits the narrower statement without treating it as external reporting.
Stop authority	Safia Bello stops a statement that broadens the perimeter or implies ownership without evidence	Reopen at a proposed audience, factor or reporting-method change.

Original completed claim record using canonical foundation scalar pointers. All numerical values are illustrative.

A claim may advance independently of the investment

The committee records the proposed physical investment and the proposed statement separately. For each statement, the reviewer names the audience, method, perimeter, counterfactual where relevant, factor basis and evidence owner. If the investment can proceed for service or commercial reasons while the public claim remains unsupported, the decision can authorise the investment with a narrowed statement. If a particular recognised claim is essential to revenue or compliance, missing eligibility evidence becomes an investment condition. The record preserves this dependence so a later change in reporting treatment prompts the right response.

Different methods can burden a concise decision

An executive audience may find multiple emissions statements confusing and prefer a single headline. A concise dossier can still distinguish the purpose of its headline, state the chosen boundary and flag the material excluded perspective. The full evidence map can remain in supporting records. The objection is strongest when alternative perspectives would not change the immediate action and are clearly irrelevant to the intended claim. It is weakest when a smaller total has been selected precisely because it improves the narrative. Concision should remove redundant explanation while preserving the meaning on which the reader is being asked to rely.

No recognised emissions statement is certified

A claim fails this review if its wording, perimeter or ownership implication exceeds its accepted method. The retained guidance has distinct inventory, project and comparative purposes. A future proposal is not an issued replacement. Safia Bello must review applicability before an applied external statement.

Decision implications

- An inventory, project change and comparative impact are distinct questions.
- A lower displayed total does not select the appropriate accounting basis.
- Record how a recognised claim affects the investment rationale.

MECHANISMS AND WORKED STUDIES

05 Efficiency reduces a specified input requirement

A physical savings decomposition

Identify the mechanism and its affected base

An efficiency claim needs to identify the input requirement that falls while the relevant service is retained. The improvement might come from reduced conversion losses, better control of a variable load, repaired leakage or avoided waste. It might instead come from producing less, operating fewer hours or supplying a different product. Those changes can all reduce total energy, but they describe different decisions. A decomposition should show which mechanism drives the expected reduction and which conditions preserve comparable service. Otherwise a useful commercial change can be misreported as a technical performance improvement.

Technical efficiency concerns the relation between a specified useful output and its input under defined operating conditions. Utilisation concerns how equipment capacity and time are used. Production scale concerns the amount of output

required. Material efficiency concerns the material needed to provide a function, which can influence processing energy through a different pathway. These mechanisms can interact, but their evidence differs. An equipment test does not establish future utilisation. A production plan does not establish a better conversion relation. A reduced reject rate does not automatically imply the same electricity saving in every supporting system.

The distinction matters when the sponsor presents an intensity figure. A facility can use less energy per accepted product because it reduces rework, improves a process or changes product mix. It can also report a better intensity because a fixed supporting load is spread over more output. In the latter case total energy may rise. The analyst should retain both the useful-output relation and the absolute input required by the proposed operation. The committee can then value the production change while separately evaluating its energy, emissions and cash implications. A favourable ratio should not erase a larger total.

Load control provides another example. A variable-speed device may reduce unnecessary input when the service requirement falls, but the saving depends on the load pattern and the system it controls. A nameplate improvement is not enough to predict the operating result. A leakage repair can remove a loss while a production expansion increases demand elsewhere. A maintenance intervention can restore previously degraded performance without changing the design limit. Describing each mechanism and its affected load helps the reviewer distinguish a reasonable operating estimate from a generic percentage imported from a different context.

The measurement perimeter must follow the decomposition. If a measure targets a subsystem, the saving should be linked to that subsystem or converted into an explicitly supported facility effect. Applying a subsystem percentage to the entire facility overstates the reduction unless the subsystem represents the whole supplied demand. Conversely, a facility meter can conceal a valid subsystem improvement behind changes in unrelated loads. The analyst should identify the affected base and the unaffected remainder. The annual engine does not make that distinction automatically; its supplied efficiency percentage applies to the remaining demand represented in the model.

Evidence and scope

Industrial efficiency levers include motor systems, process optimisation and material efficiency.

Evidence: *Energy Efficiency 2025: Industry*

The efficiency-only study deliberately treats the supplied percentage as an overall demand reduction within the declared annual electricity perimeter. It holds added demand and additional renewable supply absent, retains the same factor and price bases, and assigns upfront capital plus continuing operating expenditure. The result therefore isolates the screen's demand-reduction mechanism. It does not

identify an actual motor, infer a measured load curve or establish a supplier guarantee. The study is useful because the conditional balance and economic effect can be reproduced without inventing equipment evidence.

A measure specification should say whether the percentage applies before or after another intervention. The annual engine applies the measure to the demand remaining at its position in the sequence. This prevents a collection of percentages from being added as though every measure removes a separate portion of the same original demand. It is a useful accounting convention, but not a technical law. Real measures may affect the same load, different loads or loads created by an earlier intervention. The engineering record must justify the interpretation before sequential arithmetic can represent the package.

The annual reduction also needs an operating commitment. A saving attributed to a control strategy may depend on settings, operator practice or a production schedule. A repair may require continuing inspection to prevent the loss from returning. A process change may require a quality-control arrangement that preserves accepted output. Those conditions belong in the investment case because the measure is an operating system rather than a purchased object. The capital item can be delivered while the assumed saving fails to persist. A decomposition should link the physical mechanism to the owner who maintains it.

The financial terms should preserve gross and net savings. Reduced energy expenditure is the gross energy-cost effect under the supplied flat price. Continuing measure expenditure reduces the cash saving available to offset capital. If the sponsor reports gross energy savings as the annual cash benefit while omitting required operating costs, the package economics become overstated. The canonical output keeps the energy-cost saving and the net annual saving distinct. This separation lets the reviewer see whether a disagreement concerns physical demand, price exposure or the cost of maintaining the intervention.

The emissions consequence is equally conditional. A lower electricity input multiplied by the same factor basis lowers attributed electricity emissions in this fixed-service study. A different factor basis or increased demand can change that relationship. The example does not establish marginal power-system response or an inventory consolidation. Its value is to show the link between the supplied physical reduction and the factor-based annual comparison. The reviewer can then decide whether a broader emissions statement requires additional boundaries or a different method.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The demand-reduction mechanism in the efficiency-only study

The study holds supply-switch and added-load terms absent while changing demand through the supplied efficiency assumption. All quantities are illustrative canonical scalars. Canonical efficiency-only input and output pointers. Energy-cost saving precedes measure operating expenditure; net annual saving includes it.

The demand-reduction mechanism in the efficiency-only study		
Mechanism field	Frozen quantity	Interpretation
Supplied reduction	20.00 %	Applies to the remaining annual demand in the model perimeter.
Demand before measure	10,000.00 MWh/year	The specified reference electricity requirement.
Demand after measure	8,000.00 MWh/year	No additional load or new supply is introduced.
Energy-cost saving	240,000.00 USD/year	The gross variable energy-charge effect.
Measure operating expenditure	10,000.00 USD/year	The continuing supplied cost of the measure.
Net annual saving	230,000.00 USD/year	The cash benefit entering the simplified constant-annuity calculation.
Annual attributed abatement	1,200.00 tCO ₂ e/year	Reduction using the unchanged supplied factor basis.

Completed Aster Works affected-load disposition

The fictional efficiency screen has a clear conditional mechanism and an incomplete equipment evidence base. The completed entries state what may be used now and what requires development.

Completed Aster Works affected-load disposition		
Decomposition question	Completed entry	Follow-up action
What input falls?	Annual electricity demand within the whole supplied screening perimeter	Reconcile the targeted equipment load to that perimeter.
What service is retained?	The existing useful production service is assumed unchanged	Confirm output, quality and operating requirements with operations.
What mechanism explains the reduction?	A supplied overall efficiency assumption; no device test or load profile provided	Develop the relevant technical and operating evidence.
What other changes occur?	No added load or supply switch in this isolated study	Keep expansion and carrier changes in separate cases.
What sustains the saving?	Continuing measure operating expenditure is included; specific maintenance conditions not supplied	Assign settings, maintenance and performance review responsibility.
Accountable evidence	Mara Sene owns EW-SCOPE; whole-meter efficiency is supplied, with no actual device or duty support	Nora Vale prepares the affected-load map before engineering-scope acceptance.
Authorised commitment	Existing-staff mapping and service reconciliation only; no equipment performance guarantee	The assumed percentage stays a screening input until the affected base is supported.
Stop authority	Mara Sene stops a subsystem estimate applied to the whole meter without reconciliation	Return the revised perimeter at the diligence review before procurement freeze.

Original completed engineering-screen record. No performance observation or actual equipment specification is asserted.

Classify the saving before accepting its percentage

The reviewer names the changed input, useful service, operating conditions and affected load. The sponsor identifies whether the reduction comes from conversion, control, waste, utilisation, scale or material change. The evidence owner links the percentage to the relevant base. Package effects are then reviewed for overlap and changed duty. A saving advances as a technical efficiency claim only when service comparability and mechanism evidence support that description. Otherwise it can remain a legitimate production or operating alternative with its different implications stated explicitly.

The decomposition changes procurement. A supplier offering an efficient device should be evaluated against the operating state in which its benefit is expected, including interfaces with the wider system. A supplier delivering a control strategy should provide an implementable operating arrangement and evidence relevant to the load pattern. A maintenance proposal should identify how restored

performance will be checked and preserved. The buyer should avoid procuring a metric detached from a service. The evidence record connects the claimed reduction to the acceptance criteria for the actual intervention.

It also changes the verification question. If production falls after commissioning, the lower meter total cannot by itself show that the proposed efficiency mechanism worked. If production rises, a higher total cannot by itself show that the mechanism failed. A useful verification design follows the affected load and adjusts for the declared operating conditions using an agreed method. The original decomposition helps reviewers locate what must be measured and which adjustments might be justified. It prevents an after-the-fact story from replacing a testable physical proposition.

The committee should use the isolated study to identify a decision condition rather than announce a universal saving potential. The conditional arithmetic may justify developing equipment and duty evidence, comparing an alternative measure or investigating an operating cost. It does not show how common the supplied percentage is or how likely the facility is to achieve it. A stronger recommendation states which mechanism has support and which missing proposition would change the action. This preserves the educational value of the calculation while resisting its conversion into an unsupported site forecast.

A facility-level estimate can be proportionate

A concept screen may reasonably use an overall engineering percentage before every affected load has been metered. The estimate can help determine whether detailed investigation is worthwhile. The objection to excessive decomposition is persuasive when the preliminary action is inexpensive and reversible. It does not justify presenting the assumed percentage as guaranteed equipment performance or applying a subsystem estimate to an unrelated base. A proportionate record can state the estimate, its affected perimeter, the reason it is plausible and the evidence required before a stronger obligation is accepted.

Sequential percentage arithmetic is not an engineering specification

The efficiency-only result depends on a whole-demand percentage. A device-only estimate that cannot be reconciled to that base would invalidate the supplied interpretation. Mara Sene must revise the perimeter or percentage scope; changing price would not repair this physical defect.

Decision implications

- Total energy, intensity, service and utilisation can move differently.
- A supplied efficiency percentage applies to a particular demand base.
- Gross energy-cost saving and net continuing cash saving are distinct.

MECHANISMS AND WORKED STUDIES

06

Electrification changes more than the energy carrier

An electrification operating envelope

Appraise the delivered service and its operating envelope

Electrification changes an energy carrier within a service system. Its appraisal should begin with the service that the electrical alternative must deliver, rather than with a generic comparison between electricity and fuel. A process may require thermal energy at a particular condition, mechanical output during a critical duty or a response that preserves product quality. The proposed technology can change conversion losses, control, supporting loads and production arrangements. The investment question is whether the complete operating alternative provides the required service with acceptable physical, commercial and delivery consequences.

Purchased energy is therefore an input to the comparison rather than the functional outcome. An electrical process might deliver the same useful service with a different input quantity from the existing fuel process. It might also require a different supporting system or change the product's processing route. The analyst needs a relation between input and usable output under the relevant operating conditions. An electricity-only calculation can record the added demand, but it cannot infer the displaced fuel or the equivalence of service. Those missing terms determine whether the boundary is adequate for the intended electrification claim.

Thermal service makes this distinction particularly clear. The process can depend on how heat reaches the material, how rapidly conditions change and whether the equipment maintains the required quality through variable operation. An energy quantity available elsewhere in the facility may be unusable for that duty. A technology capable of meeting an average requirement may be unsuitable for a demanding production state. The appraisal should identify the operating envelope, supporting equipment and acceptance evidence. It should not treat a favourable average energy estimate as proof that every required state can be supplied.

Connection and equipment capacity add a different constraint. A proposal with moderate annual electricity demand can still require a substantial change in instantaneous load or power quality. The facility may need connection work, internal distribution changes, protection arrangements or a revised operating schedule. These changes affect capital, lead time and production risk. The annual

engine has no representation of those requirements. A sponsor should therefore record capacity and connection as separate feasibility propositions rather than assume that an annual supply balance establishes electrical deliverability.

The timing of operation can also shape the commercial result. Energy prices or contractual obligations may depend on when the new load runs, while the production system may allow limited flexibility. A proposal described as flexible should identify who can move the load, what production cost that movement creates and which constraints remain. A process cannot be scheduled freely merely because electricity is cheaper at another time. The operating envelope should preserve the relation between commercial opportunity and actual service flexibility. The screen can motivate that investigation but cannot calculate it from annual demand alone.

Evidence and scope

Process heat transfers thermal energy to materials for manufacturing operations.

Evidence: **Process Heat Basics**

The original operating-envelope record separates service acceptance, input conversion, capacity, temporal operation and commissioning. Service acceptance states what the alternative must deliver. Input conversion states how the electrical demand and displaced carrier relate to that service. Capacity states the conditions under which the new equipment can run. Temporal operation states how demand aligns with available supply and commercial terms. Commissioning states how the facility moves from the current system to the proposed one. Each proposition has a different evidence owner and can block a different stage of commitment.

The displaced-carrier record is essential for an emissions comparison. It should identify the existing input, the credible alternative without the project and the relevant factor basis. If the old equipment would have been replaced anyway, the comparison may need to distinguish the new electrical option from an alternative replacement. If the electrical process changes production, the useful-service comparison must reflect that change. A lower emission factor for electricity does not alone establish the full result. The input quantities and boundaries govern the comparison before the factors are applied.

Supporting loads can create hidden effects. A new electrical process may change cooling, ventilation, pumping or treatment requirements. An existing fuel system may have recoverable heat that serves another purpose. Removing that system can shift demand elsewhere. The appraisal should map these interfaces instead of evaluating only the new principal device. The committee does not need every engineering detail at the concept stage, but it needs to know whether a missing interface could reverse the expected benefit or require a material commitment outside the stated capital scope.

Commissioning is another operating state, not a footnote. A production facility may need parallel systems, temporary supply, qualification batches or a controlled shutdown to adopt the new process. The transition can create cash costs and service risks even if the eventual steady-state operation is attractive. A constant annual screen begins after the supplied state is assumed to exist. It does not model the route to that state. The implementation case should specify the conversion sequence and the evidence that the facility can sustain acceptable service during and after the change.

Operating capability should be assessed alongside equipment capability. Staff may need new control practices, maintenance skills or fault-response procedures. A supplier may retain proprietary support responsibilities that affect availability and cost. The appraisal should identify who owns each critical operating action and how performance will be accepted. A technical demonstration under supplier control does not establish the facility's continuing operating arrangement. The investment becomes executable when the relevant capabilities and obligations are secured, rather than merely when the equipment description is persuasive.

Completed Aster Works carrier-conversion hold

This completed fictional scoping record intentionally withholds a full electrification conclusion. It shows how an added electricity term can be used to organise missing evidence without assuming displaced fuel or service equivalence. Original operating-envelope record. The added-demand case supplies an electrical term only; the other propositions remain development work.

Completed Aster Works carrier-conversion hold		
Envelope proposition	Completed status	Required evidence or action
Required useful service	Existing production service assumed, no process specification supplied	Define accepted output, quality and relevant operating states.
Added electrical input	Represented in the canonical annual demand case	Develop the equipment and duty relation to useful service.
Displaced fuel input	Absent from the electricity schema	Record the carrier, quantity and credible without-project alternative.
Connection and supporting systems	Not represented	Confirm capacity, interfaces, protection and supporting loads.
Timing and flexibility	Annual total only	Retain load timing and production constraints where material.
Commissioning and operating ownership	Not represented	Develop conversion, qualification, maintenance and response arrangements.
Accountable evidence	Mara Sene owns EW-FUEL and EW-SERVICE; displaced fuel and thermal duty are absent	Prepare a useful-service and carrier-boundary specification before conversion-option selection.
Authorised commitment	Specification development only; the complete fuel-switch conclusion is withheld	Added electrical demand remains a component result rather than a full conversion appraisal.
Stop authority	Mara Sene stops technology selection if service quality or supporting heat has no acceptance record	Idris Ko withholds installation release at the maintenance-plan freeze.

Illustrative calculation. Assumptions and sensitivity are published with the model.

What the added-demand case actually establishes

Only the electricity boundary is changed. The resulting increase in attributed electricity emissions must not be interpreted as the full climate effect of an unmodelled fuel switch.

What the added-demand case actually establishes		
Electricity field	Frozen quantity	Permitted reading
Added demand	2,000.00 MWh/year	An annual electrical load is introduced.
Final electricity demand	12,000.00 MWh/year	The new demand is met by the supplied grid basis.
Final attributed emissions	7,200.00 tCO2e/year	The electricity-only result rises within this boundary.
Attributed annual abatement	-1,200.00 tCO2e/year	A negative reduction denotes increased electricity emissions here.
Net annual cash saving	-245,000.00 USD/year	The supplied electricity and operating expenditures exceed the baseline energy saving.
Package abatement cost	not defined	No positive abatement denominator; the cost-per-tonne metric is unavailable.

Canonical added-demand scalar pointers. All inputs and results are illustrative, with no avoided-fuel credit.

Expand the boundary when the claim requires displaced service

The reviewer asks whether the proposed statement concerns added electrical demand or the complete change in service provision. If it concerns the complete conversion, the dossier must include the relevant displaced carrier, useful-service relation, supporting loads and credible alternative. Connection, temporal supply and commissioning are reviewed as feasibility conditions. The annual electricity result can remain a valid component while the broader appraisal is incomplete. The committee should authorise the missing engineering work or a bounded trial rather than interpret the component result as proof for or against the entire electrification proposal.

The added-demand example deliberately creates an interpretive trap. A reader could see higher electrical emissions and conclude that electrification is always counterproductive. Another reader could assume that a large displaced-fuel benefit must exist and announce success without recording it. Both interpretations go beyond the retained case. The calculation establishes the consequence of supplied added electricity within an electricity-only perimeter. It

does not decide whether the broader conversion is beneficial. Recognising that limitation is an analytical result because it identifies the evidence the decision still needs.

A complete comparison should preserve both feasibility and alternatives. The best electrical technology in a generic description may be unsuitable for the facility's production state or unavailable within its connection schedule. A less ambitious efficiency intervention may be preferable while the larger conversion is developed. A staged approach may preserve service and collect relevant evidence. These possibilities do not follow automatically from the screen; they are options the committee can develop once the operating envelope reveals the constraint. The purpose of the record is to turn an attractive concept into a set of testable operating choices.

The recommendation should distinguish the disposition of the component from the disposition of the whole proposal. The electrical demand estimate may be accepted for further engineering while the fuel counterfactual remains unresolved. The process may be technically viable while connection timing prevents near-term execution. The investment may be required for service reasons while its emissions claim remains conditional. Stating these positions separately helps the organisation progress without pretending that every question has been answered at once. It also prevents a narrow adverse result from prematurely excluding a potentially sound broader alternative.

A broad screen can use explicit carrier assumptions

A preliminary electrification appraisal can reasonably include engineering assumptions about displaced fuel and useful service before final design. The counterargument is that requiring complete process proof would delay valuable investigation. This paper accepts explicit provisional assumptions in a method that actually represents those carriers and relations. The annual electricity schema does not. The repair is to use a suitable expanded model and record the assumptions, rather than insert an unreported avoided-fuel benefit into the interpretation of the electrical output. The strength of a screen depends on its fit to the question.

No complete electrification calculation is supplied

Displaced fuel and useful thermal service are absent. A complete carrier-conversion claim is therefore held regardless of the electrical result. Mara Sene must support the service, carrier and interface comparison before the added-demand component can be incorporated into an appropriate wider appraisal.

Decision implications

- Added electricity is only a component of a complete carrier-switch appraisal.
- Capacity, timing and commissioning can constrain an attractive steady state.
- A missing displaced-service term requires a wider method or a narrower claim.

MECHANISMS AND WORKED STUDIES

07 Emission factors need a stated basis

A factor selection and disclosure worksheet

Choose the factor that answers the stated question

An emission factor is a relationship defined on a particular basis. It is not a universal property of electricity that can be moved between regions, periods and reporting questions without changing meaning. A factor may attribute emissions from a specified generation mix, represent a contractual reporting basis or estimate a response to a change in load. The analyst should identify that basis before applying the factor. A precise value with an unidentified denominator, boundary or purpose is less useful than a clearly stated provisional assumption whose limits can be challenged.

The selection begins with the intended claim. A corporate purchased-energy statement, a facility screening comparison and a power-system consequence require different evidence. The energy quantity must also be identified: electricity generated, delivered, bought or used can involve different boundaries. Losses and upstream effects may be included or excluded. The reviewer should not infer those choices from the unit alone. A factor labelled per unit of electricity is still incomplete if the relevant electricity stage and emissions perimeter are unresolved.

Geography and time matter because the factor relates to a specified system. A historical regional value may be appropriate for an inventory question under a particular method while remaining insufficient to predict the consequences of a future intervention. A supplied annual value can conceal variation during the facility's operating hours. That variation may or may not be material to the decision. The analyst should record the selected geography, period and temporal resolution, then explain why they fit the question. The existence of an official dataset does not remove the need to choose an appropriate field and application.

Contractual attribution introduces evidence beyond the physical annual balance. A supply arrangement can contain attributes, claims and conditions that matter to a reporting method. An annual quantity of renewable energy in the screen does not demonstrate those contractual requirements. It also does not establish exclusive ownership of a reporting attribute. The reviewer should ask which instrument, supplier record or programme rule supports the intended statement. The commercial label on an energy product should not be allowed to answer an unassessed accounting question.

A marginal or consequential question needs a counterfactual about what changes in the energy system when load or supply changes. Such a question can depend on timing, operating constraints and the horizon over which the system responds. A simple annual multiplication can be a preliminary approximation under an explicitly appropriate basis, but it is not an automatic dispatch estimate. More resolved methods also have scopes and assumptions. The analyst should choose the resolution that fits the decision and preserve the method's limits rather than treating complexity as a substitute for relevance.

Evidence and scope

Purchased-energy guidance includes contractual-instrument quality and transparent disclosure.

Evidence: [Scope 2 Guidance](#)

Evidence and scope

Electricity-rate applications depend on the dataset field and calculation basis.

Evidence: [eGRID2023 Technical Guide](#)

The eGRID and AVERT sources illustrate why factor selection should be application-specific. They are retained here as public methodological context for electricity emissions information and temporally resolved change estimation within their stated jurisdictions. The study does not import a numerical factor from either source and does not run a power-system model. It would be inaccurate to describe all eGRID information as incapable of supporting avoided-emissions approximations, just as it would be inaccurate to treat every published rate as a complete marginal estimate. The relevant dataset field, method and scope determine the interpretation.

The annual Transition lab instead accepts supplied grid and additional-renewable factors. Its arithmetic assigns each factor to the corresponding annual energy used. The model cannot infer whether the factors have consistent lifecycle coverage, whether they describe the same electricity stage or whether a contractual method permits their use. The input names describe their role in the illustrative calculation, not a certification of accounting basis. A user must supply that basis explicitly before applying the screen to a real reporting or investment question.

Consistency between factors is essential to the comparison. A generation-stage grid factor and a lifecycle renewable factor can produce a difference partly driven by unlike boundaries. An analyst could then interpret that difference as a physical transition benefit even though part of it comes from accounting selection. The factor record should state a common basis or explain why different bases are appropriate for the intended question. If the difference is unresolved, the dossier should retain separate interpretations rather than present a single preferred result as self-evident.

The factor should also retain provenance and edition. Public guidance can be revised, historical datasets can be updated and a contract's attributes can change. The evidence record should name the retained source and the time to which the value applies. A future analyst needs to know whether a result changed because demand changed, the factor changed or the method changed. These are different mechanisms and may require different governance responses. Retaining the edition makes historical replication possible without implying that the same factor remains appropriate for every future decision.

Factor sensitivity should be separated from physical performance. Changing the grid factor in the screen changes attributed emissions while leaving annual electricity demand and energy charges unchanged. A lower abatement result in such a test is not evidence that the efficiency measure performs worse. It is evidence that the same supplied physical change has a different attributed consequence under the alternative factor. The distinction becomes especially important when a financial saving remains identical while cost per tonne moves sharply. The denominator can change without a change in engineering or cash benefit.

Evidence and scope

Temporally resolved change estimation can require hourly energy and system information.

Evidence: *AVERT User Manual, Version 4.3*

The record should explain who can approve a factor change. An engineer may update a demand estimate, while a reporting specialist may interpret a contractual method and a system analyst may develop a marginal scenario. Allowing any participant to substitute a preferred factor can create an unstable comparison whose recommendation depends on presentation incentives. A factor change should retain its reason, applicability and effect on the intended claim. This does not require a bureaucratic process for every concept assumption; it requires an accountable interpretation when the result supports a material obligation or public statement.

Where factor uncertainty spans different methods, a simple numerical range may be inadequate. A location-based interpretation and a consequential interpretation are not always endpoints of the same variable. They may answer different questions and use different boundaries. The dossier should present them as separate statements when appropriate, rather than place them in a range that suggests one unknown true factor is waiting to be discovered. Sensitivity is strongest when the tested alternative preserves the meaning of the claim. A method change requires its own explanation.

The reviewer should finally resist the idea that lower attributed abatement automatically weakens the investment. The package may still release cash, improve service or meet a legitimate obligation. Conversely, a large attributed reduction

does not establish favourable economics or executability. A factor challenge reveals which proposition moves. The committee can then decide whether the change affects the investment rationale, a reporting statement, or only the interpretation of a screening metric. Keeping that consequence explicit is the purpose of the factor-selection record.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Completed Aster Works factor and mandate hold

The foundation factors are deliberately supplied assumptions. The record does not assign an actual location, instrument or dataset to them. Those gaps determine which statements remain unavailable. Original completed factor record with canonical input bindings. No public-source numerical factor is adopted.

Completed Aster Works factor and mandate hold		
Factor record field	Completed foundation entry	Implication
Grid factor	0.60 tCO ₂ e/MWh, illustrative	Used for annual grid energy within the screen.
Additional-renewable factor	0.02 tCO ₂ e/MWh, illustrative	Used for annual renewable energy admitted within demand.
Common attribution basis	A common hypothetical screening basis is assumed	No lifecycle or recognised reporting applicability is verified.
Region and historical period	No actual region or measured period supplied	Do not present either value as a local published factor.
Contractual attributes	No instrument or ownership evidence supplied	No market-based reporting eligibility is established.
System response	No dispatch, timing or counterfactual system model supplied	No marginal consequence is certified.
Accountable evidence	Safia Bello owns EW-FACTOR; both factors are illustrative, and the low-factor case fails the chosen reference mandate	Return basis and mandate alternatives before the claim-signature gate.
Authorised use	Compare supplied attribution cases; no official regional or contractual factor is asserted	A commercial-only action requires Idris Ko to record an explicit objective change.
Stop authority	Safia Bello withholds the reference climate wording while factor basis or mandate remains unresolved	Do not use a more negative ratio to conceal the smaller reduction.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Changing the factor leaves the supplied physical and commercial state intact

The diagnostic compares the supplied foundation case with its canonical reduced-grid-factor challenge. It changes the attribution parameter while retaining the package and supplied price multiplier.

Changing the factor leaves the supplied physical and commercial state intact			
Diagnostic field	Supplied factor case		Reduced factor case
Grid factor, tCO2e/MWh	0.60		0.30
Annual abatement, tCO2e/year	3,810.00		1,860.00
Net annual saving, USD/year	380,000.00		380,000.00
Package NPV, USD	263,709.65		263,709.65

Canonical foundation sensitivity output pointers. These are selected illustrative tests without a probability or factor forecast.

Select a factor through its purpose and boundary

The reviewer states the emissions question, energy stage, system perimeter and period. The evidence owner identifies a factor source or a clearly labelled provisional assumption that fits those fields. The accounting reviewer checks contractual and programme conditions where relevant. The analyst tests whether an admissible alternative basis changes the decision or intended statement. If the basis is unresolved, the recommendation narrows the claim or requests targeted evidence. A lower factor is accepted because it is appropriate to the declared method, not because it makes the project appear more attractive.

A conventional provisional factor can support an early screen

An early concept assessment may need a conventional factor before complete site and reporting evidence is available. That is reasonable when the factor is labelled provisional, its basis is stated and the authorised action is limited. The objection to delay is persuasive if a wide range of appropriate factors leaves the preliminary action unchanged. It does not justify selecting a favourable factor with an incompatible boundary or making a recognised reporting statement without the required evidence. The screen should retain the next factor-validation task and the consequence if its assumption fails.

No official dataset value or reporting eligibility is adopted

No fixture factor is an official regional, contractual or lifecycle value. A basis change can alter the claimed reduction while leaving cash intact. EW-FACTOR remains illustrative, and Safia Bello withholds the reference mandate when its admissible interpretation no longer supports that statement.

Decision implications

- The unit of a factor does not identify its full accounting basis.
- A factor challenge can change abatement without changing demand or cash.
- Different reporting questions may require separate methods rather than one factor range.

MECHANISMS AND WORKED STUDIES

08

Abatement must be measured against an alternative

A canonical transition app abatement study

Define what would happen without the package

Abatement is a difference between defined states. The project state matters, but the alternative matters equally because it determines what change is attributed to the intervention. A low final emissions total does not establish a large reduction if the credible alternative was already low. A large reduction from an obsolete historical state does not establish the additional contribution of a proposal when another improvement was already planned. The analyst should explain what would happen without the project, why that alternative is credible and how the comparison preserves useful service and accounting basis.

The counterfactual is a decision proposition rather than a hidden historical truth. The organisation may have several feasible ways to maintain service, and the relevant alternative depends on the commitment being considered. An existing asset could continue, be repaired, be replaced with conventional equipment or be retired. A supply arrangement could be renewed or changed. The sponsor should identify which alternative the appraisal uses and why it represents the decision context. Where plausible alternatives produce materially different results, retain them as distinct cases instead of concealing disagreement in a single baseline total.

A historical reference can inform the alternative without defining it completely. Meter and production records describe actual past operation within their boundaries. The counterfactual may need to account for required replacement, committed maintenance, a changed production plan or a contract expiry. Those terms should be supported and disclosed. The analyst should avoid selecting a deliberately poor continuation merely to increase the apparent benefit of the proposal. The comparison earns credibility when the without-project state is a reasonable action the organisation might take, not a straw alternative that makes the project inevitable.

Service equivalence remains essential. Comparing a proposed process at reduced output with a baseline at full service can create apparent abatement by changing the function. That can be a valid operating choice if its commercial and service effects are included. It should not be described as the same-service technical effect. Likewise, shifting an activity outside the facility can change its attributed emissions without establishing the total consequence. The counterfactual record should state the function, quantity boundary and relevant displaced activity so the emissions difference answers the intended question.

The factor basis should be applied coherently across states. A change in the factor itself can be part of a supply intervention or an external scenario, but the appraisal should distinguish those mechanisms. If the baseline uses a broader emissions perimeter than the project, the difference partly reflects a method change. If future grid changes would occur under both alternatives, crediting all of them to the proposal can overstate its contribution. The analyst should map common conditions and intervention-specific changes explicitly. This is a causal comparison before it is a subtraction.

Evidence and scope

A project baseline procedure is selected for the defined assessment context.

Evidence: [The GHG Protocol for Project Accounting](#)

The foundation study uses a deliberately simple counterfactual: the supplied annual electricity demand is met by the supplied grid basis without any listed measures. The project state then applies demand efficiency followed by additional annual renewable supply. Both states use the declared illustrative factors and flat energy prices. This comparison is transparent and reproducible. It is not presented as a validated alternative for an actual industrial facility. Its purpose is to expose how the model moves from a reference annual electricity balance to a package state and a conditional abatement result.

The order of calculation is important. The efficiency term reduces remaining demand. The supplied renewable quantity is then admitted up to that demand, leaving grid energy to meet the remainder. Emissions are assigned to energy used under the respective supplied factors. Excess renewable supply would be curtailed within the annual model rather than credited as negative grid energy. These conventions make the state internally intelligible. They do not establish hourly availability, contractual attributes or the power-system response. The comparison remains within the annual electrical perimeter.

The package reduction concerns the baseline-to-final difference. Incremental measure reductions concern the difference between adjacent sequential states. The distinction matters because a measure's assigned incremental benefit can depend on preceding measures. A supply change after efficiency affects the demand that remains; efficiency after a supply change affects a different mix. The package total can remain invariant while those increments change, or the final physical state can

change when added loads interact with a subsequent percentage. The reviewer should identify which difference is being reported before treating the result as an intrinsic property of a measure.

The financial counterfactual should be aligned with the physical one. If the baseline assumes continuing grid expenditure, the project savings compare that expenditure with the final supplied energy cost and measure operating expenditure. A mandatory replacement cost, production revenue change or unavoidable contract payment is not included unless represented by the selected method. The foundation screen includes upfront listed capital and constant annual energy-related cash savings. It does not compute the full difference between complete industrial business cases. A favourable package result should therefore be used as bounded screening evidence rather than a comprehensive investment valuation.

The study's held-constant record is as important as its changed terms. It holds the useful-service assumption, annual baseline, factor bases, prices, horizon and discount convention fixed. It changes the supplied efficiency and renewable-supply package within that perimeter. A later test that changes price or factor answers a different question and should say so. Retaining this experimental structure helps the reader distinguish a physical intervention from an economic or attribution scenario. It also allows another analyst to reproduce the exact conditional result without guessing what else changed.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The foundation counterfactual and package state

The annual electricity reference is supplied explicitly, then transformed by the listed package. No actual facility, factor or tariff is asserted.

The foundation counterfactual and package state		
Balance term	Reference or final quantity	Meaning
Baseline demand	10,000.00 MWh/year	Supplied demand before the listed package.
Baseline attributed emissions	6,000.00 tCO2e/year	The reference grid-factor attribution.
Final demand	8,000.00 MWh/year	Demand after the supplied efficiency measure.
Final grid energy	3,500.00 MWh/year	The annual demand not met by admitted additional renewable energy.
Final renewable energy used	4,500.00 MWh/year	Additional annual supply used within remaining demand.
Final attributed emissions	2,190.00 tCO2e/year	The sum of the supplied factor-based energy attributions.
Package annual abatement	3,810.00 tCO2e/year	The baseline-to-final comparison within the same annual perimeter.

Canonical foundation input and output pointers. All quantities are illustrative; annual totals do not represent hourly dispatch.

Completed Aster Works counterfactual scoping decision

The record distinguishes what the reproducible foundation comparison assumes from the evidence that a real counterfactual would require.

Completed Aster Works counterfactual scoping decision		
Challenge	Foundation record	Condition for applied use
Why continue the baseline?	Continuation is a supplied screening convention	Identify the credible without-project decision and required replacement.
Is useful service equivalent?	Unchanged service is assumed	Confirm production, quality and required operating states.
Are common external changes retained?	No future external change is represented	Apply relevant changes consistently across project and alternative.
Are displaced activities included?	Only annual electricity terms are supplied	Expand the boundary where omitted carriers or activities are material.
What does the result authorise?	Further package engineering and commercial investigation	Obtain evidence before a recognised reduction or full investment claim.
Accountable evidence	Nora Vale owns EW-BASE; continued grid operation is a supplied convention, with no actual replacement plan	Mara Sene prepares the without-project alternative memo before cash-case sign-off.
Authorised commitment	Existing-staff alternative and service review only; no additionality claim	Leila Chen retains the original screen alongside any supported replacement pathway.
Stop authority	Leila Chen stops an applied valuation that credits mandatory replacement as entirely new benefit	Return the material alternative at the diligence review.

Original completed challenge record. Missing evidence remains an explicit condition, not an assumed favourable alternative.

Challenge the alternative before crediting the reduction

The reviewer asks whether the without-project state is feasible, service-comparable and relevant to the commitment date. The sponsor records planned and mandatory actions that would occur independently. The analyst identifies common conditions, intervention-specific terms and boundary exclusions. If an admissible alternative changes the decision, the dossier retains it as a separate study or requires evidence to select between alternatives. If the numerical method omits a decisive carrier or activity, it is expanded or its conclusion is narrowed. The reported reduction remains a conditional comparison, not a property of the proposed equipment alone.

A counterfactual challenge can reveal an opportunity even when it reduces claimed abatement. If the organisation would replace an inefficient asset anyway, the incremental transition investment may be smaller than the package's full capital amount. A fuller comparison could therefore reduce attributed additional abatement while changing incremental economics. The annual screen does not compute that replacement alternative automatically. The point is that a more credible counterfactual can alter several terms together, and the analyst should not repair only the emissions denominator while leaving an inconsistent financial baseline in place.

The record should preserve uncertainty about the alternative without assigning invented probabilities. A retained case can show the consequence of continued operation, another can represent a conventional replacement, and a third can represent a changed production plan if the relevant method supports them. These cases help the committee identify what evidence matters and what commitment would remain defensible across them. They do not form an expected value unless an appropriate probability basis is supplied. The number of scenarios is not evidence of their likelihood, and a favourable majority is not a decision rule.

The counterfactual should finally be reviewed when the underlying decision changes. A proposal developed for a discretionary concept may later become part of a mandatory replacement or a different production strategy. The original comparison can remain historically reproducible while no longer representing the live choice. An accountable decision record states which change triggers a new appraisal and who owns that review. This preserves the distinction between reproducing the old arithmetic and sustaining the current recommendation. The baseline-to-project difference is useful only while its alternative remains relevant.

A conventional continuation can support preliminary comparison

An analyst may lack enough information to develop every future alternative at concept stage. Continuing the supplied state can be a proportionate provisional counterfactual when its limitations are explicit and the action concerns investigation. The objection to excessive option development is strongest when plausible alternatives would not change that action. It is weaker when known replacement, contract expiry or production changes materially shape the claimed reduction. The repair is to document the provisional alternative and the conditions that require revision, rather than demand exhaustive certainty or treat an obsolete continuation as the definitive baseline.

The illustrative alternative is not validated site evidence

The continuation baseline has no actual replacement or operating evidence. A credible mandatory alternative can change both cost and reduction. Leila Chen must keep those terms aligned in a revised method rather than retain the old cash benefit with only a new emissions denominator.

Decision implications

- A reduction depends on a credible alternative as well as a project state.
- Package and incremental comparisons use different reference states.
- Align financial and emissions counterfactuals when the alternative changes.

MECHANISMS AND WORKED STUDIES

09 Cost per tonne can reward the wrong project

An abatement-cost interpretation framework

Read the numerator and denominator before the quotient

Cost per tonne condenses an economic numerator and an emissions denominator. That compression is useful when the terms are coherent and the decision concerns the price of a specified reduction. It becomes misleading when the reader treats the ratio as a complete investment ranking. A project can have a favourable ratio and a small absolute contribution, a large reduction and an unattractive cash outcome, or a financial benefit with no positive abatement. The analyst should preserve the underlying quantities so the committee can identify which objective the ratio actually informs.

The annual electricity engine uses annualised net package cost in the numerator. It converts supplied upfront capital into an equivalent annual charge under the supplied horizon and discount convention, then subtracts net annual cash savings. The denominator is the annual attributed reduction from the supplied baseline to the final package state. This aligns annual bases within the simplified constant-flow model. It does not mean that the equivalent annual capital charge is an actual financing payment or that the project has a recognised emissions credit. Annualisation is an analytical comparison convention.

A negative ratio has a specific conditional meaning when abatement is positive: the represented annualised cost is negative, so the supplied energy-related cash savings exceed the equivalent annual capital charge. It does not establish that the project requires no upfront money, has no implementation risk or will achieve the supplied performance. It also does not imply that every project with a more negative ratio is preferable. A ratio can become more negative because its positive denominator becomes smaller while the same financial saving remains. That change can weaken absolute climate contribution while apparently improving the ratio.

The foundation and low-factor studies expose this denominator effect. The low-factor case retains the same physical demand, renewable quantity, capital, operating costs, prices and financial convention. Only the supplied grid factor changes. The net annual saving and NPV therefore remain identical in the canonical output, while attributed annual abatement falls. The package cost per tonne becomes more negative. Interpreting that movement as an unqualified improvement would reward a smaller emissions denominator rather than a stronger investment. The paired study makes the source of the movement inspectable.

A positive ratio also needs the underlying terms. It can indicate an annualised cost for achieving positive attributed abatement under the supplied assumptions. Whether that cost is acceptable depends on the objective, alternatives, resource constraint and authorised willingness to pay. A ratio alone does not identify the amount of capital required or the liquidity exposure. It does not show whether the facility can execute the measure, whether the reduction is recognised or whether another package offers a better service combination. The committee must connect the ratio to a defined decision rather than allow it to choose its own objective.

The denominator condition is part of the definition

Package abatement cost = net annualised package cost / positive annual attributed abatement. A nonpositive abatement denominator makes this metric unavailable in the canonical screen.

Canonical metric expressed symbolically. Negative net cost with positive abatement is distinct from a nonpositive emissions denominator.

A zero abatement denominator requires a different disposition. Dividing a financial cost by a nonexistent reduction cannot produce a meaningful cost for reducing emissions. The canonical screen returns an unavailable metric rather than fabricating a value. That behaviour should survive tables, exports and narrative. An unavailable ratio is not the same as a zero cost per tonne, and it should not be placed at the favourable end of a ranking. The underlying physical and financial results can still be assessed on their own terms.

The zero-abatement study uses equal supplied factors for grid and additional renewable energy. Its supply change reduces the represented energy expenditure because the supplied prices differ, but it produces no attributed reduction under that common factor basis. The financial saving is therefore compatible with an unavailable abatement-cost metric. This is not a mathematical anomaly. It demonstrates why financial value and climate contribution should remain distinct. The proposal could deserve commercial investigation while its emissions benefit remains unsupported within the retained case.

Illustrative calculation. Assumptions and sensitivity are published with the model.

A smaller denominator can make the negative ratio look better

The paired cases hold all physical and financial inputs constant except the supplied grid factor. Their different ratios must be read with the unchanged financial outcome and different absolute abatement.

A smaller denominator can make the negative ratio look better			
Comparison field	Foundation		Low-factor case
Grid factor, tCO2e/MWh	0.60		0.03
Final demand, MWh/year	8,000.00		8,000.00
Annual abatement, tCO2e/year	3,810.00		105.00
Net annual saving, USD/year	380,000.00		380,000.00
Net annualised cost, USD/year	-34,992.96		-34,992.96
Package NPV, USD	263,709.65		263,709.65
Abatement cost, USD per tCO2e	-9.18		-333.27

Canonical foundation and low-factor pointers. Every value is illustrative; the factor change is a diagnostic, not a regional forecast.

A negative abatement denominator also makes the metric unavailable in the engine. The added-demand study increases attributed electricity emissions within its boundary. Reporting a signed quotient as though it were an attractive negative abatement cost would confuse an emissions increase with a saving opportunity. The appropriate record states the direction of the emissions change and the financial result separately. If a broader carrier-switch appraisal could reverse the complete emissions conclusion, that appraisal needs the missing carriers and service relation. The unavailable ratio cannot repair the incomplete boundary.

Uncertainty near a small denominator calls for particular care. A modest change in factors, operating scope or counterfactual can move the result toward no reduction or an increase. The ratio can become very large in magnitude while the decision-relevant physical change becomes small. A confidence range for the ratio may be difficult to interpret when the sign of the denominator is unresolved. The analyst should report the underlying abatement alternatives and the conditions that determine the sign, rather than present a single precise quotient as though its basis were stable.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Factor tests change the denominator while prices remain fixed

The selected illustrative tests vary only the supplied grid factor within each retained package. Lower attributed abatement does not change the supplied physical energy or cash terms. The negative cost-per-tonne comparison must therefore retain its denominator.



Original deterministic drawing from foundation and low-factor canonical sensitivity pointers. Connectors pair selected discrete tests only; they are not an unperformed continuous response curve, a regional factor estimate or a probability distribution. The table retains the cash and ratio quantities.

The package and incremental ratios should not be mixed. An incremental measure cost is associated with the change from the preceding sequential state, while the package ratio compares the baseline with the final state. Reordering measures can alter incremental attribution even when final package results remain unchanged. The user should therefore avoid presenting a sequence of marginal blocks as independent opportunities that can be selected without interactions. The displayed increments are conditional on the supplied execution order and assumptions. They are not a solved portfolio of autonomous abatement measures.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Financial benefit with no attributed abatement

The case holds the supplied grid and renewable factors equal. The model can report a positive financial screening result while withholding the abatement-cost ratio.

Financial benefit with no attributed abatement		
Case field	Frozen quantity	Interpretation
Grid factor	0.02 tCO2e/MWh	The supplied attribution factor.
Additional-renewable factor	0.02 tCO2e/MWh	Equal to the grid factor in this diagnostic.
Annual attributed abatement	0.00 tCO2e/year	No reduction under the declared factor comparison.
Net annual saving	220,000.00 USD/year	The supplied price difference still creates cash savings.
Package NPV	1,557,937.16 USD	A simplified financial screening result, without a climate reduction.
Package abatement cost	not defined	No positive abatement denominator is available.

Canonical zero-abatement input and output pointers. An unavailable metric is preserved, rather than replaced by a favourable numeric cell.

Use the ratio only after its terms survive challenge

The reviewer confirms a positive, decision-relevant abatement denominator and a coherent annualised cost numerator. The dossier then reports absolute abatement, capital, net saving and the ratio together. A factor or counterfactual challenge is traced to the term it changes. Nonpositive abatement removes the ratio from a reduction-cost comparison while leaving physical and financial findings available. If interactions matter, incremental figures retain their sequence and package totals. The committee chooses an action against its authorised objective and constraints; it does not infer universal preference from the smallest displayed quotient.

A committee with a climate objective may care about total achievable reduction within a capital or delivery constraint. A committee with an operating-cost objective may care about cash release and implementation exposure. A committee balancing both needs a transparent tradeoff rather than a metric that silently substitutes one for the other. The ratio can support that discussion by showing an economic condition per positive reduction. It cannot impose a funding limit or resolve the value of service, resilience or enabling capacity. The appraisal should identify the objective the ratio informs and retain the other decision terms.

An attractive negative ratio can justify closer examination of why the opportunity remains unimplemented. The missing explanation could concern capital availability, production disruption, evidence confidence, operating incentives or contractual charges that the screen omits. It would be premature to conclude that management has ignored a guaranteed saving. The diagnostic should prompt a search for the binding condition. If that condition is resolved, the opportunity may become executable. If it changes the cash or physical terms, the model should be revised before the committee relies on the original quotient.

The strongest use of cost per tonne is therefore explanatory. The analyst shows how a defined package's economics and reduction combine, identifies which assumptions govern the quotient and tests a consequential alternative. The reader can then distinguish a change in engineering, a change in price and a change in attribution. This preserves the compact metric while preventing it from obscuring the mechanism. A ratio becomes a useful decision aid when it is accompanied by enough context to reveal why it moved and what that movement means for the proposed action.

A compact metric can improve comparability

A standardised abatement-cost metric can help a committee compare a large set of defined opportunities and identify promising areas for investigation. Requiring a full dossier beside every entry would make the screen cumbersome. The compact metric is useful when the entries use coherent boundaries and annualisation, retain material interactions and link to their underlying records. The objection does not justify ranking unavailable ratios as favourable, ignoring absolute abatement or treating negative cost as guaranteed cash. A concise register can preserve these distinctions without abandoning the efficiency of a common comparison field.

The metric does not create a carbon value or financing plan

The quotient excludes carbon income, repayment and implementation constraints. Its main falsifier is a nonpositive or unstable reduction denominator, which removes it from reduction-cost comparison. Even a defined negative ratio cannot settle the reference climate mandate or the unsecured-surplus condition.

Decision implications

- A more negative cost per tonne can reflect less abatement with unchanged cash benefit.
- An unavailable ratio is distinct from zero cost per tonne.
- Incremental ratios retain their sequence; package totals answer a different comparison.

MECHANISMS AND WORKED STUDIES

10 Tariffs and duty shape cash savings

A flat energy-price sensitivity study and missing tariff-component record

Connect the physical change to the charge that responds

Physical energy savings become cash savings through a tariff or contract. That relation should be examined rather than assumed. A bill can contain variable energy charges, capacity-related charges, fixed payments, minimum commitments and other terms. Reducing annual consumption may affect some terms while leaving others unchanged. A proposal that substitutes supplied energy can introduce a new obligation or preserve a payment for unused quantities. The analyst needs to identify which expenditure responds to the intervention and which expenditure remains. Multiplying saved annual energy by an average bill rate can obscure that distinction.

A flat variable price is a useful first abstraction when it fits the relevant charge. It lets the screen isolate how a physical change affects expenditure under a supplied unit price. It is less useful when the intervention changes load timing or peak demand, or when contractual terms constrain the cash released. The annual Transition lab uses supplied grid and renewable energy prices in this narrow way. It has no demand charge, time-of-use schedule, fixed fee or minimum purchase obligation. A user should therefore treat its annual saving as a conditional energy-charge calculation, not an automatic forecast of the total bill.

Duty connects physical operation to the commercial basis. A measure that runs during expensive periods can have a different cash effect from the same annual energy change during inexpensive periods. A peak reduction can matter even when annual consumption moves little. A new process can add electrical demand at a time when connection or tariff constraints are binding. Annual totals do not identify these effects. The operating record should state when the relevant load occurs, whether it can move and what service or production consequences a different schedule would create.

A contractual supply arrangement can also change the relation between energy used and energy paid for. The screen charges only the annual renewable energy admitted within remaining demand. It does not charge curtailed supplied energy as a separate purchase obligation, earn export revenue or model storage. A real contract may allocate those costs and rights differently. The commercial reviewer

should identify the relevant arrangement rather than infer it from the physical cap. A package can pass the annual balance while its assumed cash benefit fails under an obligation to pay for energy the facility cannot use.

Maintenance and supporting expenditure should be retained independently of energy charges. A technology may require service contracts, consumables, periodic replacement or additional operating capability. A saving can depend on a continuing expense that the sponsor initially leaves outside the energy comparison. The canonical measure operating-expenditure field captures a supplied constant annual amount but cannot assess its completeness. The record should explain what it includes and whether a changed duty affects it. Net cash savings should reflect the operating arrangement needed to sustain the physical benefit.

The foundation and adverse-price studies keep the same demand-reduction and renewable-supply package. Their physical electricity and attributed emissions outcomes are identical because prices do not enter the physical balance. The adverse case instead supplies a lower grid price and a higher renewable price. That change removes the financial benefit under the retained capital and operating terms while preserving positive attributed abatement. The paired study isolates a commercial condition. It does not demonstrate that the technology performs worse or that a future tariff will follow the adverse assumptions.

The comparison is useful because it avoids changing every assumption at once. A financial outcome can reverse while the engineering proposition remains unchanged. The committee should then ask whether the commercial terms can be supported or secured, rather than request a different physical model to explain the cash movement. If the investment is justified partly by a climate objective, the adverse result can reveal the cost of pursuing that objective under the supplied prices. If the investment depends entirely on cash savings, the same result identifies a condition that must be resolved before implementation.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The physical package survives while the price case reverses its economics

Only the supplied grid and renewable prices differ between these paired authored studies. Physical demand, factors, package, capital, operating costs, horizon and discount convention are retained.

The physical package survives while the price case reverses its economics			
Comparison field	Foundation		Adverse-price case
Grid price, USD/MWh	120.00		70.00
Renewable price, USD/MWh	80.00		140.00
Final demand, MWh/year	8,000.00		8,000.00
Annual abatement, tCO2e/year	3,810.00		3,810.00
Net annual saving, USD/year	380,000.00		-215,000.00
Package NPV, USD	263,709.65		-4,220,256.77
Abatement cost, USD per tCO2e	-9.18		146.98

Canonical foundation and adverse-prices pointers. These illustrative prices are not forecasts or executed terms.

The app's built-in price challenges answer a different question. They apply a common multiplier to both supplied energy prices while retaining the factor and physical package. This tests a movement in the overall price level under a fixed relative relationship. It does not test every change in the relative grid and renewable prices, nor does it simulate a time-of-use tariff. The adverse-price study is a separately authored case that changes the relative terms. These tests should not be pooled into a statistical forecast. Their role is to reveal which commercial mechanism affects the recommendation.

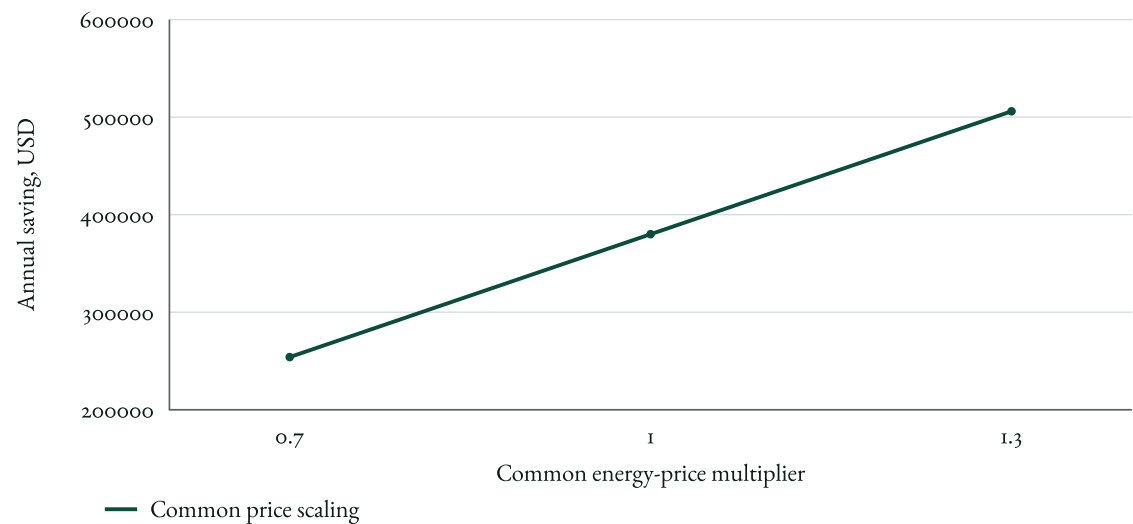
A tariff review should distinguish a market assumption from an enforceable term. A current quoted price might support a concept comparison but remain unavailable at the intended volume, duration or service condition. A contracted price may still have adjustment clauses, indexation, taxes or delivery conditions. A historical bill rate may reflect a load pattern that the project changes. The reviewer should record the price's status and applicability, together with the conditions under which it can be used in the investment case. A number copied from a commercial document is not automatically the marginal charge avoided.

The cash effect also needs a timing convention. A measure may achieve steady-state savings only after commissioning, ramp-up or operating correction. A contract may begin payments before the full benefit is available. The constant annual screen has no representation of those timing mismatches. A fuller case should model them when material to liquidity or value. The tariff record helps identify which cash terms need a schedule rather than a yearly average. An attractive annual total can coexist with an unacceptable period of cash exposure.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Common price scaling is a different challenge from relative prices

The canonical built-in tests scale both supplied energy prices together while retaining the physical package and measure operating expenditure. They show a price-level condition; the separate adverse-price study changes the relative terms.



Original deterministic drawing from foundation canonical sensitivity pointers. Connectors organise selected tests, not a future price forecast. No time-of-use charge, demand charge, probability or continuous tariff optimisation is represented.

Completed Aster Works tariff and surplus disposition

The record accepts the supplied flat prices for an educational screen while making the missing tariff propositions explicit. It does not substitute a guessed charge for an unresolved contract term.

Completed Aster Works tariff and surplus disposition		
Commercial term	Completed screening status	Decision-directed evidence
Variable energy charge	Supplied flat grid and renewable prices applied to energy used	Confirm the relevant marginal charges and delivery basis.
Demand or capacity charge	Not represented	Determine whether the load or peak changes the charge.
Time-of-use schedule	Not represented	Map the affected load timing to applicable periods.
Fixed or minimum payment	Not represented	Identify charges that persist when physical demand falls.
Unused supplied energy	Annual excess receives no bill, export or storage treatment	Review purchase obligation, curtailment rights and permitted export.
Measure operating expenditure	Supplied constant annual amount	Confirm sustaining costs, maintenance and duty dependence.
Accountable evidence	Owen Diallo owns EW-PRICE and EW-SURPLUS; enforceable rates and unused-supply obligations are absent	Prepare nonbinding bill-component and surplus-term records before supply-term selection.
Authorised commitment	Commercial clarification record only; current adverse prices are rejected under the cash rule	No new supply contract or support revenue is approved.
Stop authority	Leila Chen stops a saving based on fixed payments assumed to disappear; Idris Ko stops a binding arrangement	Return revised terms and canonical recomputation before commercial release.

Original completed commercial record. Items outside the engine require a fuller applied tariff and cash model.

Trace each saving to a charge that can actually change

The commercial reviewer maps the physical load change to the relevant tariff or contract term. Each term is classified as avoided, introduced, unchanged or unresolved under the proposed operation. The analyst uses an appropriate temporal basis where timing or peaks matter. The operating owner confirms that any flexibility used in the case is achievable without an omitted service cost. If a decisive term is unresolved, the next action is targeted contract clarification or a wider cash model. The committee treats a flat-price screen as complete only for the terms it actually represents.

The sensitivity record should identify which commercial condition can be controlled. A sponsor may be able to negotiate a fixed term, redesign the package, reduce surplus supply or adjust operating practice. Other conditions may remain exposures that the committee must accept or avoid. The screen cannot choose

among those responses without the relevant terms and constraints. It can show why the question matters. A recommendation that names the decisive tariff condition is more useful than one that simply asks for a more conservative price.

A price challenge should not be used to disguise a physical evidence problem. If the efficiency percentage lacks support, testing many tariffs does not validate the saving. If the supply quantity is unavailable during production, a favourable flat price does not make it usable. Commercial and engineering reviews should remain connected through the same operating state, but their missing propositions need distinct remedies. The committee should allocate investigation to the field that can change the decision, rather than let a detailed tariff model lend credibility to an unsupported physical assumption.

The result register should preserve gross energy expenditure, sustaining costs and the net cash term used in valuation. This helps the reader distinguish a supply-price disadvantage from additional maintenance or capital exposure. It also makes later contract changes interpretable. If a new tariff changes only the cash result, the physical proposition can remain intact while the recommendation is reopened. If a new operating schedule changes both load and charges, the study needs a revised physical state as well. The record should follow the mechanism rather than preserve the original headline at all costs.

An average unit rate can be an efficient preliminary screen

A concept assessment can use a flat rate when the affected expenditure is predominantly variable or when tariff detail is unlikely to change the next action. The objection to early commercial complexity is reasonable if the record states what the rate represents and retains material omissions. A total-bill average is less defensible when fixed charges, peaks or minimum payments drive the result. The analyst can test a bounded assumption and request the decisive terms before commitment. Proportionality permits a simple model; it does not make every omitted charge responsive to energy savings.

No complete tariff, forecast or financing cash schedule is modelled

Flat energy prices cannot test fixed payments, peaks, time periods or paid unused supply. A contractual term that prevents cash release invalidates the applied saving even if the energy balance stands. Owen Diallo must return that term and a suitable recomputation before commercial release.

Decision implications

- Saved energy and released cash have a contractual relationship.
- A price reversal can change financial value while leaving physical abatement unchanged.
- Common price scaling and relative-price changes are distinct diagnostics.

MECHANISMS AND WORKED STUDIES

11 Interactions make project savings non-additive

An interaction and sequencing exhibit

Distinguish marginal attribution from final-state change

A package is not generally the sum of standalone measure promises. Measures can affect the same load, change the base on which a later measure operates or share an enabling system. A supply change can serve demand that an efficiency measure later removes. An added process can create load to which a subsequent efficiency assumption applies. These interactions change the meaning of incremental benefits. The analyst should identify the affected states and compare the complete package before treating individual reductions as independent opportunities.

Overlap is a physical relationship before it is a ranking problem. If an efficiency measure removes part of a load, a supply measure can serve only the remaining load unless another use is represented. If supply already covers most annual demand, a later efficiency measure may reduce renewable energy used rather than the grid energy that would have been removed in a standalone case. The package can still have a strong final result. The incremental attribution differs because the preceding state differs. A measure does not possess an invariant annual abatement amount outside its package and reference state.

The paired overlap studies make this distinction explicit. They contain the same efficiency and supply measures, the same baseline, factors, prices, capital, operating costs and financial convention. Only the supplied sequence is reversed. In this particular pair the final demand, energy mix, emissions and financial results are identical. The emissions reduction assigned to each step is different. The result is package invariance with changing marginal attribution. It does not establish that order never matters; it establishes exactly what order changes in this defined package.

Incremental attribution can be useful for explaining the path from the baseline to the package. It shows which change occurs at each supplied stage and helps reveal overlap. It becomes misleading when those increments are separated from their sequence and presented as standalone opportunities. A later measure's displayed reduction can be much smaller after an earlier measure has already changed the state. That difference is not necessarily inferior engineering performance. The reviewer should preserve the preceding state and identify whether the increment answers an implementation question, an attribution question or a selection question.

The sequence in the annual engine is an order of state transformations. It is not a construction schedule, a commissioning plan or an optimisation result. A real project may require some measures to precede others because of connection, control or process dependencies. The model does not enforce those requirements. It can show a conditional supplied order and compare its reversal, but the operating team must determine whether either order is feasible and whether the percentage scope represents the actual affected loads. The numerical permutation is a challenge, not an implementation instruction.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Marginal attribution changes while the overlap package stays fixed

The studies reverse only the order of the same supplied measures. Each row reports the reduction from the state immediately preceding that step.

Marginal attribution changes while the overlap package stays fixed			
Study sequence	Step	Incremental abatement, tCO ₂ e/year	Emissions after step, tCO ₂ e/year
Efficiency first	Demand efficiency	1,200.00	4,800.00
Efficiency first	Supplied annual renewable energy	4,640.00	160.00
Supply first	Supplied annual renewable energy	5,220.00	780.00
Supply first	Demand efficiency	620.00	160.00

Canonical overlap–efficiency–first and overlap–supply–first output pointers. Incremental quantities retain their package context.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The final overlap-package invariance is a separate result

The identical final quantities are a property of these supplied cases. They do not make every sequential transformation interchangeable.

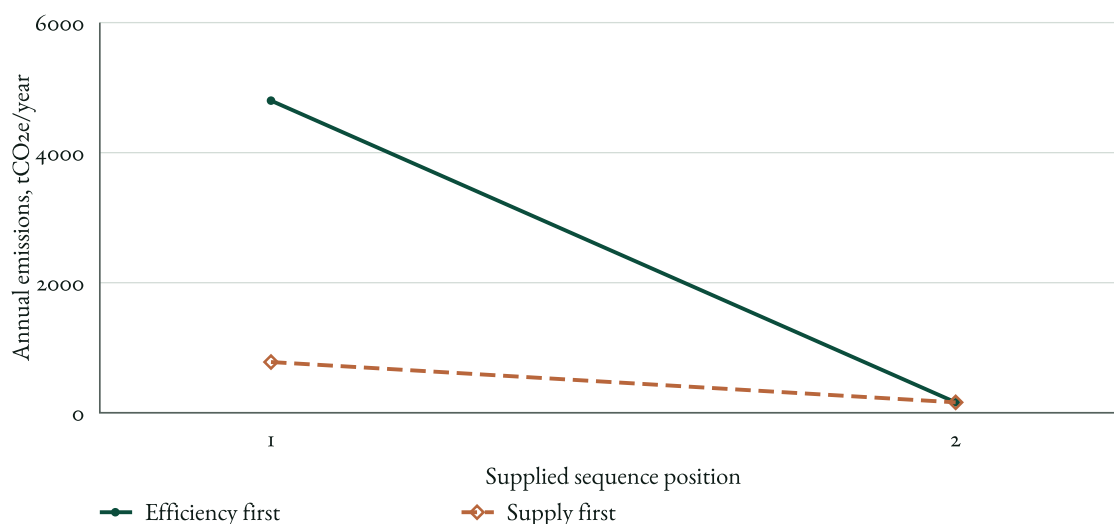
The final overlap-package invariance is a separate result			
Final package field	Efficiency first	Supply first	
Demand, MWh/year	8,000.00	8,000.00	
Renewable energy used, MWh/year	8,000.00	8,000.00	
Unused supply, annual MWh	1,000.00	1,000.00	
Annual abatement, tCO ₂ e/year	5,840.00	5,840.00	
Net annual saving, USD/year	520,000.00	520,000.00	
Package NPV, USD	1,318,760.57	1,318,760.57	

Canonical paired overlap package pointers. All quantities are illustrative and retain the annual electricity boundary.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Different intermediate attribution converges to the same final state

The paired illustrative packages reverse the same measures. Their first completed states differ, but their final annual emissions coincide. Read the incremental reductions and final package quantities in the accompanying tables.



Original deterministic drawing from the paired overlap canonical output pointers. Connectors link discrete completed states; the horizontal axis is supplied sequence position, not time or a commissioning schedule. No intermediate operating trajectory or optimisation is calculated.

Added demand provides a counterexample to universal order invariance. In the sequence-interaction study, demand is added before a percentage reduction is applied. Reversing the order applies efficiency to the original demand and then adds the new load. The final demand therefore differs under the engine's supplied interpretation. The study exposes a physical assumption: whether the efficiency measure can affect the added load. The appropriate engineering response is to examine that scope, not assume that whichever numerical order yields the larger benefit is the correct implementation plan.

A load-specific model could represent those relationships differently. If the new load is unaffected by the efficiency measure, applying the facility-wide percentage after addition would overstate the saving. If the efficiency intervention genuinely controls the enlarged system, the later percentage can be a reasonable abstraction. If the measures affect separate loads, a different decomposition may be preferable. The annual engine uses the supplied remaining-demand convention because it is transparent. The engineering record must establish whether that convention is adequate for the actual package under consideration.

Shared infrastructure introduces another kind of interaction. Connection work, controls, supporting equipment or operating capability may enable several measures. Counting their full cost against each standalone measure can overstate package expenditure; omitting them because no individual measure owns the interface can understate it. The screen sums listed upfront capital and constant operating costs without a dependency architecture. The analyst should allocate or represent shared terms coherently in an expanded case. The committee needs to understand both the cost of the complete operating state and the consequence of excluding a measure.

The same issue applies to avoided costs. A package may eliminate a system only when all required measures are implemented. A standalone measure cannot claim the entire removal saving if the old system remains necessary. Conversely, a package that changes supporting demand should retain the resulting expenditure even if it sits outside the principal equipment contract. The review should trace every claimed shared benefit to the condition that makes it available. A package calculation with coherent scope is stronger than a collection of attractive component business cases that cannot coexist.

Selection should therefore follow dependency and package analysis. An abatement-cost curve that sorts supplied increments by price can be a useful communication device, but it can suggest independent selection when increments overlap. The Transition lab retains the supplied sequence for its incremental display. It does not solve a constrained measure portfolio or search all feasible packages. The committee should treat the increments as an explanation of a defined package and develop the relevant alternatives separately. A sorted visual should never be allowed to create feasibility or independence that the underlying model lacks.

Illustrative calculation. Assumptions and sensitivity are published with the model.

A different permutation changes the final physical state

The sequence-interaction case adds electrical demand and applies an efficiency percentage. The reverse result changes which demand the percentage can affect under the supplied model convention.

A different permutation changes the final physical state			
Final field	Supplied order		Reversed order
Demand, MWh/year	9,000.00		9,500.00
Attributed emissions, tCO2e/year	5,400.00		5,700.00
Package NPV, USD	-208,711.81		-660,876.49

Canonical sequence-interaction output and reverse pointers. The comparison tests scope; it is not a construction schedule.

Completed Aster Works package-scope review

The record distinguishes an attribution-only permutation from a permutation that changes the physical state. It identifies the evidence needed to interpret either result.

Completed Aster Works package-scope review		
Interaction question	Completed finding	Decision consequence
Does order change the overlap package?	Final state and financial result are invariant in the paired overlap studies	Retain different step attribution without claiming a different final benefit.
Does order change added-demand interaction?	Final demand differs in the supplied and reverse outputs	Verify whether efficiency affects the added load.
Are shared interfaces represented?	No connection or enabling-system dependency architecture is supplied	Develop complete package costs and feasibility before selection.
Can increments be selected independently?	No independent-selection or optimisation claim is supported	Compare defined feasible packages rather than sum unrelated marginal promises.
Is the reverse order executable?	No commissioning or schedule evidence is supplied	Treat reversal as a numerical challenge until operations validates it.
Accountable evidence	Mara Sene owns EW-SCOPE; numerical overlap is checked, but actual affected-load and commissioning relations are absent	Prepare a load-interface matrix before engineering-sequence acceptance.
Authorised use	Use overlap invariance and reverse-demand difference to identify scope questions	No permutation is accepted as a construction schedule.
Stop authority	Mara Sene stops a sequence that applies efficiency to an unsupported added load or removes required service	Return an executable scope at the maintenance-plan freeze.

Original completed package review. The named studies remain supplied illustrative cases.

Classify the interaction before comparing the package

The reviewer maps each measure to its affected load and preceding state. The analyst distinguishes a change in incremental attribution from a change in final physical output. Shared costs, supporting loads and enabling conditions are recorded for the complete package. The operating owner identifies feasible sequences and service constraints. A numerical permutation can reveal a missing scope assumption but cannot choose the engineering sequence. The committee compares coherent executable alternatives, retaining package totals and conditional increments rather than treating every displayed measure as an autonomous investment.

The interaction record can prevent a negotiation error. A buyer may ask each supplier to guarantee a standalone saving, then discover that the combined installation removes the same waste more than once on paper. A stronger procurement record identifies the shared state and the basis for package acceptance. Suppliers can still be held accountable for their defined mechanism, but the total claim is reconciled at the relevant perimeter. This avoids asking separate contracts to prove additive benefits that the physical system cannot deliver.

Staging can be diagnosed by separating the state needed for a later measure from the benefit claimed for the first stage. An interface may make conversion possible while delivering little immediate reduction itself. Removing that interface from the pathway should prevent the later state; if another credible route still permits conversion, the particular design is an option rather than a necessary enabler. The annual screen cannot value that strategic choice or enforce its dependency. Keep the enabling condition explicit instead of reallocating later reductions to make every stage look attractive. This preserves the difference between a weak standalone ratio and a coherent implementation sequence.

The ultimate test is whether the package description and its numerical state tell the same story. If the narrative says the efficiency measure affects only existing equipment while the arithmetic applies it to a newly added load, the result requires repair. If the narrative says surplus energy will be sold while the model curtails it without revenue, the commercial case requires expansion. The interaction review uses such discrepancies to direct development work. It improves the recommendation by identifying which relation must be supported, rather than by making the package appear uniformly favourable.

Standalone screens can organise early options

Individual measure screens can be efficient before a final package is designed. They help identify plausible mechanisms and allocate engineering effort. The counterargument is valid when the screens remain provisional and their benefits are not summed without an interaction review. Package development can then combine, exclude or redesign measures with appropriate affected-load evidence. Requiring a final dependency model before any concept is considered would be excessive. Treating independent preliminary promises as a final combined guarantee would be equally weak. The appropriate transition is from isolated mechanism screens to a reconciled package state.

The engine does not optimise or schedule measures

Reversal is a numerical scope challenge, not an executable schedule. An efficiency measure unable to affect the added load would invalidate the corresponding sequence interpretation. Shared interfaces and avoided costs also need package reconciliation before component increments can support a combined commitment.

Decision implications

- Identical package totals can coexist with different measure attribution.
- A changed final state reveals a different interaction assumption.
- A numerical order is not an optimised or executable schedule.

MECHANISMS AND WORKED STUDIES

12

Rebound changes the delivered benefit

A rebound scenario framework with assumed parameters

Separate technical performance from changed use

A technical intervention changes an operating opportunity, and the organisation may respond to that opportunity. Lower input cost can make additional production attractive. Improved control can support a different duty. Better service can encourage more use. These responses can alter total energy even when the input requirement for a comparable unit of service falls. An appraisal should distinguish the engineering mechanism from the operating or demand response, then identify which total consequence matters to the decision. The existence and size of a response should be investigated rather than assumed from a generic label.

Rebound describes a response that offsets part of an expected input reduction through changed use or activity. It is not a synonym for every production increase after an investment. Expansion may have been planned independently. Product mix may change for unrelated commercial reasons. An intervention may enable higher quality rather than greater volume. The analyst should specify the causal proposition and the evidence that would distinguish it from an external change. Without that distinction, an added-energy scenario can be useful as a stress condition but cannot establish how behaviour will actually respond.

The operating response can also be desirable. A facility may invest to release a capacity constraint and produce more useful output. Higher total energy in that case does not necessarily indicate technical failure or a poor investment. It does change the absolute emissions and commercial comparison. The committee should identify whether its objective concerns efficiency, total emissions, production value or a combination. A proposal that improves intensity while increasing total demand needs a description that retains both results. Reporting only the favourable ratio would obscure the tradeoff the investment actually creates.

A response can occur through several channels. Operators may use newly available capacity, change settings, extend duty or adopt different production practices. Management may revise output plans once operating costs fall. Customers may respond to a changed product or price. The facility may add supporting loads that were omitted from the initial concept. These channels have different evidence and governance owners. The analyst should avoid assigning them a common percentage merely because they all increase energy. An explicit scenario should state which activity changes and why it is plausible for the decision context.

The time of the response matters. A measure might deliver an initial reduction before production expands or operating practice drifts. A constant annual case cannot represent that trajectory. It can retain alternative steady states for investigation, but a lifecycle commitment may require the transition between them and its cash implications. The measurement plan should identify the conditions that would show which state is emerging. This connects a provisional scenario to a learning action rather than treating it as a prediction. The organisation can then revise the operating or investment decision as evidence develops.

Evidence and scope

Impact evaluation separates outcome change from attribution to the intervention.

Evidence: [Magenta Book: Central Government guidance on evaluation](#)

The annual electricity engine contains an added-demand term and a sequential efficiency term. They can represent supplied operating states, but the engine does not estimate a behavioural elasticity, production response or rebound frequency. The user chooses the added quantity and the percentage scope. The calculation then transforms the annual demand accordingly. A study using those fields should therefore say that it tests an assumed operating condition. It should not announce that the resulting added load is an evidence-based estimate of how the facility or its customers will behave.

The sequence-interaction study illustrates an assumed package that adds demand and then applies efficiency to the enlarged annual base. Its final demand remains below the supplied baseline under that convention. Reversing the order produces a different final demand because efficiency is applied before the load addition. These results expose the assumed affected base; they do not identify a causal response. The analyst should ask whether the efficiency measure truly controls the added load and whether the added demand is independent, enabled or induced. The same arithmetic can describe different causal stories with different decision implications.

The added-demand study isolates another condition: electricity use increases without an offsetting efficiency measure or supplied renewable change. Its negative attributed abatement is valid within its electricity-only boundary. It

should not be used as a complete appraisal of a service expansion or fuel conversion whose benefits are omitted. The case helps identify the need to record the wider function and carriers. A scenario can be adverse for a specific metric while remaining incomplete for the broader investment. Recognising that incompleteness prevents both exaggerated optimism and premature rejection.

Scenario design should preserve the distinction between fixed-service and changed-service questions. A fixed-service efficiency case asks what input is needed to deliver the same declared function. A production-growth case asks how input changes under a larger or different function. A behavioural-response case asks whether the intervention causes that change. These questions may all be relevant, but they require different evidence. The dossier should label them separately and avoid treating an assumed changed-service state as a measured causal offset to technical savings.

The held-constant record should be especially clear when comparing operating cases. If the package, price, capital or baseline also changes, the financial difference cannot be attributed solely to the demand response. The studies in this chapter are used to explain their own physical assumptions, not to estimate an isolated financial rebound effect across unlike packages. A more targeted applied study would retain the appropriate common terms and change the specific response parameter. The canonical engine can recompute such a supplied state, but the evidence for choosing it remains outside the computation.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Supplied operating states are assumptions, not response estimates

The cases have distinct measure specifications. They demonstrate their own annual electricity states rather than provide an estimated behavioural effect or an isolated financial comparison.

Supplied operating states are assumptions, not response estimates		
Study and field	Frozen quantity	Interpretation
Sequence-interaction added load	2,000.00 MWh/year	Demand is added before the efficiency step.
Sequence-interaction efficiency	25.00 %	Applied to the remaining enlarged demand under the model convention.
Sequence-interaction final demand	9,000.00 MWh/year	The supplied combined state, not a predicted production response.
Sequence-interaction reverse demand	9,500.00 MWh/year	A different scope ordering creates a different final state.
Added-demand final demand	12,000.00 MWh/year	An isolated electrical load addition in its own study.
Added-demand annual abatement	-1,200.00 tCO ₂ e/year	The electricity-only attribution increases in that condition.

Canonical sequence-interaction and added-demand pointers. The added quantities and efficiency scopes are explicitly illustrative.

Completed Aster Works operating-response investigation

The fictional record separates a supplied growth condition from a causal rebound estimate. Its completed status directs the evidence needed before a forecast or performance claim is made.

Completed Aster Works operating-response investigation		
Response proposition	Completed status	Evidence or action
Technical fixed-service saving	Retained in a separate efficiency-only screening study	Verify the affected load and service equivalence.
Additional activity	An added annual electricity quantity is supplied for challenge	State the activity and whether it is planned, enabled or induced.
Causal link to the measure	Not established	Design evidence that distinguishes intervention response from external change.
Effect on the absolute target	Annual electricity and attributed emissions are recomputed for each supplied state	Retain totals alongside any intensity statement.
Operating control	No settings or production governance is modelled	Assign actions and review triggers that can maintain the intended state.
Accountable evidence	Nora Vale owns EW-OUTPUT; no actual production or causal response dataset is supplied	Define a fixed-service and changed-production evidence design before production-plan approval.
Authorised commitment	Existing-staff design of the response comparison only; no elasticity or rebound forecast	Mara Sene retains planned expansion separately from an induced-use hypothesis.
Stop authority	Nora Vale stops a causal claim inferred only from a changed facility total	Return the proposed comparison at the diligence review.

Original completed scenario-governance record. No actual behavioural, production or frequency data are asserted.

Choose the objective before judging the response

The committee identifies whether it seeks a fixed-service input reduction, lower total emissions, additional production value or a combination. The analyst separates technical performance from planned scale and possible induced activity. Each scenario names the changed service and causal assumption, retaining common terms where a targeted comparison is intended. The evidence owner designs monitoring or evaluation suited to the disputed proposition. A response is accepted, constrained or investigated according to the authorised objective, rather than automatically labelled a failure or silently excluded from the annual balance.

Test the operating response against competing service instructions. A measure may be specified to reduce energy at fixed duty while management separately intends to increase production. Determine whether the expanded duty would occur without the intervention or whether lower operating cost induces it. The first belongs in the reference operating plan; the second is a potential intervention response. An instruction to maintain an absolute energy target can then conflict

with the production mandate rather than merely require better settings. Identify that conflict before claiming that governance eliminates rebound. The response remains an operating choice with service and commercial consequences, not an adjustment the screen estimates automatically.

Verification should preserve both mechanism evidence and total outcomes. A targeted equipment measure can perform as designed while facility consumption rises because another load expands. A facility total can fall while the targeted mechanism fails because production contracts. The measurement arrangement should distinguish those findings and state which obligation it evaluates. A savings guarantee, an absolute climate objective and a production strategy can therefore need different records. The organisation should not ask an undifferentiated meter comparison to settle all of them.

Use a service-change comparison to diagnose an unexpected energy total. If the intervention's affected equipment uses less energy for comparable duty while another load expands independently, its mechanism may remain sound although the facility's absolute objective is missed. If duty is unchanged and settings drift, the result instead points to operating persistence. If cheaper service appears to induce more use, investigate that causal route before changing the baseline. Preserve the evidence supporting each interpretation and avoid forcing every deviation into the same correction. These branches identify whether to revise the reference plan, repair operation or reconsider the intended objective; they do not manufacture a rebound estimate.

An uncertain response need not dominate every screen

A concept assessment cannot estimate every possible behavioural or production response. If the next action is limited and the fixed-service mechanism is clear, a labelled alternative operating condition can be enough to reveal whether the question is material. The objection is valid when further response analysis has little decision value. It is weaker when the investment rationale depends on expansion or when an absolute emissions commitment could be undermined by changed use. The record should state the relevant objective, retain a proportionate challenge and identify what evidence would require a revised commitment.

No rebound elasticity or production forecast is calculated

Added energy is a supplied state, not a behavioural elasticity. Without a service and causal design, a changed total cannot identify induced use. Nora Vale must distinguish planned scale, technical performance and response before the scenario supports an attributed rebound or forecast claim.

Decision implications

- A supplied added-load case is not an estimated behavioural response.
- Intensity, total energy and production value answer different questions.
- Monitoring must distinguish the affected mechanism from wider operating changes.

GOVERNANCE AND APPLICATION

13 Measurement effort should match performance risk

A measurement-and-verification selection matrix

Design verification around the proposition being relied upon

Measurement and verification should be designed around the saving proposition and the obligation that relies on it. A meter can establish energy passing its boundary, but the saving is a comparison with a relevant alternative under specified conditions. The plan must therefore identify the affected system, baseline, operating variables, adjustment method and responsibility for interpreting change. Installing more meters without resolving that comparison can produce detailed data that fail to answer the decision question. The method should make the relevant mechanism observable and the attribution rule contestable.

The measurement boundary presents a tradeoff. Isolating a targeted system can reveal its performance with less interference from unrelated facility activity. It can also omit interactions that the package creates elsewhere. Whole-facility information can capture combined effects but may make a small intervention difficult to distinguish from production, weather or other changes. A simulation can represent interactions when direct measurement is limited, but its calibration and structural assumptions need challenge. Method choice follows the mechanism, signal and obligation rather than a generic preference for the most detailed technique.

The useful-service record should accompany energy measurement. If a process delivers less accepted output after commissioning, lower input does not alone establish the intended efficiency. If output rises, greater input does not alone show failure. The plan should identify relevant production, quality and operating variables and explain how they relate to the saving comparison. It should also identify variables that the intervention itself changes. Adjusting away a change caused by the measure can remove part of its effect, while failing to adjust an independent change can misattribute the result.

The plan needs to distinguish measured and stipulated terms. A limited-parameter approach can be proportionate when the unmeasured terms are sufficiently understood for the obligation. The record should name those assumptions and the risk they allocate. A measured-system approach can reduce reliance on some assumptions while retaining boundary and adjustment questions. A whole-facility approach can provide a package result without identifying every component's

contribution. A calibrated simulation can extend the comparison beyond available meters, but its apparent precision should not be confused with independently measured truth.

Agreement before implementation is valuable because the performance result can otherwise influence the chosen method. The parties should record the baseline conditions, adjustment triggers, data quality requirements, inspection responsibilities and reporting process while the comparison is still prospective. A later revision can be legitimate, especially after a structural change, but it needs an authorised reason and retained history. The plan should prevent an unexplained adjustment from becoming a universal remedy for an unfavourable result. It should also prevent a valid performance improvement from being dismissed because unrelated conditions changed.

Evidence and scope

FEMP distinguishes isolation, measured-system, facility and calibrated-simulation verification approaches.

Evidence: Measurement and Verification Options for Federal Energy- and Water-Saving Projects

The published method families

The source distinguishes generic approaches; selection still depends on the project boundary and obligation.

The published method families	
Published option	Method basis
A: retrofit isolation	Critical parameter measurement, with engineering and stipulated terms.
B: isolation or system level	Measurement of all relevant parameters.
C: whole-building verification	Facility energy information with relevant adjustments.
D: building or component verification	Calibrated simulation of the relevant energy system.

Narrow paraphrase of the retained DOE FEMP options page. Jurisdiction and contract applicability remain separate.

Evidence: Measurement and Verification Options for Federal Energy- and Water-Saving Projects

An isolated measurement design is attractive when the targeted load can be separated and the principal saving mechanism can be traced within that perimeter. The analyst should still ask whether supporting loads or another system change materially. If an intervention transfers demand across the boundary, the isolated result can overstate the package benefit. The plan can expand the perimeter or include an explicit interaction treatment. It should state which effect is being measured and which effect remains estimated, rather than claim that isolation automatically removes every attribution problem.

A facility-level design is attractive when the package affects many systems or when interactions are central to its benefit. Its challenge is the ability to distinguish the package change from normal variation and structural shifts. The analyst should examine whether the retained service and operating variables make the comparison interpretable. A larger quantity of billing data does not ensure a stronger inference if the conditions are poorly recorded. The method needs a signal relevant to the obligation and an adjustment design that can be independently reviewed.

A simulation-based design should retain the model structure, parameter provenance and calibration evidence. A model can match a historical total through different combinations of assumptions, with different predictions after the intervention. Calibration therefore needs more than an attractive fit to a selected period. The reviewer should ask which information constrains the relevant mechanism and whether the model responds credibly to operating changes. The simulation can be useful when its scope and uncertainty are explicit. It should not become an unrestricted substitute for missing baseline and service evidence.

The plan should also separate installation verification from continuing savings. An inspection can confirm that equipment has been delivered, connected and commissioned. A short performance test can confirm an operating condition. Continuing savings depend on the maintained duty, controls and wider conditions over time. The obligations may require different evidence at each stage. A successful installation check should not be described as proof of every future annual saving. Conversely, a change in facility duty should not invalidate an equipment acceptance result that remains within its stated scope.

Data integrity is part of the method. Missing intervals, changed meter boundaries, time alignment, calibration and operating records can affect the comparison. The plan should define how these issues are detected and treated, and which conclusion remains unavailable when the evidence is incomplete. A missing reading should not become a zero consumption value by default. A new meter should not silently replace a different old perimeter. The process needs an auditable trail from raw information to the reported result, with a distinction between correction, estimation and measured data.

Completed Aster Works measurement-method disposition

The fictional efficiency proposal has no actual meter or production dataset. This completed selection record recommends evidence development and makes the method conditional on the identified boundary. Original completed plan for investigation. It is not a realised-savings certificate or an actual contract M&V plan.

Completed Aster Works measurement-method disposition		
Selection field	Completed provisional entry	Condition or owner
Saving mechanism	Reduced electrical input for an unchanged targeted service	Engineering to reconcile affected load and service.
Isolation opportunity	Potential subsystem boundary, not yet verified	Measurement lead to confirm meters and supporting interactions.
Primary method direction	Develop an isolated approach if the relevant load can be separated	Retain estimated terms and assess their risk explicitly.
Facility cross-check	Use wider records to investigate package effects	Operations to retain production and structural-change information.
Alternative method	Consider facility or calibrated-model comparison if isolation omits decisive effects	Reviewer to justify method fit and uncertainty.
Current disposition	Approve scoping and temporary evidence collection	No savings guarantee or achieved result is asserted.
Accountable evidence	Nora Vale owns EW-METER and EW-SCOPE; actual isolation and supporting interactions remain unverified	Choose isolation scoping as the next task before instrument-plan approval.
Authorised commitment	Existing-staff boundary and logging design only; no sensor purchase or measured-saving acceptance	A facility or calibrated alternative is held for a demonstrated isolation failure.
Stop authority	Mara Sene stops service-disrupting access; Nora stops a guarantee based on unrecorded stipulated terms	Return the method and responsibility record before procurement freeze.

Select the method through boundary, signal and obligation

The sponsor states the saving and service proposition. The measurement lead identifies what can be isolated, what interacts beyond that boundary and which variables determine the comparison. The reviewer tests whether the method can distinguish the relevant change with proportionate evidence. Estimated and measured terms are separated, adjustment rules are agreed and reporting responsibilities assigned. A method is accepted because it can answer the obligation under relevant conditions. If no method currently supports that answer, the decision authorises evidence development or narrows the promised result rather than treating data volume as assurance.

The acceptance record should specify who bears a measurement risk. If an operating factor is stipulated, the parties should understand how a different actual duty affects the guarantee or reported saving. If a facility comparison includes unrelated changes, the adjustment responsibility should be clear. If a simulation depends on a supplier model, the buyer should understand its accessibility and review conditions. These allocations do not follow from the method label alone. A well chosen approach can still fail as an agreement if the parties rely on incompatible interpretations.

A measurement design can be tested by asking which competing explanation it could reject. A simple installation inspection can reject absence of the specified equipment but cannot distinguish achieved savings from a production decline. A targeted meter can investigate the affected mechanism while missing an added load elsewhere. A facility comparison can capture the total while requiring a defensible account of unrelated changes. Select the design whose observable quantity separates the explanations that matter to the obligation. More instrumentation is useful when it resolves that distinction, while a costly broad dataset that leaves the service comparison undefined may add little. This makes proportionality a property of the question rather than the size of the apparatus.

At verification close, try the alternative diagnosis before accepting the first. A lower affected-load reading with unchanged useful service supports one interpretation; the same reading with lost service requires investigation of the service reduction. A stable affected load with lower facility consumption suggests another change outside the measure. Missing intervals that coincide with high-duty operation create a data-selection concern before they create a performance conclusion. The resulting disposition can approve a supported measurement design, request a missing operating record or reject an untestable guarantee. The diagnostic preserves the difference between an equipment issue, a duty change and a data problem without treating verification as one undifferentiated pass.

Verification cost can exceed its decision value

A small or stable intervention may not justify a costly instrumented study. Limited measurements and defensible estimates can be appropriate when they support the intended obligation and allocate material uncertainty transparently. The objection is especially strong for a reversible measure with low performance exposure. It is weaker for a complex package, a material savings guarantee or a public claim that depends on interactions. The repair is a proportionate method and a narrow statement, rather than either universal maximal measurement or a declaration that all savings are verified because the equipment was installed.

No empirical measurement or calibrated model is supplied

No actual meter series, equipment test or calibrated model exists here. Isolation is a scoping disposition until EW-METER supports the boundary and estimated terms. A material interaction outside that boundary would trigger method reconsideration before savings acceptance.

Decision implications

- Metered energy and attributable savings are different propositions.
- Method selection depends on boundary, signal and obligation.
- Installation, performance testing and continuing savings need distinct evidence.

GOVERNANCE AND APPLICATION

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Capital constraints and operational disruption matter

A transition investment pathway

Reconcile capital, useful life and the transition route

A transition package can be economical in its eventual operating state and still fail as a capital commitment. The equipment price may omit connection, civil work, controls, supporting systems or qualification. Commissioning can interrupt production or require temporary arrangements. The useful operating life may differ from the appraisal horizon, and a component may need replacement while the package continues. The committee needs a cost and delivery perimeter that corresponds to the physical state being valued. A capital figure should not become credible merely because it produces a favourable ratio in the screen.

The cost boundary begins with the complete operating alternative. If the final state requires a supporting asset, its cost belongs somewhere in the package or an explicitly recognised shared arrangement. If it requires changes in the facility, the

owner and cost need to be identified. Excluding an enabling term because it appears in another department's budget can make the project look cheaper without changing the organisation's total commitment. Conversely, assigning every shared cost to each alternative can distort comparison. The record should identify the cost mechanism and the allocation convention before the financial result is interpreted.

The technical baseline connects capital scope to the service and energy balance. A supplier quotation may cover a device while the balance assumes a wider operating system. The buyer should reconcile the quotation, exclusions, interface responsibility and acceptance requirements with the proposed state. A change in equipment duty can require a different specification; a changed connection condition can require additional work. The appraisal should retain these relations so cost updates can be traced to physical scope. An unexplained contingency cannot substitute for identifying a missing system.

Commissioning requires a separate route from the existing operation to the proposed one. A facility may need a shutdown, parallel equipment, temporary energy, training or production qualification. The steady-state energy balance does not establish that this route is feasible. A schedule should identify the dependencies and the service risks, while the cash model should include material transition expenditure and delayed benefits. The annual engine assumes the supplied package state for its constant annual saving. It does not calculate the cost or timing of reaching that state.

Asset life is another proposition requiring evidence. A supplied appraisal horizon is an analytical parameter; it is not a durability certificate, a remaining-life assessment or a contract term. Equipment can degrade, need major maintenance or become unsuitable for a changed production strategy. A package can include components with different replacement requirements. The analyst should distinguish physical life, economic use, contract duration and the period over which benefits are being valued. These periods can coincide, but the coincidence should be justified rather than assumed from a default input.

Evidence and scope

Cost estimates require a defined technical baseline and documented assumptions.

Evidence: Cost Estimating and Assessment Guide

A replacement pathway can change the comparison substantially. Continuing an old asset may involve maintenance and an eventual replacement that the proposal avoids or brings forward. The proposed technology may require a renewal during the organisation's service horizon. A full appraisal should compare coherent pathways, including relevant residual or disposal treatment. The Transition lab does not model those schedules. It annualises the listed upfront capital and uses a

constant annual saving over the supplied horizon. This simplification can support a concept screen when the omitted pathway is not decisive, but it should not be mistaken for lifecycle completeness.

The annualisation convention should be explained in plain language. The engine uses the supplied discount rate and horizon to express upfront capital as an equivalent annual amount, then compares that amount with constant annual savings. That equivalent amount is not an actual lease, debt repayment or maintenance reserve. It helps compare a supplied capital commitment with annual benefits under the retained convention. A financing proposal can have different cash timing and obligations. The committee should keep the analytical charge separate from the payment plan that determines liquidity and contractual exposure.

The horizon can also affect the apparent quality of the opportunity. Extending a constant benefit farther into the future gives it more time to offset upfront capital under the screen. That result is arithmetic conditional on benefit persistence and continued service relevance. It does not prove that the equipment or operating arrangement will sustain the benefit for the added period. A horizon challenge should therefore be tied to life and operating evidence, rather than used merely to improve a weak result. The organisation should identify what must remain true for the chosen period to be defensible.

Downtime belongs in both feasibility and economics. A production interruption can be acceptable for a planned maintenance window and unacceptable during a critical service period. Its cost can include lost output, temporary supply, requalification or recovery. The annual engine has no field for those terms. The reviewer should decide whether they are immaterial for the preliminary action or whether a fuller case is required. A package with strong steady-state savings may need staging or redesign to fit the facility's transition constraint. Refining energy prices alone would not resolve that problem.

The cost record should distinguish scope uncertainty from price uncertainty. An unknown interface means the system definition is incomplete. A defined component with an uncertain quotation is a different problem. A schedule risk can affect both expenditure and benefit timing. These uncertainties call for different actions: engineering clarification, market evidence or delivery development. Combining them into an undifferentiated allowance makes the total look cautious while reducing the ability to challenge it. The estimate should show the assumptions that matter to the commitment and the evidence needed to close them.

Evidence and scope

Life-cycle cost comparison includes expenditure beyond initial acquisition.

Evidence: Raising economic efficiency in view of life-cycle costs

Illustrative calculation. Assumptions and sensitivity are published with the model.

What the foundation capital convention includes

The foundation screen treats the listed capital as upfront and the supplied annual saving as constant over the horizon. These are illustrative assumptions, not a physical-life or financing determination.

What the foundation capital convention includes		
Capital convention field	Frozen quantity	Meaning
Listed efficiency capital	800,000.00 USD	Upfront supplied measure expenditure.
Listed supply capital	1,800,000.00 USD	Upfront supplied measure expenditure.
Total listed capital	2,600,000.00 USD	The sum of listed package capital, without unlisted interfaces.
Appraisal horizon	12.00 years	A supplied valuation period, not verified asset life.
Discount rate	8.00 %	A supplied convention, not a cost-of-finance quote.
Discounted annuity factor	7.54 (annual-payment factor)	The constant annual saving conversion used by the canonical model.

Canonical foundation input and output pointers. An equivalent annual cost is an appraisal convention and not a contracted payment.

Completed Aster Works capital-scope hold

The fictional screen has listed measure capital but no engineering or commissioning dossier. The completed record identifies what remains conditional before implementation.

Completed Aster Works capital-scope hold		
Scope question	Completed screening entry	Next responsible action
Principal equipment	Capital is supplied by measure, without a quotation package	Procurement to confirm inclusions, exclusions and acceptance scope.
Connection and supporting systems	Not represented	Engineering to reconcile final-state interfaces and cost ownership.
Commissioning and downtime	Not represented	Operations to develop a feasible conversion and production plan.
Useful life and renewal	A valuation horizon is supplied; life evidence is absent	Asset owner to identify persistence, maintenance and replacement conditions.
Disposal or residual treatment	Not represented	Finance and asset owner to determine material lifecycle terms.
Current decision	Use the screen to scope a fuller case	Do not interpret annualised capital as an available payment plan.
Accountable evidence	Leila Chen owns EW-COST; listed capital is illustrative and actual interfaces, quotations and transition costs are absent	Prepare the equipment-exclusion and commissioning-cost map before budget-request sign-off.
Authorised commitment	Cost-scope development using existing staff only; no capital payment or financing term	Mara Sene supplies the transition and service requirements to the same map.
Stop authority	Idris Ko stops an implementation request that treats the annuity charge as available finance or omits an enabling system	Return a reconciled scope before maintenance-plan freeze.

Original completed capital development record. No missing cost is silently entered as a zero value.

Require a route to the valued operating state

The sponsor reconciles the proposed final service and balance with the complete equipment, interfaces and operating arrangements. The cost lead separates scope gaps, pricing uncertainty and timing exposure. Operations defines the transition route and acceptable service interruptions. The asset owner supports the useful period and renewal pathway. Finance models material cash timing and lifecycle terms outside the screen. The committee can authorise development, staging or implementation according to the evidence available. A favourable steady-state value is supporting evidence only when the organisation can reach and maintain that state within its obligations.

The record can reveal a smaller implementable alternative. A modest efficiency intervention may fit an existing shutdown and connection while a larger conversion requires unavailable infrastructure. A staged package may secure an enabling interface before replacing the principal process. An alternative

procurement arrangement may change capital timing without changing the physical state, although its obligations need a proper comparison. These options should be developed explicitly. The screen does not select them automatically, but the scope review shows which constraint makes their development valuable.

Classify a capital revision by its physical consequence. A device-price amendment can change cash while leaving demand and abatement untouched. A newly required supporting load changes the operating state as well as the commitment. A revised quality condition may change service, equipment selection and the appropriate counterfactual together. Compare the proposed revised system with the system whose benefit is still cited before accepting the new cost. If they differ, update the affected physical comparison rather than attach the old saving to the new commitment. This diagnosis makes the revision consequential and reveals why a simple price update is different from an expanded implementation scope.

Compare the steady-state opportunity with the route into it. A package may provide attractive annual savings but require a shutdown that the service commitment cannot tolerate. Another route may preserve service through temporary supply while introducing payments or obligations absent from the annual screen. Identify the commissioning sequence, the service maintained at each step and the payable commitment that permits the step. The equivalent annual charge remains a screening explanation, while procurement and funding terms determine actual payment timing. A positive simplified NPV therefore supports investigation of the route; it cannot establish that the institution can sustain the liquidity and service consequences of reaching the modelled state.

Detailed lifecycle work can wait until a concept is promising

An initial screen can reasonably omit renewal and commissioning detail when the immediate action is limited to investigation and the omissions are unlikely to reverse that action. Demanding a final estimate at inception would waste effort on weak concepts. The objection is valid only if the record identifies material scope gaps and reserves implementation approval. A proposal whose apparent value depends on a long unsupported horizon, omitted connection or ignored shutdown already needs targeted development. Proportionality permits staged evidence; it does not permit a concept cost to masquerade as a complete capital commitment.

The screen is not a lifecycle or financing schedule

The valuation horizon is not physical life, and the annuity charge is not funding. An omitted connection, transition cost or renewal can invalidate the applied commitment. Leila Chen must reconcile these terms with the same service state before a complete capital case is signed.

Decision implications

- The valued final state needs a complete cost and delivery perimeter.
- An appraisal horizon is distinct from physical life and payment timing.
- Scope gaps, price uncertainty and transition exposure need different remedies.

GOVERNANCE AND APPLICATION

15

Carbon prices are assumptions with decision boundaries

A conceptual incentive-condition framework and an adverse energy-price comparison

Distinguish an assumed value from a payable benefit

A transition proposal can be assessed under an energy-only cash case, an incentive case or a wider economic case. These perspectives may use the same physical balance while valuing different consequences. A carbon value can represent an assumed policy signal, a shadow value for appraisal, an avoided charge or an expected credit payment. Those terms are not interchangeable. The committee should identify which perspective is being presented and whether the value changes an actual cash obligation, an analytical welfare comparison or only the organisation's stated preference for an outcome.

An emissions reduction does not automatically create revenue. A credit payment depends on eligibility, ownership, verification, quantity, delivery and commercial terms. An avoided charge depends on the activity subject to the charge and how it responds to the intervention. A grant depends on the relevant commitment and payment conditions. A shadow value can help compare societal consequences without appearing in the sponsor's bank account. The appraisal should preserve these distinctions before using a per-tonne value to make an energy-only screen appear investable.

The direction of the question matters. A sponsor might ask what support would make a defined package financially acceptable. A public decision maker might ask whether the package's wider benefits justify its resource cost. A commercial buyer might ask whether a contractual payment can be secured. Those questions require different terms and authorities. An illustrative support threshold is not a forecast of a carbon market, and a social valuation is not a financing offer. The dossier should name the decision and the evidence needed for the chosen perspective.

A symbolic break-even condition can clarify the missing information. A recurring support amount would need to offset the relevant annualised net cost if the cost and support use the same timing and valuation convention. Converting that support to a per-unit amount requires a positive eligible quantity and an enforceable entitlement to payment. The annual attributed abatement from the screen is not automatically that eligible quantity. Payment may concern a different boundary, duration or verification outcome. The analyst should not replace those conditions with a favourable factor-based result.

The Transition lab contains no carbon-price field, credit income, tax, grant or policy-payment schedule. Its package ratio is a cost descriptor under supplied energy prices and capital conventions. A positive abatement cost can show that the energy-related annual saving is insufficient to offset equivalent annual capital under those assumptions. It does not calculate a recognised credit price needed for financing. The committee can use the ratio to understand the size and source of a screening cost, while reserving an incentive case for a method that actually represents the applicable obligations and cash terms.

Evidence and scope

Public appraisal separates relevant benefits, costs and uncertainty.

Evidence: The Green Book

A support condition is conditional on eligible quantity

Annual support needed = relevant net annualised cost, where that cost is positive. Per-unit support condition = annual support needed / positive eligible annual quantity. Eligible quantity, entitlement and payment timing require separate evidence.

Original symbolic decision relation. No carbon-payment calculation, market price or programme eligibility is implemented in the annual electricity engine.

The adverse-price study provides a useful energy-only starting point. It retains positive annual attributed abatement while its supplied prices create a negative net annual saving and an unfavourable simplified NPV. That combination may prompt investigation of an incentive or a different commercial arrangement. The model does not prove that support will be available or adequate. It shows which energy-related terms make the package costly under this case. A support proposal should then establish its own quantity, timing, eligibility and risk before the committee relies on it.

An incentive case should state whether support is assumed, announced, committed or earned. Those statuses have different evidential meanings. A sponsor can explore a hypothetical term to understand decision sensitivity, provided it is labelled as such. An announced programme can still have application, availability or acceptance conditions. A commitment can still depend on performance and documentation. An earned payment can still have settlement timing. The record should prevent a provisional prospect from appearing as unconditional cash. The investment stage should follow the strength of the support evidence.

The quantity basis needs its own review. A programme might recognise a project reduction under a specified baseline and boundary, a contractual attribute or a verified performance result. The annual screen's attributed emissions difference may not satisfy those rules. The reviewer should map the recognised quantity to

its method and evidence rather than assume equivalence because both use emissions units. If only part of the modelled reduction is eligible, the support condition changes. If the sign or persistence of the reduction is uncertain, a fixed payment assumption can be particularly weak.

Timing can also invalidate a simple threshold. A payment received after verification may not fund upfront expenditure or early operating exposure. A temporary incentive may end before the package's useful period. A performance failure can reduce the quantity or delay settlement. An annualised comparison can describe overall value while missing a liquidity constraint. A fuller incentive case should represent the relevant schedule and obligations. The committee needs to know whether support changes project value, available cash, risk allocation or all of them.

Double counting deserves an explicit check. A supplied energy price can already include a charge that the intervention avoids. Adding the same avoided amount again as a separate carbon benefit would overstate cash savings. A social appraisal can legitimately consider consequences beyond sponsor cash, but it should distinguish those terms from transfers or existing price effects under the relevant method. The reviewer should trace each claimed benefit to its mechanism and recipient. A label such as carbon benefit does not establish that a term is additional to the rest of the case.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The energy-only adverse case does not contain support

The retained output reports a costly energy-related package with positive attributed abatement. It supplies no eligible-credit quantity, payment or policy-price threshold.

The energy-only adverse case does not contain support		
Energy-only field	Frozen quantity	What it can establish
Annual attributed abatement	3,810.00 tCO ₂ e/year	A positive factor-based annual reduction within the screen.
Net annual saving	-215,000.00 USD/year	The supplied energy and continuing-cost condition.
Net annualised cost	560,007.04 USD/year	Equivalent annual package cost under the retained convention.
Package NPV	-4,220,256.77 USD	Simplified value without policy or credit income.
Package abatement cost	146.98 USD/tCO ₂ e	Cost per positive attributed annual reduction, not verified eligibility.
Support or incentive income	Not represented	A separate applied model and evidence are required.

Canonical adverse-prices pointers. Every value is illustrative; the ratio remains a cost descriptor rather than an actual carbon-payment condition.

Completed Aster Works incentive-income rejection

The fictional sponsor has an energy-only screen and no identified support agreement. The completed record prevents a hypothetical incentive from being treated as secured value.

Completed Aster Works incentive-income rejection		
Support question	Completed status	Decision consequence
Purpose of additional value	Investigate whether a costly package merits a wider appraisal	Separate sponsor cash from societal or organisational value.
Instrument or payer	None identified	Do not include a secured payment in the recommendation.
Eligible quantity	Not established by the annual screen	Obtain the relevant method, boundary and acceptance evidence.
Ownership and entitlement	Not supplied	Confirm who can claim and receive the benefit.
Payment period and timing	Not supplied	Develop a cash schedule before relying on support for liquidity.
Current disposition	Retain the energy-only case and scope the missing incentive evidence	Do not label the package financed or credit-approved.
Accountable evidence	Owen Diallo owns EW- INCENTIVE; no payer, eligible quantity, entitlement or payment term is identified	Record the absence before any support-dependent funding proposal.
Authorised use	Retain the energy-only case; hypothetical support may guide development but is excluded from secured cash	Leila Chen does not sign an incentive-funded investment case.
Stop authority	Safia Bello stops eligibility inferred from attributed abatement; Idris Ko stops a funding representation based on unsecured support	Reopen only on documented applicable terms and a suitable cash schedule.

Original completed support diligence record. No current programme, market quotation or payment entitlement is asserted.

Keep value, cash and entitlement separate

The committee states whether it is considering energy savings, a sponsor incentive or wider economic benefit. The analyst records each additional term with its recipient, quantity basis, status and timing. The reporting and commercial reviewers verify eligibility and entitlement where relevant. Finance tests the cash schedule and avoids duplicating price effects. A hypothetical term can remain a sensitivity condition, but a commitment that depends on it requires evidence proportionate to that dependence. The energy-only result stays visible so the contribution of support can be assessed rather than hidden inside a revised headline.

A package can proceed for a legitimate wider purpose without being profitable under an energy-only screen. The organisation may have an authorised climate objective, service obligation or strategic pathway that justifies an additional resource cost. The decision record should state that rationale and the cost accepted. It should not retrofit an unsupported credit revenue to make the package appear commercially self-funding. Transparent justification allows the committee to compare alternatives and understand the obligation it accepts. A positive abatement result and an authorised willingness to pay are distinct propositions.

Conversely, an energy-only package with favourable cash savings may not need an incentive to justify investigation. Adding speculative support can distract from the conditions that actually govern implementation, such as duty, capital scope or contract charges. The committee should identify whether additional value is decision-relevant before investing effort in it. If the investment is already robust on supported cash terms, a claim or incentive may be a separate opportunity with its own evidence process. Keeping it separate protects the core case from an unnecessary dependence.

Diagnose a support-dependent case by removing the support premise and observing which argument remains. The energy-only cash proposition may remain viable, while the intended reporting or incentive claim fails. Alternatively, support may be decisive for sponsor cash, in which case eligibility, payment period and quantity basis become commitment conditions. A changed social value affects appraisal without necessarily affecting receipts; a changed energy price affects the underlying cash case before support is considered. Trace these mechanisms separately. The annual demonstrator does not calculate carbon receipts, so this diagnosis identifies the commercial evidence and suitable financing analysis required rather than inserting an unsupported value into its output.

Hypothetical support can reveal useful thresholds

A sponsor need not wait for a signed incentive agreement before exploring what conditions would make a proposal viable. A labelled hypothetical support condition can guide negotiation, option development and policy analysis. The objection to forbidding all such exploration is persuasive. The condition becomes misleading when it is reported as available revenue, when eligible quantity is assumed from an incompatible screen or when cash timing is ignored. A threshold study should name the assumptions, retain the unsupported terms and use an appropriate model. Exploration can clarify the next action without claiming that the required support exists.

No carbon-market or programme forecast is provided

No payment entitlement, eligible quantity or policy-price forecast is supplied. A support condition is conceptual until those terms and timing are established in a suitable model. Owen Diallo must not promote hypothetical value into secured cash; Safia Bello controls the associated recognised claim.

Decision implications

- A shadow value, avoided charge and credit payment have different meanings.
- A modelled reduction is not automatically an eligible paid quantity.
- Retain the energy-only case when exploring a support-dependent alternative.

GOVERNANCE AND APPLICATION

16 Transition finance cannot repair an impossible process

A feasibility-to-finance decision gate

Separate positive value from an executable funded commitment

Investability combines a credible operating proposition with an executable and affordable commitment. A positive screening value can support investigation, but it does not show that the asset can be delivered, the service sustained or the required cash provided. The committee should distinguish technical feasibility, commercial readiness, implementation capability and financing. Each layer concerns a different failure mechanism. A proposal can pass one layer while remaining conditional at another. Keeping the layers visible prevents a technically attractive concept from being promoted to a finance-ready investment through presentation alone.

Technical feasibility concerns the complete operating state and its constraints. The equipment must deliver the required service within the facility's relevant duty, interfaces and capacity. The physical balance should include the carriers and supporting loads needed for the claim. Connection, production quality and safety questions require their own evidence. The annual electricity screen accepts a supplied state and has no design acceptance or operating-constraint solver. Its arithmetic can reveal an internal contradiction, but it cannot establish that a real installation can achieve the assumed state.

Commercial readiness concerns obligations that make the physical and financial case available. Procurement scope, supplier performance terms, energy prices, delivery responsibilities and relevant reporting attributes can all matter. A quotation or discussion can indicate a possibility while leaving material terms unresolved. The sponsor should identify which terms are committed, which are provisional and which depend on further evidence. A saving based on an unavailable tariff is a conditional opportunity. A performance assumption unsupported by acceptance terms is an engineering and contractual gap, not a financing input that should be quietly discounted away.

Implementation capability concerns the organisation's ability to convert the concept into continuing service. A capital budget does not supply a shutdown window, trained staff or an accountable operating owner. A technology that works elsewhere may require site-specific integration and qualification. The investment record should identify who owns the transition, the critical interfaces and the conditions that permit release of the next commitment. Implementation risk should be connected to concrete actions and evidence. A general confidence score cannot substitute for a missing operating arrangement.

Financing concerns cash timing, obligations and the basis on which capital can be supplied. An NPV compares a defined benefit stream with cost under a valuation convention. A liquidity schedule asks whether cash is available when payments fall due. A debt assessment asks whether contractual repayment can be supported under the relevant terms and stress conditions. Those questions are related but distinct. The annual screen's positive NPV does not answer either of the latter questions. The committee should not infer funding availability from a metric that contains no financing structure.

Evidence and scope

Debt appraisal relates available project cash to repayment obligations.

Evidence: *Key Issues in Developing Project Financed Transactions*

The source discussion of coverage ratios is retained as narrow financing context. It does not provide a lender commitment or a universal acceptance threshold for the fictional package. The Transition lab has no debt drawdown, interest, amortisation, reserve, repayment schedule or cash-available-for-debt-service field.

No coverage ratio is calculated in this paper. A fuller finance case would need the actual structure and a coherent operating cash model. The relevant institution or capital provider would assess that case under its own authority and requirements.

The positive foundation NPV is therefore a conditional screening finding. It arises from supplied constant energy-related savings discounted over the supplied horizon, less upfront listed capital. The output can justify developing the opportunity's evidence and implementation route. It does not show that the sponsor has cash for the capital, that a supplier will accept deferred payment or that a lender will fund the package. The committee should identify which funding route is being considered and what evidence that route requires, rather than allow the app's result to imply one.

A funding route can change the obligations even when the physical package remains fixed. A purchase, service arrangement or financed contract can allocate performance, maintenance, payment and ownership differently. Comparing them requires a full record of cash terms and responsibilities. A lower initial payment can come with a continuing commitment that the annual capital field does not represent. A supplier guarantee can shift some risk while leaving production and counterfactual questions with the buyer. The appraisal should compare coherent contractual alternatives, not infer that a different payment label removes the underlying resource cost.

Stress testing should be directed at the cash and service terms relevant to the capital provider. Lower savings, delayed commissioning, adverse prices or required maintenance can affect the ability to meet payments. A positive lifetime value can coexist with a period of inadequate cash. The annual price and factor challenges are not a financing stress model. They reveal screening sensitivities within constant annual assumptions. An applied financing schedule should represent the timing and obligations that determine affordability and repayment, retaining the physical assumptions that support its cash benefits.

The funding decision should also recognise competing organisational commitments. A package with positive value can still be deferred because capital, staff or shutdown capacity is required elsewhere. That is a resource-allocation judgement outside the energy screen. The committee can record why it advances a smaller opportunity, stages the package or waits for an enabling condition. The stronger explanation states the screening result and the binding constraint. Changing assumptions until the favoured funding choice appears to maximise NPV would conceal the decision rather than clarify it.

Illustrative calculation. Assumptions and sensitivity are published with the model.

A favourable screening value leaves financing propositions open

The foundation result is reproduced as energy-related value under the supplied annual convention. The rows retain the distinction between that result and propositions the engine does not calculate.

A favourable screening value leaves financing propositions open		
Decision layer	Retained foundation finding	Unresolved proposition
Screening capital	2,600,000.00 USD listed upfront	No actual procurement payment or available sponsor funding is established.
Screening annual benefit	380,000.00 USD/year net saving	No actual operating cash series or commissioning ramp is supplied.
Screening NPV	263,709.65 USD	Positive conditional value does not establish liquidity or funding.
Debt repayment	Not represented	No debt structure or coverage ratio is computed.
Delivery readiness	Not represented	The installation route and accountable capabilities need evidence.
Recognised claim or support	Not represented	Reporting acceptance or incentive entitlement is a separate condition.

Canonical foundation pointers plus explicit scope gaps. All numerical quantities remain illustrative.

Completed Aster Works readiness and funding hold

The fictional committee can advance a promising screen without describing it as financed. The completed disposition assigns development tasks according to the unresolved layer.

Completed Aster Works readiness and funding hold		
Gate question	Completed disposition	Owner and next evidence
Physical concept internally coherent?	Annual electricity arithmetic is reproducible; real engineering remains unverified	Engineering to validate service, affected loads and interfaces.
Commercial basis secured?	Supplied prices and costs are assumptions	Commercial lead to obtain relevant enforceable terms.
Implementation route available?	No commissioning plan or site capability record supplied	Operations to develop transition and acceptance arrangements.
Funding route established?	No actual capital source or payment structure supplied	Finance to select and model the relevant route.
Permitted next commitment?	Advance targeted engineering, commercial and funding development	Chair to preserve conditions before implementation release.
Accountable evidence	Leila Chen owns EW-FUNDING; no actual payment schedule or funding source is supplied	Prepare the funding-route requirements before any finance representation.
Authorised commitment	Named engineering, meter and commercial development only; implementation remains withheld	Idris Ko records satisfied scenario gates separately from applied readiness gaps.
Stop authority	Leila Chen stops a liquidity or repayment conclusion inferred from the screening NPV	Return actual obligations at the funding-route selection event.

Original completed committee record. It contains no institutional approval or commitment by a capital provider.

Advance the proposition that has evidence

The committee identifies the commitment requested and tests the relevant layers separately. A coherent screen can authorise investigation while technical design remains conditional. A viable technical alternative can proceed to procurement development while commercial terms remain provisional. A delivery-ready package can await funding without losing its physical finding. Finance assesses cash timing and obligations under the selected structure. The final release record states which conditions are satisfied, which remain open and which authority accepts the residual exposure. No single energy metric is used as a certificate for all layers.

Test a proposed financing condition by identifying the obstacle it removes. A confirmed connection term can resolve access to supply while leaving load evidence uncertain. A performance acceptance method can make a guarantee testable while leaving an unaffordable payment schedule unchanged. A capital quote can define price while omitting the enabling interface. Connect each condition to the specific physical, commercial or cash proposition it supports and ask whether the remaining obstacle still defeats the commitment. This produces a

sequence of necessary tests rather than an instruction to make the package bankable. Readiness develops when the decisive links are established, not when another reassuring attachment is added.

A trial preserves flexibility only if its commitments can actually be stopped. Examine temporary connections, supplier exclusivity, bespoke interfaces and the service changes needed to conduct the activity. A nominally small trial may constrain later alternatives through those obligations even when its direct expenditure is modest. Conversely, engineering work that resolves an uncertain connection or quality condition can improve the later choice without selecting the final equipment. Compare the learning proposition with the commitments required to obtain the answer. Staging is useful when it resolves a consequential uncertainty at acceptable service and cash exposure; repeated small approvals do not preserve an option if they cumulatively eliminate the alternatives.

Investability should be tested at the connection between accepted evidence and an executable obligation. Reproducing the annual screen confirms its conditional computation. A tested operating arrangement can support service under stated duty. Agreed commercial terms define who supplies, pays and bears exclusions. A credible funding route addresses when those obligations can be met. If one link remains absent, locate it explicitly instead of transferring confidence from a stronger neighbouring link. The analytical dossier can direct that missing work, but cannot create field performance, recipient agreement or financing availability. This connection test makes the remaining limit useful to the proposed commitment rather than a general disclaimer about the publication.

Every useful investment need not be a standalone finance project

An organisation can fund a measure from its balance sheet, incorporate it into normal maintenance or procure an energy service without a separate project-finance structure. Requiring a debt-style dossier for every intervention would be inappropriate. The gate architecture adapts to the chosen commitment: it still needs a credible physical state, commercial terms and affordable obligations, but the financing questions depend on the route. Coverage ratios are relevant only where the structure makes them relevant. A proposal should not be rejected for lacking an unnecessary financing form, nor described as funded because that form has been omitted.

No finance-readiness or institutional acceptance is established

No repayment or liquidity schedule is computed. A positive NPV cannot close EW-FUNDING, and the public financing context supplies no capital-provider decision. The funding route determines the required evidence; Leila Chen withholds readiness until its actual obligations are represented.

Decision implications

- Technical, commercial, delivery and funding layers can have different dispositions.
- Positive NPV does not establish liquidity, repayment or available capital.
- Conditions should identify a missing proposition and the evidence that closes it.

GOVERNANCE AND APPLICATION

17

Claims of avoided emissions need disciplined language

A transition claims acceptance protocol

Make the exact statement follow its evidence chain

A transition investment can generate a defensible internal comparison while its proposed external statement remains unsupported. The statement may broaden the boundary, imply verified performance or assign a benefit to a party without the necessary evidence. The reviewer should inspect the exact wording and intended audience rather than approve a general impression that the project is beneficial. A claim is a proposition someone may rely upon. Its scope should follow the method, evidence and authority that establish it, including any material conditions still unresolved.

Attribution concerns which change the intervention causes and which role a participant can legitimately describe. An equipment supplier, operator, energy provider and funder can all contribute to a project without each owning an independent copy of the same reduction. They can explain their roles, but a total constructed by summing overlapping claims can exaggerate the physical consequence. The record should distinguish contribution, accounting attribution, contractual entitlement and recognised credit. Those relationships need not be identical. The annual screen contains none of the evidence needed to resolve them automatically.

A physical reduction also needs a consistent perimeter. If a facility closes an energy-intensive activity and purchases the output elsewhere, its local meter may show a reduction while the wider service chain changes differently. If the project uses a supplied renewable quantity, an annual factor comparison may not establish exclusive attributes or a consequential power-system result. The analyst should identify material shifted activities and the intended claim boundary. A narrow facility statement can remain useful, but it should not be silently enlarged into a complete product or system claim.

Leakage is a question about effects outside a chosen assessment perimeter that can offset or alter the intended consequence. The analyst should not assume every possible secondary effect is material, nor assume none exists because the main balance looks attractive. A proportionate review identifies plausible mechanisms, the evidence available and the decision relevance of the gap. The response might be to expand the assessment, retain a conditional statement or narrow the claim. The purpose is to make the omitted relation assessable rather than attach an untestable general caveat to every project.

Double counting can arise within the package as well as across parties. Standalone measure reductions can overlap, contractual attributes can be reused in incompatible statements, and a cash term can be counted both inside an energy price and as a separate benefit. These are different problems. The claim review should identify the object being counted and the record that prevents duplication. A general assertion that double counting has been avoided is insufficient if the reduction, attribute and payment have no traceable boundaries. The package balance and claims ledger should preserve the relevant distinction.

Evidence and scope

Comparative impacts are reported separately from corporate inventory accounting.

Evidence: Estimating and Reporting the Comparative Emissions Impacts of Products

The acceptance record proposed here begins with the exact statement. It identifies whether the statement describes a supplied screen, a measured operating result, a recognised inventory treatment or another method. It then names the physical boundary, reference state, factor basis, period and evidence owner. The reviewer checks whether the words imply more than those records establish. A draft saying that an illustrative screen indicates a reduction under supplied factors has a different evidential status from a statement that an installed project has delivered verified emissions savings.

The next field records who may rely on the statement. An internal committee can use a provisional comparison to approve investigation while preserving its assumptions. A buyer relying on a guarantee needs the applicable measurement and contractual terms. A public audience needs wording that does not invite a broader interpretation than the evidence supports. A programme needs its own acceptance conditions. The record should identify that use explicitly. Passing an internal analytical review does not automatically authorise a different external reliance, even when the same numerical figure is reused.

The evidence chain should distinguish installation, operation, attribution and recognition. Installation evidence can show what equipment exists. Operating evidence can show energy and service under stated conditions. Attribution requires a comparison and adjustment method. Recognition depends on the

applicable reporting, contractual or programme authority. A dossier can contain strong evidence at an early link while lacking a later one. The statement should stop where support stops. This allows the organisation to communicate genuine progress without claiming that every later proposition has already been accepted.

A claim review should also retain exclusions in language that the audience can understand. A technical appendix can explain factor bases, but a headline that implies a complete system reduction may remain misleading despite the appendix. Material limits should travel with the statement at the point of reliance. The wording can be concise: an annual electricity comparison under supplied assumptions is a clear defined result. The review should avoid vague qualifiers that leave the main proposition unchanged. Precision means describing the actual quantity and method rather than placing a broad claim beside a general disclaimer.

The record should preserve disagreements and authority. Engineering may support a demand reduction while a reporting specialist withholds a contractual emissions treatment. Commercial staff may regard a support payment as plausible while the programme has not accepted eligibility. The committee should identify which statement each view concerns and who can decide its applicability. A vote among unrelated expertise does not necessarily resolve the technical or contractual proposition. The disposition can approve a narrower statement, request evidence or wait for the relevant authority while the investment progresses on a separate rationale.

The claim chain has distinct objects of acceptance

The original chain identifies what each evidence layer can establish and what remains outside it. A reader should locate the proposed statement at the relevant layer.

The claim chain has distinct objects of acceptance		
Evidence layer	Proposition supported	Proposition still open
Reproduced screen	Supplied inputs produce the retained conditional output	The inputs describe actual operation.
Installation and commissioning	Defined equipment and tests meet acceptance scope	Continuing annual savings and causal attribution.
Operating records	Energy and useful service within the measured perimeter	The change is attributable to the intervention.
Comparison and adjustment method	A defined saving or impact estimate under its conditions	Every external reporting or credit treatment.
Applicable recognition	The relevant authority accepts the stated treatment or obligation	Unrelated audiences, methods or ownership claims.

Original claims-governance synthesis. No installation, realised saving or programme acceptance is asserted for the fictional studies.

Completed Aster Works exact-statement disposition

The fictional foundation study is released only as an educational internal screen. This completed record states the accepted wording and the statements that remain unavailable.

Completed Aster Works exact-statement disposition		
Release field	Completed entry	Reason or condition
Accepted proposition	The supplied annual electricity package has a reproducible factor-based comparison	Canonical inputs and outputs are retained as illustrative.
Audience and use	Reader learning and internal scoping of further evidence	No actual project recommendation or verified performance is implied.
Physical perimeter	Annual electrical demand and admitted supply only	Fuel, lifecycle, hourly dispatch and other facility activities are absent.
Ownership or credit claim	Withheld	No instrument, programme eligibility or entitlement record is supplied.
Realised-savings claim	Withheld	No actual meter, service or adjustment dataset is supplied.
Reopening trigger	An applied dataset, wider claim or changed method is proposed	Review scope, evidence and authority before changing the statement.
Accountable evidence	Safia Bello owns EW-CLAIM; internal illustrative wording is accepted and external performance wording withheld	Retain the wording and basis before briefing-signature gate.
Authorised use	Reader learning and fictional internal scoping only; no actual organisation, credit owner or realised saving is represented	Idris Ko keeps investment investigation separate from claim release.
Stop authority	Safia Bello stops broader wording at claim-signature gate without applicable evidence and authority	Reopen on a proposed applied dataset, audience or reporting method.

Original completed claim record. It makes a concrete disposition without asserting external publication or acceptance.

Approve wording at the level the evidence supports

The sponsor submits the exact statement and intended reliance. The reviewer traces its quantity, boundary, reference, method and ownership implications to retained evidence. Engineering, accounting and commercial owners resolve the propositions within their competence. The authorised decision maker approves, narrows, conditions or withholds the wording. The investment disposition is recorded separately where it can proceed without the claim. A later change in evidence, method or audience triggers review of the affected statement rather than automatic reuse of a previously approved headline.

The record can support collaborative communication. Partners can describe their specific contributions and refer to a common assessment without implying independent additive reductions. A supplier can report delivering the relevant equipment, an operator can report the measured operating comparison, and a funder can report supporting the investment. Each statement should retain its object and basis. The organisation should avoid a total that aggregates roles as though they were separate physical effects. Contribution can be meaningful without inventing exclusive ownership of an emissions quantity.

The record also protects a sound investment when a claim changes. A reporting revision may require different wording or evidence while the equipment continues to save energy. A contractual attribute may expire while a production benefit remains. A measurement review may revise the estimated reduction without invalidating the installed service. These changes should be traced to the affected proposition and, where material, to the investment rationale. Treating every claim challenge as an attack on the entire project discourages honest revision. A layered record makes correction proportionate.

Review a proposed public sentence by reconstructing the quantity its ordinary reader would understand. A statement that a facility used less electricity is different from a statement that the intervention caused avoided system emissions. The latter requires a counterfactual and perimeter beyond a simple purchasing comparison. A statement that partners contributed to one measured change need not imply separate additive changes. Compare the proposed wording with the retained method, factor basis and service record, then narrow the sentence where the reconstruction requires unsupported assumptions. Preserve the supported result and identify any missing evidence needed for the broader statement. Exact numerical reproduction cannot resolve that communication gap.

Communication must remain understandable

A public or executive audience cannot be expected to read a full technical ledger before understanding progress. A concise statement can retain the essential quantity, boundary, evidence status and material condition, with supporting records available for challenge. The objection to excessive detail is valid when detail is redundant for the reliance. It is not valid when simplification turns a conditional annual screen into a verified system-wide achievement or creates an ownership claim without evidence. The review should improve the headline itself, rather than rely on a distant appendix to repair an overbroad proposition.

The claim record is not certification or legal interpretation

A reproduced illustrative figure has no external recognition or ownership. Widened wording, a changed audience or an applied dataset reopens EW-CLAIM. Safia Bello may release only the supported statement; a valid service investment cannot repair an inaccurate physical or reporting proposition.

Decision implications

- Contribution, attribution, entitlement and recognition are distinct relationships.
- Approve the exact wording and intended reliance.
- A claim revision can be separate from the disposition of the physical investment.

GOVERNANCE AND APPLICATION

18 Operating teams own persistence

A persistence and responsibility plan

Maintain the mechanism and review the premise

A transition measure is an operating arrangement whose benefit can change after commissioning. Equipment can deteriorate, settings can drift, production can move and contractual conditions can expire. A capital item remaining in place does not establish that its expected saving remains available. The appraisal should identify the mechanism that sustains the benefit, the owner who maintains it and the evidence that would show a material change. Persistence is a condition of the investment case, not an automatic consequence of initial acceptance.

Physical performance and financial performance can diverge over time. A measure can continue to reduce electricity while a tariff change reduces its cash saving. A supply arrangement can continue to serve demand while a factor revision changes attributed abatement. A control system can remain technically capable while operating practice no longer uses it as intended. These findings require different

responses. The review should identify which proposition moved before classifying the investment as successful or unsuccessful. An aggregate value comparison can conceal the mechanism the organisation needs to address.

The operating plan should connect maintenance to the saving mechanism. A leakage repair needs an arrangement that detects recurrence. A control measure needs settings, permissions and inspection that preserve its intended duty. A process change needs operating capability that maintains useful output. Supporting equipment may require attention even when the main device remains sound. The relevant expense and responsibility should be included in the case. A saving whose sustaining action has no owner is an incomplete operating proposition, even if the supplier's initial performance test is persuasive.

A review indicator should be interpretable. Total facility electricity can reflect production and unrelated loads as well as the measure. A targeted load indicator can miss interactions elsewhere. A maintenance completion count can show that an activity occurred without proving that performance was restored. The plan should identify indicators for mechanism, service, wider balance and cash where each is material. These indicators can be reviewed together, but they should not be treated as interchangeable evidence. The organisation needs enough information to distinguish deterioration from a legitimate change in duty.

The baseline adjustment rule also remains important after installation. A structural change can make the original comparison inappropriate, while a routine operating variation can be handled under the agreed method. A correction should retain the original record and the reason for revision. Adjusting the reference whenever savings disappoint would make performance difficult to challenge. Refusing every adjustment could make a valid measure appear to fail under changed conditions. The governing rule should identify which change justifies an adjustment and who is authorised to accept it.

Evidence and scope

Verification effort is proportionate to performance risk and expected savings.

Evidence: **Measurement and Verification for Federal Energy Savings Performance Contracts**

The canonical screen discounts a constant annual energy-related saving over the supplied horizon, holding demand, factors, prices and continuing costs fixed. Its bounded educational comparison therefore excludes degradation, changing production, a future grid path, contract renewal and maintenance cycles. The persistence record must identify the evidence that supports continuity over an applied horizon. A precise NPV remains conditional on that unverified operating premise.

A dynamic benefit path requires a suitable model. If commissioning delays savings, equipment performance changes materially or a supply agreement lasts for a different period, a constant annual amount may be inadequate. The analyst

should not reinterpret the screen's NPV as though those effects were already included. Nor should an arbitrary reduction in the annual saving replace a mechanism-based path when timing is decisive. The appropriate response is to develop the relevant operating and cash schedule, preserving the scope and evidence for each term. The screen can remain a reference case alongside that development.

The review should distinguish preventable drift from an accepted strategic change. Operators might change controls unintentionally, or management might authorise a new production regime that alters the original demand. A maintenance failure and a deliberate expansion are different findings. The former can call for corrective action under the operating obligation; the latter can call for a new appraisal and target discussion. The record should identify who can change the state and what review is required. This avoids a situation in which the original case remains the official expectation while the organisation has chosen a different operation.

An emissions factor change can require another kind of revision. The same physical saving may receive a different attributed emissions result under updated or differently applicable factors. The organisation should retain the reporting basis and distinguish a method or attribution update from physical performance. If the investment depends on recognised quantities or incentive income, the change may also affect the financial case. The operator should not be blamed for an attribution change that the equipment cannot control, but the committee should understand its consequence for a claim-dependent rationale.

Continuing cost should be checked with the same discipline. A service contract can change, a consumable requirement can emerge or a supporting asset can need renewal. If the original operating expenditure did not include a material sustaining term, the net benefit should be revised. The review should identify whether this reflects an omitted assumption, a new condition or a performance problem. Those interpretations affect learning and accountability. A flat annual cost in a screen is not a statement that all future maintenance obligations have been priced or secured.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The constant-benefit premise of the foundation screen

These quantities identify the supplied annual convention. They are retained for replication, not presented as guaranteed performance across the horizon.

The constant-benefit premise of the foundation screen		
Persistence premise	Frozen quantity	Evidence still needed
Annual net saving	380,000.00 USD/year	Operating and commercial conditions that sustain the saving.
Annual measure expenditure	40,000.00 USD/year	Completeness of maintenance and supporting obligations.
Annual attributed abatement	3,810.00 tCO2e/year	Appropriate continuing factor and reporting basis.
Appraisal horizon	12.00 years	Useful-service and benefit-persistence evidence.
Package NPV	263,709.65 USD	A fuller path where timing or degradation is material.

Canonical foundation pointers. Every value is illustrative, and no time-varying performance or cash path is computed.

Completed Aster Works persistence-plan disposition

The fictional package has no actual installation or continuing data. This completed plan assigns what would be monitored and how a finding would be interpreted before an applied saving is claimed.

Completed Aster Works persistence-plan disposition		
Review object	Provisional record	Response to material change
Affected load and useful service	Retain compatible energy and service information	Investigate mechanism drift separately from production change.
Controls and maintenance	Assign accountable settings and sustaining tasks	Correct an unauthorised operating departure and record its effect.
Structural facility change	Retain authorised change history	Review baseline adjustment and the investment case.
Factor and reporting basis	Retain source edition and applicability	Revise the affected statement and any dependent incentive case.
Tariff and sustaining cost	Retain applicable terms and cost scope	Recompute cash value under a suitable current model.
Investment disposition	Keep the original conditions and review owner	Reopen the commitment when a decisive premise no longer holds.
Accountable evidence	Mara Sene owns EW-OPERATE; no actual installation or continuing measurements exist	Assign settings, maintenance and change-control tasks before commissioning-plan approval.
Authorised commitment	Prepare a persistence and response plan only; the constant annual benefit is not guaranteed	Nora Vale specifies mechanism and service indicators in the same plan.
Stop authority	Mara Sene stops an unauthorised duty change; Safia Bello withholds continuing performance claims without evidence	Return changes at the operating-review event and before a renewed claim.

Original completed operating-governance record. Roles and actions are conceptual, not an assertion of actual site performance.

Diagnose the changed proposition before assigning the response

The review compares the relevant physical, service, operating, attribution and cash records. The owner identifies whether a change concerns equipment performance, operating choice, external commercial terms, accounting basis or evidence quality. Corrective action addresses a controllable mechanism; an authorised structural change prompts an appropriate adjustment or new appraisal; a reporting revision changes the statement it affects. The committee reviews the investment when a decisive condition fails. The process preserves the original record so learning can distinguish a faulty premise from a changed environment or an implementation departure.

Persistence monitoring should isolate the relation that changed. If useful service is stable but the affected load rises, examine settings, maintenance and performance. If service expands, compare duty before attributing the rise to failure. If physical saving persists while cash falls, inspect tariffs and continuing obligations. If the

dataset becomes incomplete, suspend the affected inference while repairing collection rather than immediately classifying the equipment as unsuccessful. These branches request different actions and can be specified without inventing numerical thresholds. An applied plan still needs evidence-based triggers and authority, but its diagnostic route should distinguish an operating defect, a commercial change and loss of observability.

The review can reveal a stronger operating case than the original one, but favourable findings need the same discipline. A lower energy total may reflect reduced production, a revised factor may improve attributed abatement without better equipment, or a new price may increase cash benefit without a physical change. The organisation should retain the mechanism of improvement rather than claim every positive movement as project performance. This helps it understand which benefits are robust and which depend on changing conditions. It also makes a future adverse revision less likely to be treated as an inexplicable reversal.

Transfer a persistence lesson by testing its conditions against the receiving process. A setting correction may transfer where the same control mechanism, duty and service requirement exist. A favourable tariff lesson may fail when the receiving bill includes another payable component. A capital exclusion discovered during commissioning may matter only where the same interface is absent. State the mechanism and compare these conditions before reusing an estimate or operating rule. The retained findings can improve affected-load mapping, scope definition and measurement design without supplying a universal saving factor. A single project outcome becomes useful evidence for another choice only through this explicit comparison.

Operational complexity can overwhelm a small measure

A modest, stable measure may not justify a dedicated monitoring system or frequent committee review. Existing maintenance and operating records can be sufficient when they address the relevant mechanism and obligation. The objection is valid if additional review would not change action. It is weaker when a large benefit, variable duty or support-dependent claim requires continuing evidence. The plan should fit the measure and integrate with normal operations. Proportionate persistence governance can be simple, but it still needs an owner, interpretable evidence and a response to a material premise changing.

No continuing performance path is estimated

No dynamic degradation, contract-renewal or production path is estimated. A changed sustaining mechanism can invalidate constant benefit. Mara Sene must distinguish operating drift, authorised structural change and external attribution or price revision so corrective action addresses the right premise.

Decision implications

- An installed asset and a persistent benefit are distinct propositions.
- Physical, attributed and financial performance can move differently.
- A finding needs an owner and a response linked to its mechanism.

GOVERNANCE AND APPLICATION

19

The committee needs balanced evidence

An investment memo for transition projects

Connect the analysis to an accountable next commitment

A committee brief should make the requested commitment and its decisive conditions visible. It should not begin with a collection of favourable metrics and leave the reader to infer what action follows. The chair needs to understand the service, physical mechanism, commercial consequence, evidence status and unresolved obligations. A concise brief can do this by linking each proposition to its supporting record and identifying the question that would change the disposition. The numerical model is one part of that architecture. Its role is to support a defined decision rather than supply an automatic recommendation.

The brief should lead with the proposed action. A request for engineering development, a reversible trial and implementation release have different evidence needs. The sponsor should state the scope of the requested action, its resource commitment and the alternatives that remain available. If the proposal is a concept, the brief should identify what the concept result has made worth investigating. If it is an implementation request, the brief should establish the route to the valued operating state and the relevant obligations. The reader should not need to discover the decision stage from a footnote.

The physical account should remain short but complete for its declared scope. It identifies useful service, baseline, affected demand and supply, the package mechanism and material exclusions. It should state whether the result concerns annual electricity, a broader carrier conversion or another boundary. The brief can refer to supporting evidence for equipment and duty, but it should preserve any gap that could alter the decision. A simplified balance is useful when the committee knows what it contains. A broad narrative that outruns the balance weakens the recommendation even if the numbers themselves are correct.

The economic account should distinguish capital, net annual saving, value and cost per positive reduction. Each answers a different question. The brief should also identify the price and time conventions and the commercial condition most likely to change the cash result. A support-dependent case should retain the energy-only result and the status of the additional benefit. A positive NPV should not be presented as available funding. The reader needs enough information to assess why the result is favourable, which term is uncertain and what action would resolve that uncertainty.

Attach evidence status to each proposition. An exactly reproduced illustration can retain hypothetical site parameters; a real quotation can leave duty unsupported; a physical test can leave contractual emissions treatment unresolved. Identify the remaining obligation beside the result and name the evidence that closes it. A general validated label would collapse these different states and obscure what the committee can commit to next.

Aster Works is a fictional operator whose committee must preserve its current accepted batch-quality service while investigating an annual electricity package. Idris Ko chairs the decision; Mara Sene owns operation; Nora Vale owns measurement; Owen Diallo owns commercial terms; Leila Chen owns finance; and Safia Bello owns reporting. Their authority is deliberately bounded to existing-staff preparation of named evidence records. No equipment order, physical site work, binding supply agreement, finance representation or external reduction claim is authorised. The deadline is the diligence review before the maintenance-plan freeze. These are authored teaching conditions, not actual corporate delegations.

For the fictional Aster Works mandate, progression under current terms requires nonnegative energy-only screening NPV. Advancing the same climate proposition requires foundation-reference annual abatement. A supply commitment with annual excess requires settled purchase, use and timing terms. These are authored teaching rules, with no threshold borrowed from a reporting standard or lender. Passing them permits bounded development only while applied service, meter and commercial evidence remains absent.

The foundation package passes the conditional cash and reference-abatement gates and has no annual supplied excess. Idris authorises Nora's meter-boundary specification, Owen's nonbinding tariff clarification record and Mara's interface-scope review. Implementation stays withheld. The adverse-price case has the same physical result, but the negative financial screen rejects progression under those commercial terms. Leila records rejection of the terms rather than rejection of the technology. The team may develop a genuinely different arrangement and recompute it; it may not change the physical percentage merely to conceal the price problem.

The low-factor case reaches a different held branch. Cash remains identical to the foundation case, while the attributed reduction no longer meets the chosen reference mandate. Safia withholds the reference climate proposition and Idris

requests an authorised decision on the mandate and factor basis. The more negative cost per tonne cannot repair the smaller reduction. A commercial-only investment could still be investigated if the committee expressly changes its objective. That is a new disposition with a retained reason, not a silent substitution of the favourable ratio for the failed climate condition.

The curtailment alternative passes the supplied cash and reference-abatement conditions but has annual supplied energy beyond demand. The screen pays only for energy used and gives the excess no revenue. Owen has no evidence of the actual purchase obligation, delivery timing or permitted use of surplus. The supply arrangement is therefore held despite positive screening value. He must return EW-SURPLUS before supply-term selection. Mara can stop any proposed operating change that threatens accepted service, Safia can stop an unsupported claim, and Idris stops any commitment outside the authorised development scope. The case demonstrates a second constraint changing the action without changing a favourable metric.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Computed cases produce different accountable branches

The provisional reference climate floor is 3,810.00 tCO₂e/year, selected from the foundation output solely as an authored teaching mandate. A pass concerns the supplied scenario rules; every implementation remains withheld pending applied evidence.

Computed cases produce different accountable branches				
Case	NPV, USD	Abatement, annual tCO ₂ e	Excess, MWh/year	Disposition
Foundation	263,709.65	3,810.00	0.00	Approve named development tasks only.
Adverse prices	-4,220,256.77	3,810.00	0.00	Reject current commercial terms.
Low factor	263,709.65	105.00	0.00	Hold the reference climate mandate.
Curtailment	212,988.09	5,800.00	6,000.00	Hold unsecured supply arrangement.

Original fictional commitment rules applied to canonical outputs. These gates are a paper demonstration, not a hidden feature of the Studio engine.

Completed Aster Works authority and evidence record

This is a completed fictional decision record with known absent applied evidence and a concrete authorised development action. It contains no unanswered template question or claimed actual measurement.

Completed Aster Works authority and evidence record		
Evidence and status	Accountable task	Deadline and stop authority
EW-CALC: canonical input and output reproduced; illustrative	Leila Chen retains the cash screen and rejects adverse terms under the adopted rule	Before diligence review; Idris Ko stops any funding representation.
EW-METER: actual raw data absent; annual demand is a supplied assumption	Nora Vale prepares the existing-meter boundary and logging specification	Before maintenance-plan freeze; Mara Sene stops production-disrupting work.
EW-SERVICE: actual quality and duty record absent	Mara Sene defines the unchanged accepted batch-quality service and interfaces	Before any installation request; Mara withholds operating release.
EW-PRICE: supplied flat prices, no enforceable tariff evidence	Owen Diallo prepares a nonbinding term and bill-component clarification record	Before diligence review; Leila withholds an applied cash sign-off.
EW-FACTOR: illustrative common basis, no actual reporting eligibility	Safia Bello records factor provenance and the held low-factor mandate	Before claim-signature gate; Safia withholds external wording.
EW-SURPLUS: no purchase, timing or use term established	Owen Diallo records the unused-supply obligation for the curtailment alternative	Before supply-term selection; Idris withholds the binding arrangement.

Original fictional record. Evidence identifiers refer to retained assumptions or explicit gaps; names and authority are authored for this case.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Completed Aster Works committee-summary disposition

Requested disposition: advance targeted engineering, measurement and commercial development. Implementation, recognised emissions reporting and financing remain conditional. The retained calculation is illustrative and serves reader learning and scoping.

Completed Aster Works committee-summary disposition		
Brief element	Completed statement	Decision significance
Physical scope	Annual electricity only; unchanged useful service assumed	Engineering must validate service and affected loads.
Package state	8,000.00 MWh/year final demand; 3,500.00 MWh/year grid energy	The supplied efficiency and annual supply quantities form a reproducible screen.
Attributed annual reduction	3,810.00 tCO ₂ e/year	Factor basis, ownership and recognised treatment are not verified.
Listed upfront capital	2,600,000.00 USD	Connection, commissioning and actual funding terms remain outside the case.
Net annual saving	380,000.00 USD/year	Flat prices and constant continuing expenditure are supplied assumptions.
Package NPV	263,709.65 USD	Conditional value supports development, without proving liquidity or financing.
Decisive next evidence	Affected-load and service record; relevant tariff terms; complete interface scope	Target investigation at the propositions that could change implementation.
Accountable evidence	Idris Ko adopts the recorded cash, reference-abatement and surplus gates; EW-CALC is reproducible but illustrative	Return named evidence tasks at the diligence review before maintenance-plan freeze.
Authorised commitment	Existing-staff meter, tariff and interface records only; implementation and public claims withheld	Leila Chen records adverse-term rejection, Safia Bello records low-factor hold, Owen Diallo records surplus hold.
Stop authority	Idris Ko stops scope expansion; Mara Sene stops service exposure; Safia Bello stops unsupported wording	A changed mandate or applied evidence requires a new explicit disposition.

Original completed briefing record using canonical foundation pointers. It is not an actual committee decision or approval.

The chair should then test the recommendation against its strongest relevant alternative. A simpler efficiency measure, a different supply arrangement or a staged package can offer a different combination of service, capital and evidence needs. The brief should state why the current action is preferable at the present stage. It need not pretend that every final alternative has been designed when the decision concerns development. It should preserve the alternatives that investigation can still change and identify any commitment that would foreclose them. This gives staging a clear decision purpose.

Sensitivity should be interpreted through the mechanism it changes. A lower factor can reduce attributed abatement without affecting the supplied cash result. Adverse relative prices can reverse the financial outcome while preserving physical abatement. A sequence change can alter marginal attribution or the final demand, depending on the package. The brief should select the challenges that matter to the action and explain their consequence. A long scenario list with no disposition adds less value than a concise challenge that identifies a condition the sponsor must resolve.

The committee should ask which missing proposition has the greatest decision value. If the physical percentage applies to an uncertain load base, measurement and engineering scope can be more valuable than further price detail. If a contract preserves fixed payment, commercial review can be more valuable than a refined abatement factor. If connection timing blocks execution, scheduling and interface development can be decisive. The brief should identify that priority and assign an owner. The purpose of analysis is to reduce consequential uncertainty, not to complete every possible field in an undirected checklist.

The Aster Works branches show how a disposition can specify the next differentiating test. The low-factor alternative does not need another copy of the unchanged cash calculation to resolve its climate-mandate hold; it needs a supported attribution basis or an authorised reconsideration of that mandate. The surplus alternative needs the payable treatment and operating route for unused supply, since a favourable annual screen leaves that issue open. The foundation package's permission concerns bounded diligence, with service and field evidence still required. These different tests direct the fictional team toward the obstacle in each branch. An instruction to improve the case would conceal those distinctions.

Dissent should remain connected to a proposition. An operating representative may question the shutdown route, a commercial representative may question the price term, and a reporting reviewer may withhold a public statement. These concerns need not imply disagreement about the arithmetic. The chair should record whether the concern changes the current action or a later gate. A majority preference cannot establish a technical interface or contractual entitlement. Preserving the dissent helps the organisation learn whether the condition was resolved and prevents a later problem from appearing unforeseeable.

Challenge the proposition that could change the action

The original map directs committee questions to evidence and consequence. It avoids treating every concern as a reason to rerun the same numerical screen.

Challenge the proposition that could change the action		
Committee challenge	Evidence that answers it	Potential disposition change
Does the percentage affect the represented load?	Equipment, duty and service reconciliation	Redesign the physical case or commission targeted measurement.
Will the saving release the claimed cash?	Relevant tariff, contract and sustaining-cost terms	Revise the commercial case or negotiate a decisive term.
Does the factor support the intended statement?	Consistent basis and applicable reporting evidence	Narrow the statement or use the appropriate assessment method.
Can the organisation reach the final state?	Interfaces, commissioning and operating ownership	Stage, defer or redesign implementation.
Can the commitment be funded and sustained?	Actual payment and cash schedule under the selected route	Resolve affordability before implementation release.

Original decision-directed challenge framework. The questions refer to the defined appraisal, not universal approval thresholds.

Close the meeting with a proposition-specific disposition

The chair reads the requested action, the supported findings and the decisive unresolved conditions. The committee records the accepted scope and the person authorised to own each next task. The brief identifies the evidence that would permit the next commitment or require a revised recommendation. A separate statement records any public claim or funding conclusion that remains withheld. The minutes preserve material dissent and the comparison alternatives. This closure makes the analytical result reviewable and the next action accountable without implying that all later gates have already been passed.

Reconstruct a changed committee case by comparing inputs in mechanism groups. A demand or affected-load revision changes the physical state; a factor revision changes attribution; a tariff revision changes cash; a package-scope revision can change several groups together. Start with the group that changed and inspect its dependent statements rather than describing every amendment as a new project value. The saved input supports this comparison and exact recomputation, while minutes retain the action and obligations adopted from it. A scenario vault can hold the numerical case under the chosen privacy arrangement; it cannot establish whether the committee authorised the changed commitment.

After the meeting, the sponsor should report progress against the conditions rather than only the original headline value. A supplier engagement can confirm a tariff term while leaving load evidence unresolved. A measurement campaign can revise the efficiency estimate while improving confidence. A connection study can reveal a capital interface that changes the package. These are useful findings even

when they weaken the screen. The next brief should explain their mechanism and disposition consequence. Preserving the original case supports learning; preserving its favourable number at all costs would defeat the purpose of development.

Check the brief's compression by asking a reader to explain the difference between the low-factor and surplus holds without consulting their common headline NPV. The first concerns the reference attribution and provisional climate mandate; the second concerns unused energy and its operating or payable treatment. If the brief hides that distinction, add the decisive relation to the front record and move routine explanation to its supporting packet. Keep material assumptions where the decision relies on them. The fictional committee then receives a concrete next test rather than a calculator verdict, while the complete tables remain available to inspect the physical and cash basis.

Committees can overburden routine decisions

A routine intervention under an established operating and procurement framework may not need a bespoke large dossier or an elaborate meeting. The brief can be proportionate and use existing records where their applicability is clear. The objection is strongest when the commitment is modest and the mechanism familiar. It is weaker when the proposal changes service, depends on an unresolved tariff or makes a material external claim. A concise proposition-specific brief can simplify governance by directing attention to the actual decision, instead of multiplying generic approvals or omitting the condition that could change it.

The fictional brief supplies no actual approval

The completed Aster Works record is fictional authority applied to illustrative cases. It approves a defined development scope, not installation, financing or a public reduction claim. Its rule thresholds are authored choices. Applied evidence or a changed mandate requires a new disposition.

Decision implications

- Lead with the action and the evidence that could change it.
- Interpret challenges through the physical, cash or claim proposition they affect.
- Retain the numerical case and the authoritative decision record together.

GOVERNANCE AND APPLICATION

20

When physical balances do not settle the decision

A strongest-counterargument assessment

Make the physical-first thesis conditional and falsifiable

The strongest objection to this study is that a physical balance can become an overly narrow investment doctrine. Organisations invest for service, reliability, flexibility, capability and strategic opportunity as well as energy savings or attributed abatement. An annual electricity balance cannot represent all those objectives. If physical-first means rejecting every proposal that lacks a positive annual reduction or an attractive cost per tonne, the doctrine would exclude legitimate investments and misdescribe the decision. The thesis must therefore be stated conditionally: a defined physical transition claim needs a coherent balance, but investment choice needs the relevant wider objectives and constraints.

The zero-abatement study makes the objection concrete. Its supplied factors yield no attributed annual reduction, while its supplied prices produce a favourable financial screen. The unavailable abatement-cost metric does not establish that the supply alternative is worthless. It establishes that this case does not support a positive reduction within its factor-based boundary. A committee pursuing cost savings can investigate it on the financial proposition. A committee pursuing an absolute emissions objective cannot call it a reduction under the retained assumptions. The same case supports different dispositions when the authorised objective differs.

Resilience presents another limitation of annual totals. A facility may value continued service during a supply interruption, recoverability after a fault or the ability to operate under a constrained system. Those benefits depend on equipment, timing, dependencies and operating capability. Additional annual energy labelled unused by the screen does not establish such a benefit, but neither does its annual unused status prove that every wider design is unnecessary. A resilience appraisal would need an appropriate operating and failure model. The annual cap is a useful boundary convention, not a universal judgement about the value of capacity.

Flexibility can matter without lowering annual energy. A process that changes its timing may relieve a binding operating or commercial condition. The benefit depends on what can move, the service cost of movement and the relevant system response. The annual engine cannot represent that value. A physical-first approach should therefore select the physical model that fits the service and

decision, rather than insist that every worthwhile intervention produce a lower annual electricity total. The broader discipline concerns coherent mechanisms and boundaries; the retained annual model is one deliberately limited application.

Enabling capability raises a related challenge. An early interface, control system or operating capability may have little immediate abatement while making a later package feasible. The value depends on the later alternatives, their uncertainty and the commitment path. Assigning the entire future benefit to the enabling measure can overstate its contribution, but assigning no value because the present annual screen has no effect can understate the strategic role. The committee needs an explicit pathway appraisal. The annual cost-per-tonne metric cannot resolve that choice through a missing or small denominator.

Illustrative calculation. Assumptions and sensitivity are published with the model.

A zero-abatement case can retain a financial proposition

The frozen case challenges an investment doctrine that treats a positive abatement denominator as the sole source of value. Its cost saving is conditional, while its climate interpretation remains restricted.

A zero-abatement case can retain a financial proposition		
Case result	Frozen quantity	Decision distinction
Annual attributed abatement	0.00 tCO2e/year	No positive reduction within the supplied common factor basis.
Net annual cash saving	220,000.00 USD/year	A price-based commercial proposition remains.
Package NPV	1,557,937.16 USD	A favourable simplified financial result can coexist with no abatement.
Package abatement cost	not defined	Unavailable does not mean worthless for every authorised objective.

Canonical zero-abatement pointers. The case is illustrative and provides no actual supplier or funding recommendation.

The study also risks privileging the quantities it can calculate. Energy, factors and flat prices are convenient fields. Service quality, production disruption, social consequences and institutional capability can be harder to represent. A committee should not infer that the convenient fields are therefore more important. The appraisal should identify material consequences and choose appropriate evidence for them. Some can be treated as constraints, some as separate outcomes and some as grounds for an authorised tradeoff. Forcing them into an energy ratio can create a numerical appearance of completeness while losing their meaning.

Wider environmental effects can require another perimeter. Equipment production, materials, disposal or upstream energy can matter to a lifecycle question even when the annual facility balance improves. The analyst should determine whether such effects are material to the intended claim and use the appropriate method where needed. The paper does not infer their size from

generic technology descriptions. The annual screen's absence of those terms is a limitation, not evidence that the effects are zero. A facility-level result should remain facility-level until the wider assessment supports a broader statement.

A physical balance can also be internally complete and empirically wrong. The supplied baseline, percentage, added demand or factor may be unsupported. Conservation checks catch certain contradictions, but a perfectly reconciled fictional state can still be impossible for the equipment or unrepresentative of operation. The reviewer needs evidence about parameter meaning and service feasibility. This is why reproducible arithmetic is not enough. The balance makes the claim inspectable; engineering, measurement and applicable accounting evidence determine whether its supplied state can support an applied conclusion.

The word first should describe logical dependence rather than an inflexible work schedule. A sponsor can investigate prices, suppliers, funding and operating options in parallel with engineering. A clear commercial constraint can justify rejecting a concept before a detailed physical model is complete. A promising market term can identify which technical question is worth investigating. The architecture requires the final claims to be coherent and supported, but it need not force every project through a sequential analytical bureaucracy. Proportional development can combine evidence streams while preserving which proposition each establishes.

The annual model itself should be challenged when timing is decisive. Annual renewable matching can obscure availability during production. Constant savings can obscure commissioning or degradation. A flat price can obscure peak or contractual charges. A factor can obscure a consequential question. The response is not to abandon physical reasoning, but to adopt the right resolution or narrow the conclusion. A model earns its role when it answers a defined question; it should be replaced when its boundary or abstraction prevents that answer. No amount of polished exposition can make an unsuitable model adequate.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The annual cap does not assess a resilience design

The case reports supplied annual energy beyond demand. Its convention prevents unsupported negative grid demand or export credit, while leaving other possible service questions outside the model.

The annual cap does not assess a resilience design		
Annual balance field	Frozen quantity	Unassessed question
Renewable quantity supplied	16,000.00 MWh/year	Timing, connection and delivery availability.
Renewable quantity used	10,000.00 MWh/year	Useful service during specific operating states.
Renewable quantity curtailed	6,000.00 MWh/year	Storage, export rights or another use outside the cap.
Final annual emissions	200.00 tCO ₂ e/year	Resilience, failure response and full lifecycle effects.

Canonical curtailment pointers. These are annual screening quantities, not an hourly availability or backup-capacity study.

Choose another method when the objective changes

The original routing table states which question the annual screen can support and which question needs another model or evidence design.

Choose another method when the objective changes		
Decision objective	Appropriate role of the screen	Additional method or evidence
Annual electrical input and flat-price savings	Reproduce a supplied package and identify sensitivities	Affected-load, service and tariff validation.
Complete carrier conversion	Retain the electrical component only	Displaced-carrier and useful-service balance.
Hourly availability or flexibility	Retain annual quantities as context	Temporal operating and supply model.
Resilience and service continuity	Identify relevant energy terms without valuing resilience	Failure, dependency and recovery assessment.
Lifecycle impact	Retain a narrow facility comparison	Appropriate lifecycle boundary and inventory.
Enabling strategic pathway	Describe current package terms without future option value	Dependency, staged commitment and alternative-path appraisal.

Original method-boundary framework. It does not imply that every alternative method has been implemented in this publication.

Apply the conditional thesis and reject the universal one

The committee identifies the investment objective and the statement it must support. A physical transition claim receives a coherent balance at the appropriate boundary and resolution. Other material objectives receive their own evidence and authority. The analyst uses the annual electricity screen only for questions its schema represents. A missing or nonpositive abatement metric is reported accurately without becoming a universal investment veto. A favourable ratio is likewise not a universal approval. The final decision records the objective, tradeoff, constraints and supported propositions that actually justify the commitment.

The countercase changes how a recommendation should be written. A resilience investment should explain its service mechanism and evidence instead of borrowing an energy-saving label. A commercial supply change with no attributed reduction should report its cash proposition honestly. An enabling measure should retain the dependence on later choices rather than claim their benefit as already delivered. An efficiency package should state the service and balance that support its result. These descriptions are clearer because each investment is assessed against its actual purpose.

The narrower thesis makes a specified energy or emissions proposition assessable through a coherent balance. Valuation, wider objectives and executable commitment remain separate questions. The records connect those questions to the balance without answering them by proxy. A committee can authorise an investment for an evidenced wider purpose while withholding its unsupported transition statement, preserving the reason for each disposition.

Challenge the physical-first architecture through a change in purpose while retaining the same annual balance. A supply proposal can retain a cash case when attributed abatement is zero, but its climate proposition must be reconsidered. A resilience objective can require evidence about service during interruption even when annual energy is unchanged. An enabling investment can require a later-choice analysis rather than an isolated abatement ranking. These are changes in the question, not necessarily contradictions of the balance. The method is useful if it routes each to the missing representation and preserves any supported narrow result. It fails if it forces all legitimate objectives into positive annual abatement.

Broader value must not excuse an inaccurate physical claim

The strongest response to the countercase is that resilience, strategy or social value can become vague reasons to avoid scrutiny. A sponsor might invoke wider benefits whenever the defined energy or emissions proposition fails. The conditional architecture permits legitimate wider objectives but requires their mechanisms, evidence and authority to be stated separately. They do not repair an inaccurate balance or grant a reduction the model does not show. The committee can accept a cost for an authorised service purpose while rejecting an unsupported climate headline. Broadening the decision should improve its evidence, not make it immune to challenge.

The countercase identifies omitted questions rather than valuing them

No resilience, lifecycle, flexibility or option value is computed. Those objectives can justify a different method and authority, but cannot alter the electricity result by assertion. The conditional thesis supports assessability of physical claims and rejects a universal cost-per-tonne investment rule.

Decision implications

- A coherent physical claim is distinct from a complete investment objective.
- Nonpositive abatement is not a universal veto, and favourable cost per tonne is not approval.
- Use a different method when the service, boundary or time resolution changes.

PRACTICAL APPENDICES

21 Appendix: physical and financial calculation dictionary

A reproducible canonical electricity balance and valuation guide

Publish the instrument and its replication boundary

The technical appendix defines the retained calculation as a reproducible instrument. It accepts a complete annual electricity input object, validates the schema and measure identities, computes sequential states, and returns physical, economic and diagnostic output. The same canonical module is used by the Studio and the research reproducer. The manuscript does not implement a competing spreadsheet or Python transition model. Retained inputs and complete outputs permit another analyst to reconstruct the exact conditional calculation while keeping parameter validity and field performance as separate questions.

The input contract is more precise than a form label. Every required field has a numerical or structural type, an allowed range and a declared unit. Measure names must be unique within the package. Unknown fields are rejected rather than silently interpreted as additional model features. Missing fields, nonfinite values and values outside the supported numerical precision are errors. A legitimate zero remains a supplied value; a missing energy, price or cost does not become zero. The exported machine-readable schema is retained with the study files, and its identity is checked against the catalogued app schema.

The measure array supplies the state-transformation order. Each measure reduces the demand remaining at that step by its supplied percentage, then adds its supplied electrical demand. Its renewable quantity increases the cumulative annual supply available in the screen. The quantity used is capped at current demand, and grid energy supplies the remainder. The resulting emissions and energy cost follow the respective supplied factors and prices. This interpretation is central to replication: the percentage does not automatically apply only to a particular device, and the supplied renewable quantity is not necessarily the amount used after the cap.

The baseline state uses the supplied annual demand on the grid basis before listed measures. Incremental abatement compares the emissions immediately before and after a measure. Incremental energy-cost saving compares the corresponding energy expenditure. The measure cost combines equivalent annual capital, its supplied continuing expenditure and its energy-cost saving. The package comparison instead relates the final state to the baseline and includes all listed capital and continuing costs. These reference states should be retained when selecting an output pointer; a measure increment and a package result are different quantities.

The financial convention is a constant annual benefit with upfront capital. The discounted annuity factor converts that annual benefit over the supplied horizon and rate. At a zero supplied rate the factor uses the horizon directly, which avoids a spurious division problem. The package NPV applies that factor to net annual savings and subtracts total listed capital. Annualised net cost converts capital to an equivalent annual amount and subtracts the same annual saving. These are compatible descriptions of the retained simplified case. Neither includes debt, tax, commissioning, replacement or a time-varying benefit path.

Evidence and scope

Analytical assurance tests fitness for purpose and supporting evidence.

Evidence: [The AQUA Book](#)

Illustrative calculation. Assumptions and sensitivity are published with the model.

The retained instrument identity

The version is selected from the canonical frozen output. Source-byte and schema receipts retain the implemented instrument used for the illustrative studies.

The retained instrument identity	
Identity field	Retained value
Canonical model version	1.1.1
Paired computation	studio/apps/transition-lab/index.js::compute
Machine-readable contract	models/input.schema.json
Input identity check	Exported canonical schema equals the catalogued app schema.

Canonical foundation output identity. A version identifier is metadata rather than a claim of performance or acceptance.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Complete foundation global inputs

These fields reproduce the foundation screen. Their values are illustrative supplied assumptions, with no actual location, meter history, tariff or financing quote.

Complete foundation global inputs		
Input field	Supplied value	Unit and interpretation
baselineEnergy	10,000.00	MWh/year annual reference electricity.
gridFactor	0.60	tCO ₂ e/MWh supplied grid attribution.
renewableFactor	0.02	tCO ₂ e/MWh supplied additional-renewable attribution.
gridPrice	120.00	USD/MWh flat energy charge.
renewablePrice	80.00	USD/MWh flat charge on energy used.
horizon	12.00	Years in the constant-flow valuation.
discountRate	8.00	% per year supplied discount convention.

Canonical foundation input scalar pointers. Rates are supplied percentages; factor and price bases retain their screening meanings.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Complete foundation measure inputs

The row order is part of the input. Every supplied energy quantity is annual, capital is upfront and operating expenditure is continuing.

Complete foundation measure inputs					
Name	Efficiency, %	Added demand, MWh/year	Supply, annual MWh	Capital, USD	Opex, USD/year
Demand efficiency	20.00	0.00	0.00	800,000.00	10,000.00
Supplied annual renewable energy	0.00	0.00	4,500.00	1,800,000.00	30,000.00

Canonical foundation measure input pointers. Renewable quantities are additional supply, not an already capped output.

The abatement-cost metric is defined when its computed annual abatement denominator is strictly positive. A small positive denominator produces a ratio and can magnify uncertainty in the inputs; there is no additional positive cutoff. A zero or negative denominator produces an unavailable ratio. In that case the frozen output retains null, and the publication renders it as not defined. The result must not be replaced by a numeric zero or sorted as a free reduction. A negative net cost with positive abatement is a different case: it indicates a conditional annualised saving per attributed reduction. The technical distinction is preserved in the small-denominator and zero-denominator studies.

The reverse diagnostic runs the same supplied measures in reversed order and returns final demand, emissions and NPV. It does not return a full reversed incremental ledger or a reversed package-abatement field. The manuscript therefore selects only quantities actually present in that diagnostic when reporting it. It does not invent a missing scalar through a separate calculation. The diagnostic can reveal a scope interaction, but it does not test feasibility of either order. Engineering must interpret whether a percentage can affect the demand introduced by another measure.

The built-in sensitivity tests retain the physical package and use the supplied prices, common price-level alternatives and a reduced grid-factor alternative. Both energy prices move together in the price-level tests, while measure operating expenditure remains supplied. The factor test changes grid attribution without changing price. These are deterministic selected conditions. They contain no assigned likelihood, forecast call or global optimisation. A relative-price change, such as the separately retained adverse-price study, is a distinct authored input case and should be described as such.

Warnings identify numerical interpretations that need attention. A measure with nonpositive incremental abatement has no meaningful reduction-cost ratio. Annual supply beyond demand receives no export revenue or extra emissions credit. A supplied renewable factor above the grid factor can make displacement

adverse under the retained basis. A reversal that changes the physical result points to a sequential scope assumption. Warnings are part of the complete output, but their absence does not establish field feasibility or recognised reporting. A user should retain the method limits alongside every case.

The output has several representations of the same conditional state. Top-level fields support exact scalar bindings, measure records support the sequential ledger, and tables and metrics support readable app output. The research bindings select scalar input or output pointers and attach them reciprocally to published blocks. Reproduction recomputes the complete output before checking the selected claims. This prevents a paper from preserving only favourable summaries while the runnable case has changed. The ledger is an evidence link, not an independent source of truth that can override the canonical computation.

Select the output that answers the question

The dictionary distinguishes physical state, comparison and valuation fields. It supports pointer selection without introducing an alternate calculation. Original output-reading guide. Units follow the canonical engine and retained field meanings.

Select the output that answers the question		
Output group	Question answered	Limit to retain
energy, gridEnergy, renewableEnergy	What is the final annual electricity state?	No hourly or complete multi-carrier operation.
curtailedRenewable	What supplied annual energy lies beyond the used demand cap?	No export, storage or paid-surplus treatment.
emissions and abatement	What is the final attribution and baseline difference?	Supplied factor basis, without reporting certification.
measure abatement and incrementalCost	What changes relative to the preceding supplied state?	Sequence and affected-demand interpretation remain attached.
annualSavings and npv	What is the constant energy-related cash screen?	No liquidity, debt or full lifecycle cash schedule.
packageMac	What is annualised net cost per positive annual reduction?	Unavailable when the denominator condition fails.
reverse and sensitivity	What happens under selected deterministic challenges?	No probability, forecast or optimal package claim.

Replicate first, then challenge meaning

The reader opens the retained complete input and checks its schema and measure order. The canonical module recomputes the output, which is compared with the frozen output before any result is interpreted. Each printed scalar is checked against its input or output pointer and unit. The reader then tests the assumptions relevant to the decision, preserving the distinction between a changed input, changed method and changed operating question. Invalid input is corrected explicitly. A reproducible output can still have unsupported parameters, so applied use proceeds to the relevant engineering, commercial and reporting evidence rather than stopping at arithmetic agreement.

Verification combines exact reproduction with independent expected cases and invariants. Hand-selected physical expectations test demand, grid and renewable allocation, emissions direction, curtailment and supplied annual cash arithmetic. A zero-rate financial boundary tests the constant-benefit identity without constructing a competing discount model. Conservation, nonnegative used quantities and unavailable-ratio conditions test relations across outputs. Invalid and incomplete inputs test that errors remain errors. The paired overlap and reversed-demand checks test different sequence consequences. These checks improve confidence in the conditional engine while remaining separate from evidence that any fixture describes a real facility.

The retained figures use output pointers for every plotted coordinate. Deterministic drawing changes only coordinate scale and typography; it does not recompute transition economics. Adjacent specifications allow the audit to redraw the figures and compare their assets and scalar claims. Connectors between stages or selected tests organise the points and retain explicit reading limits. They do not add uncomputed intermediate states, probability curves or schedules. A reader should use the accompanying tables for exact values and the figure for the relationship it is designed to expose.

Fit an applied question to the instrument by tracing it through the available fields. A supported annual demand, factor basis, price and measure sequence can populate the retained screen. A duty-specific load interaction, payment for unused nominal supply or time-critical resilience objective needs a representation the screen does not provide. Identify that mismatch before entering a convenient substitute value. Preserve the complete input for replication and the omitted-mechanism explanation for interpretation. If another method is necessary, disclose its own basis and reproducibility separately. The calculation dictionary enables this fit test without treating a structurally valid input as evidence that the applied question has been answered.

Exact reproduction can create false confidence

A reader can correctly object that matching frozen output merely proves consistency with the same instrument, not truth of the model. That is why the verification record includes independently expected fields, physical invariants, boundary cases and error behaviour, and why the manuscript separates parameter evidence from computational checks. Those tests can still miss defects or inappropriate use. Independent review should challenge both the implementation and the fit to the decision. Reproduction is a necessary traceability layer for the published results, but it does not establish engineering validity, causal savings or reporting acceptance.

The technical contract preserves the annual electricity scope

The retained schema and code govern the supported bounds and precision. The appendix describes their meaning without extending the input model to fuel, heat quality, temporal operation, contractual instruments, taxes, carbon income, debt, degradation or replacement. No alternative finance or emissions pipeline is implemented in the author scripts. The illustrative inputs remain fictional and the complete outputs remain conditional. A real decision requires an appropriate wider method where the omitted mechanism is material, along with verified data and authority for the statement being made.

Decision implications

- A complete input, version and schema are part of the reproducible instrument.
- Select actual scalar fields and retain their units and reference states.
- Arithmetic verification and applied parameter validity remain different layers.

PRACTICAL APPENDICES

22

Appendix: illustrative transition studies*A falsifiable replication and extension plan***Build a comparison map and reconcile each layer**

This appendix is a laboratory notebook for the retained annual-electricity studies. Its comparison map identifies a perturbation, an expected invariant and an observable failure before inspecting a result. That ordering makes the studies useful for diagnosing the calculation. A match with frozen output establishes reproduction; a match with an independently derived identity tests a different property. All inputs remain illustrative. The complete Aster Works dispositions and authoritative responsibility register are in The committee needs balanced evidence. This appendix uses that case by reference and concentrates on the experiments behind the numerical exhibits.

Construct a comparison sheet from the complete input objects. Match global fields by name and measures by their stable names, then mark additions, deletions, field changes and changes of array position separately. A pair described as price-only must have identical demand, factors, measure terms and valuation

convention. An order-only pair must contain the same measures even though their positions differ. A standalone efficiency investment is a different package when supply capital and continuing costs are removed. This field-level classification prevents a result difference from being assigned to a cause that the actual input comparison cannot isolate.

The result register is a compact index into complete output objects, not the entire test evidence. Use its physical and cash columns to select a comparison, then read the corresponding measure records, warnings and reversed-order diagnostic. Record a predicted relationship before running the comparison: equality, a direction under stated conditions or an algebraic difference. Keep an unexpected result visible until its cause is located. Changing the prediction after seeing the result would remove the experiment's ability to expose an error in either the model or the reader's interpretation.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Result register for the original study cohort

Every row belongs to its own retained input. The quantities are illustrative conditional results, not forecasts or measured performance. The financial and physical columns should be read together before interpreting the ratio. Additional numerical boundary studies are reported separately.

Result register for the original study cohort					
Study	Demand, annual MWh	Abatement, annual tCO ₂ e	Net saving, annual USD	NPV, USD	Cost, USD per tCO ₂ e
foundation	8,000.00	3,810.00	380,000.00	263,709.65	-9.18
efficiency-only	8,000.00	1,200.00	230,000.00	933,297.94	-103.20
added-demand	12,000.00	-1,200.00	-245,000.00	-1,946,339.11	not defined
low-factor	8,000.00	105.00	380,000.00	263,709.65	-333.27
adverse-prices	8,000.00	3,810.00	-215,000.00	-4,220,256.77	146.98
zero-abatement	10,000.00	0.00	220,000.00	1,557,937.16	not defined
sequence-interaction	9,000.00	600.00	105,000.00	-208,711.81	46.16
curtailment	10,000.00	5,800.00	360,000.00	212,988.09	-4.87
overlap-efficiency-first	8,000.00	5,840.00	520,000.00	1,318,760.57	-29.96
overlap-supply-first	8,000.00	5,840.00	520,000.00	1,318,760.57	-29.96

Canonical output scalar pointers from the original ten-study cohort. Additional boundary studies are documented separately. Nonpositive-abatement ratios remain not defined.

Comparison map: a changed field must have a named effect

Use this diagnostic sheet with the complete retained fixtures. Each row names the controlled change, its expected invariant and a discrepancy that would locate a calculation or interpretation problem.

Comparison map: a changed field must have a named effect			
Comparison	Controlled change	Expected invariant	Diagnostic failure
Foundation versus low factor	Grid attribution factor only.	Demand, electricity mix, savings, capital and NPV.	A cash change indicates an unintended input difference or factor entering the cash calculation.
Foundation versus adverse prices	Grid and renewable unit prices only.	Demand, electricity mix and attributed abatement.	A physical change indicates price entering the balance or an uncontrolled fixture edit.
Overlap pair	Positions of the same efficiency and supply measures.	Final package state and value for this pair.	Equal final states with altered increments are allocation dependence, not new package savings.
Sequence interaction versus its reversal	Whether added load precedes efficiency.	Measure inventory, total capital and continuing expenditure.	Assuming final demand is invariant would hide the changed efficiency base.
Zero-abatement versus other packages	Factors and independently defined supply and cost terms.	No cross-package financial equality is predicted.	Treating all result differences as a factor effect confounds the comparison.

Original replication instrument. The zero-abatement case is deliberately classified as a separate package rather than a pure factor perturbation.

Reconciliation can locate a defect more precisely than a headline comparison. Let E denote final demand, G grid energy, R admitted renewable energy, Q accumulated renewable supply and C unused supply. The physical residuals are E minus G minus R and Q minus R minus C . Both should vanish in the annual boundary, with all quantities nonnegative. The emissions residual is reported emissions minus the sum of G times the grid factor and R times the renewable factor. The cash residual is reported net saving minus baseline electricity cost plus final electricity cost plus accumulated continuing expenditure. A nonzero residual identifies the layer that requires examination.

Apply these checks after each state transformation as well as at package close. An early residual that disappears later can be hidden by compensating mistakes. Separately check telescoping: successive emissions differences must sum to the baseline-to-final difference, and successive energy-cost differences must sum to the baseline-to-final cost saving. Sum signed increments even when an increment's cost-per-tonne field is unavailable. Dropping a nonpositive-abatement row from

those sums would change the physical package. An average of the displayed available ratios is consequently an unsuitable reconciliation; compare the summed numerators and denominators first.

Financial reconciliation uses the same constant annual convention as the engine. Capital divided by the annuity factor, less net annual saving, must equal the package annualised cost. Net annual saving times that factor, less capital, must equal NPV. These identities do not independently establish the chosen horizon or discount rate. They do detect a displaced sign, duplicated continuing cost or a mixed convention between rows and totals. Carry full canonical quantities into the check. Displayed decimals are for reading; subtraction of separately rounded values may create an apparent residual that is solely a display effect.

Derive the expected factor and price differences

The factor and relative-price pairs allow a stronger test than inspecting whether the headline improves. With B denoting baseline demand and the final mix held fixed, a grid-factor change alters abatement by B minus G , multiplied by the factor change. A renewable-factor change alters abatement in the opposite direction, by R times its change. Neither term enters the supplied bill. The factor pair therefore tests the dependency graph: attribution changes while energy and cash remain fixed. It also shows why a more negative ratio cannot be interpreted without checking the reduction quantity that divides the unchanged annual cost.

For the same fixed mix, a grid-price change alters net annual saving by B minus G , multiplied by its price change. A renewable-price change alters saving in the opposite direction, by R times its change. NPV changes by the annuity factor times the resulting saving change when capital and continuing costs are held. This gives an independent signed prediction for the relative-price comparison. A simultaneous common price multiplier answers a different question: it scales gross energy-cost saving while leaving measure continuing expenditure unscaled. The common-price diagnostic cannot be substituted for an adverse change in the relative prices.

Turn these relations into an extension design without manufacturing a new observation. Select a supported input field, state an admissible direction of change and name all fields held constant. Derive the expected difference symbolically, then compute a complete successor fixture if a numerical experiment is needed. Compare the derivative prediction only while its physical regime is unchanged. When a changed supply quantity reaches the annual cap, the regime changes and the next section supplies the appropriate prediction. A field change that also changes service, capital or a tariff obligation requires another comparison design rather than a claim of isolated sensitivity.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Changed terms that define the factor, price and denominator studies

The selected input fields make the comparison design explicit. Other complete inputs remain in the retained files; the text states when a case has a separate package.

Changed terms that define the factor, price and denominator studies			
Study field	Supplied value	Experimental role	
Foundation grid factor	0.60 tCO ₂ e/MWh	Reference attribution parameter.	
Low-factor grid factor	0.03 tCO ₂ e/MWh	Only input changed from foundation.	
Adverse grid price	70.00 USD/MWh	Changed relative commercial term.	
Adverse renewable price	140.00 USD/MWh	Changed relative commercial term.	
Zero-abatement grid factor	0.02 tCO ₂ e/MWh	Equal factor basis in a separately defined package.	
Zero-abatement renewable factor	0.02 tCO ₂ e/MWh	No attributed supply-switch reduction under that basis.	

Canonical input pointers. Values are illustrative and belong to the named experiment rather than any actual regional factor or tariff.

Signed difference ledger for a fixed annual electricity mix

Delta means successor minus reference. B is baseline demand, G final grid energy, R renewable energy used and AF the common annuity factor. Every expression assumes the other named inputs and the final physical mix are held.

Signed difference ledger for a fixed annual electricity mix			
Changed term	Abatement difference	Annual saving difference	NPV difference
Grid factor	(B minus G) times Delta grid factor	Unchanged	Unchanged
Renewable factor	Negative R times Delta renewable factor	Unchanged	Unchanged
Grid unit price	Unchanged	(B minus G) times Delta grid price	AF times the saving difference
Renewable unit price	Unchanged	Negative R times Delta renewable price	AF times the saving difference
Continuing expenditure	Unchanged	Negative Delta continuing expenditure	AF times the saving difference

Original algebraic cross-check derived from the declared electricity bill and emissions balance.

Separate path dependence, endpoint equality and the cap regime

The order experiment should distinguish an altered final state from an altered allocation along the path. Define an added demand a and an efficiency fraction e applied to the demand present at its step. Adding a before applying efficiency leaves less final demand than adding a afterwards, by a times e . This difference follows by expanding the two transformations; it does not require the app's reversed-order output as its premise. It is also an engineering question. The transformation is appropriate only if the efficiency mechanism can affect that added load. The input order encodes that scope assumption and cannot establish it physically.

Efficiency and supply accumulation behave differently. In the overlap pair, the efficiency step changes demand while the supply step changes accumulated Q ; neither alters the other's input parameter. Their final demand and accumulated supply therefore coincide, and the annual cap produces the same final mix. Intermediate states need not coincide. A reduction assigned to the first step can be reassigned to the second when the path changes. The practical verification object is a pair of endpoint and path checks: compare the complete final state for equality, then reconcile each path's signed increments to that common endpoint. Do not interpret a changed row as a new standalone benefit.

The annual cap creates a useful stress test of its own. Below the cap, an added supply quantity displaces grid energy; its cash effect depends on the price difference, and its attributed reduction depends on the factor difference. Above the cap, additional Q increases C without changing E , G or R . Under the retained used-energy charging convention it adds neither a bill saving nor an emissions reduction. Keep capital and continuing expenditure unchanged for this quantity-only diagnostic. If those costs change with Q , their financial effect is a separate perturbation. Purchase obligations for C are examined symbolically in the following worksheet appendix.

Illustrative calculation. Assumptions and sensitivity are published with the model.

Selected load and supply terms defining the remaining studies

The table exposes the terms behind the interaction and annual-cap cases. These quantities do not constitute an equipment design or a temporal supply profile.

Selected load and supply terms defining the remaining studies			
Study and field	Supplied value		Scope consequence
Sequence-interaction added load	2,000.00 MWh/year		Introduced before the supplied efficiency step.
Sequence-interaction efficiency	25.00 %		Can act on the added load under this convention.
Curtailement renewable supply	16,000.00 MWh/year		Exceeds annual demand in the retained case.
Overlap efficiency percentage	20.00 %		Same measure in both overlap orders.
Overlap renewable supply	9,000.00 MWh/year		Same supply measure in both overlap orders.

Canonical input pointers from the named studies. Percentages apply to remaining demand in the supplied sequence.

Stress plan: verify the regime, then test its invariant

Record the retained-input, prediction, recomputed-output and discrepancy references when performing a supported numerical extension.

Stress plan: verify the regime, then test its invariant			
Probe	Held conditions	Independent prediction	Evidence to retain
Supply below demand	Final demand, factors, prices and costs.	Added supply replaces equal grid energy until the cap.	Input diff, energy residuals and the signed bill and factor differences.
Supply beyond demand	Final demand and costs; used-energy charge basis.	Extra supplied energy appears only as additional unused supply.	Supply, used quantity and unused quantity, with cap regime stated.
Demand addition around efficiency	Added quantity, efficiency fraction and other measures.	Final-demand difference is added quantity times efficiency fraction.	Both ordered arrays and the affected-load interpretation.
Common positive scale	Factors, unit prices, percentages and valuation convention.	Scale energy quantities, capital and continuing costs together: amounts scale and defined cost ratios remain unchanged.	Scale rule, schema admissibility and unrounded package fields.
Signed marginal increment	Complete package and sequential state records.	Signed increments reconcile even if a row ratio is unavailable.	All rows, including nonpositive-abatement rows, and the package sums.

Original experiment design for supported annual transformations. Preserve the complete inputs and do not infer temporal supply availability from these tests.

Extend the portfolio with a falsifiable prediction

Write the challenged dependency and the expected invariant before selecting a perturbation. Compare complete input objects, retain the admissible change and state the cap regime. Recompute the whole output and reconcile physical, emissions and cash residuals. An unexpected result returns to the earliest state or field where the prediction fails. If the calculation passes but the affected-load or contractual premise is unestablished, retain that premise as a separate applied evidence task using the instruments below.

A coherent test matrix can still leave a structural error

Invariants can pass when reference and successor share the same incorrect boundary. A bill calculated consistently from used supply will not reveal a contract that charges for delivery. A perfectly reconciled demand reduction will not establish comparable service. Add a boundary challenge alongside the arithmetic tests: name a material relation that the instrument excludes, then ask whether it could change the proposed reliance. If it could, obtain evidence or choose a wider method. More perturbations inside the unchanged boundary cannot answer that structural question.

The test objects retain the annual screen boundary

These illustrative annual studies do not establish site performance, hourly matching or contractual entitlement. Their invariant tests concern the declared transformation and constant annual cash convention. Numerical equality is assessed before display rounding; applied evidence and the actual claim boundary remain necessary at reliance.

Numerical equality and a supported change of scale

Illustrative calculation. Assumptions and sensitivity are published with the model.

The small-positive-abatement study separates an undefined denominator from a small one. Annual baseline demand 1e-09 MWh, factor 1e-09 tCO₂e/MWh and 10% efficiency create positive calculated reduction 1e-19 tCO₂e/year. Zero investment and continuing cost, a one-year zero-rate convention and the supplied energy price produce package marginal cost -1000000000 USD/tCO₂e. The ratio is mathematically defined because the computed denominator is strictly positive. The extreme inputs diagnose arithmetic rather than represent measurable industrial abatement.

The canonical decimal annual balance determines whether reduction is positive, zero or negative before each quantity is converted for display. A small genuine positive reduction remains eligible for a cost ratio, without an absolute floor. Separately rounding baseline and final totals can obscure that difference, so subtracting displayed totals does not reproduce the unrounded comparison. The reversed-order physical diagnostic compares the two canonical annual emissions

balances exactly. A positive software denominator establishes neither detection capability, materiality, reporting eligibility nor a certified reduction. Those need the baseline boundary, measurement evidence and claim rules developed in the preceding chapters.

Decision implications

- Classify changed fields before attributing a result difference.
- Use signed residuals and endpoint comparisons as well as frozen-output reproduction.
- Retain the annual cap, exact sign comparison and applied boundary at each test.

PRACTICAL APPENDICES

23 Appendix: baseline and verification worksheets

A service, observation, commercial and claim evidence packet

Reconcile the service and the affected-load perimeter

Use this appendix to assemble an applied evidence packet: service reconciliation, observation eligibility, tariff comparison and adjustment design. The instruments request data and tests; they contain no populated project answers. The fictional Aster Works names, deadlines and stop authority remain in The committee needs balanced evidence. The retained numerical reference identifies the teaching calculation, while these worksheets investigate the field propositions needed for applied use.

Start the packet with a service coordinate rather than an energy total. Define accepted output, its quality condition and the relevant operating period, then map each carrier and meter to that service. Energy per accepted unit is a useful decomposition only when numerator and denominator share a perimeter and time window. Lower total consumption alongside proportionately lower accepted output can leave specific consumption unchanged. Counting rejected output as accepted would create a different apparent result. Record both total energy and the service quantity so that a change in demand can be decomposed into changed activity and changed input requirement.

Make the affected-load map concrete enough to test an overall percentage. Each measure row identifies the loads it acts on, the supporting loads it can increase and any new load that arrives before or after it. Compare the sum of the mapped loads with the meter boundary. An unmapped residual is a question to investigate, not a

load silently assigned the package percentage. If service depends on a supporting system outside the proposed meter, record that system in the interaction perimeter. This packet tests whether the annual model's scope represents the intervention before refining its parameter precision.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The numerical reference held apart from the missing field evidence

These values identify EW-CALC and remain illustrative. The baseline and service tasks are intended to determine whether a future applied case can support the same perimeter.

The numerical reference held apart from the missing field evidence		
EW-CALC field	Retained quantity	Evidence relation
Supplied annual baseline	10,000.00 MWh/year	Assumption awaiting an appropriate applied reference.
Final annual demand	8,000.00 MWh/year	Canonical conditional transformation.
Attributed annual reduction	3,810.00 tCO2e/year	Provisional reference mandate, without reporting eligibility.
Net annual cash saving	380,000.00 USD/year	Supplied flat-price and continuing-cost comparison.

Canonical foundation input and output pointers. None of the quantities is a measured Aster Works parameter.

Annotated service and meter-boundary packet

Record the source for each entered object and carry any unresolved scope item into the next parameter selection.

Annotated service and meter-boundary packet		
Packet object	Required evidence and annotation	Test before parameter use
Service coordinate	Accepted output definition, quality condition, period and excluded output.	Energy and accepted output share a boundary; rejected or reduced service is visible.
Meter perimeter	Carrier, measurement stage, connected loads, interval convention and boundary changes.	The meter captures the affected and supporting loads or names their omission.
Measure-to-load map	Existing, added and supporting loads; each measure mechanism and scope.	The aggregate percentage is supported by its affected base, without double counting shared loads.
Reference operation	Without-project operation and credible replacement or maintenance alternative.	Known mandatory changes appear in the comparator before attributing the project difference.
Observation eligibility	Raw record location, clock basis, unit, coverage and exclusion reason.	Each retained interval can be reconstructed from the raw record and the eligibility rule.
Unmapped residual	Meter total compared with mapped load totals and the uncertainty in that comparison.	The residual is explained, bounded or retained as a scope gap.

Original applied worksheet for service, load and meter reconciliation.

Evidence and scope

Project-specific verification design follows an explicit allocation of responsibilities.

Evidence: **M&V Guidelines: Measurement and Verification for Performance-Based Contracts**

Test observation eligibility, adjustment and extrapolation

The observation packet separates raw data, eligibility rules and comparison variables. Retain raw readings without overwriting them; create a separate eligibility view that marks outages, missing intervals, unusual operation and changed meter boundaries. For every excluded interval, retain the reason and the proposed treatment. A useful comparison can then be reproduced with and without a disputed eligibility choice. The audit object is the difference those choices make to the proposed saving, rather than a general statement that the data has been cleaned. A missing interval remains an unknown quantity until its treatment is supported.

Design the comparison before reviewing performance. Identify the operating variables that plausibly change the reference input requirement, specify the domain over which their relation will be used and distinguish routine variation

from a structural boundary change. A proposed adjustment based on production can be tested on retained reference periods that were not used to choose the relation. Ask whether its errors still track production, operating mode or time. A pattern tied to one of those variables suggests a missing mechanism or an inappropriate comparison domain.

Matched operating periods provide a useful challenge to the adjustment design. Compare like service and mode where the reference and project records overlap, then identify the part of the proposed claim that requires extrapolation beyond that overlap. If the intervention runs in a new mode, a historical relation can be precisely fitted and still lack support there. The worksheet should name the unsupported domain explicitly. Restricting the initial claim to supported operation, obtaining further evidence or using a suitable physical model are distinct responses. Choosing the most favourable extrapolation without an operating explanation would not resolve the gap.

Data gaps can also be challenged through bounds. Split an energy total into retained observations and the missing portion. If an accepted operating envelope supports lower and upper energy bounds for the missing intervals, carry those bounds through the same reference and project comparison. Do not create bounds from a convenient average merely because it preserves the original saving. Jointly affected gaps need a stated dependence treatment: common clock loss or a shared meter error should not be treated as unrelated uncertainties by default. The resulting range exposes whether a conclusion depends on an unobserved part of the year.

Annotated observation, adjustment and extrapolation packet

Complete the evidence references before evaluating performance. Each proposed rule has a retained test object and a consequence.

Annotated observation, adjustment and extrapolation packet		
Rule or comparison	Retained test object	Consequence of a failed test
Clock and units	Timestamp basis, interval length, carrier units and reconciliation to billing period.	Repair alignment or narrow the comparable period before calculating the difference.
Missing and excluded intervals	Eligibility mask, reason, energy bounds and result with disputed intervals included.	Show the claim range or retain a data gap; do not replace absence with zero.
Routine adjustment	Variable definition, reference evidence, applicable domain and unused-period challenge.	Revise the relation or narrow its domain when residuals retain a systematic pattern.
Structural change	Changed service, meter, equipment or production-mode record.	Redefine the comparator or method before continuing the former adjustment.
Supported overlap	Matched service and operating-mode comparison.	Separate supported differences from extrapolated operation.
Extrapolation	Unsupported domain, proposed physical relation and evidence still required.	Restrict the claim, obtain evidence or select a method that represents the new mode.

Original applied diagnostic design for adjustment and comparison domains.

Map the physical quantity to the payable obligation

Build the commercial packet as a bill comparison. Map each physical quantity to the charge it changes and retain a separate list of fixed, minimum, demand-related and contingent payments. For a flat unit price, the responsive energy quantity has a direct bill relation. For a minimum purchase or delivery obligation, used energy and paid energy can differ. Annotate the record with the charging quantity, the price basis, the persistence condition and any overlap with listed capital or continuing expenditure. A quoted unit rate without those terms cannot identify the annual cash release.

The retained surplus exhibit gives a concrete entry point for a symbolic comparison. Let H be an additional constant annual payment for unused supply and K an omitted upfront interface cost. Hold the physical package, other costs, horizon and discount convention fixed. Applied NPV would then be screening NPV less the annuity factor times H , less K . Under a nonnegative-NPV rule, the admissible H is no greater than screening NPV less K , divided by the annuity factor. If that upper bound is negative, no nonnegative H can satisfy the rule. The applicable bill basis supplies the terms for this algebraic test.

If the price applies to all nominal supply, the extra unused-supply payment in that comparison is unused quantity times the applicable unit price, provided the same charge has not already been included elsewhere. A contract may have another quantity basis, credits or timing, in which case its own bill relation replaces that expression. The original annual engine charges only used energy and gives the

excess no value. Its physical result cannot answer the charging question. The exhibit preserves the held proposition at reliance, while the symbolic test identifies the particular commercial term capable of consuming the value margin.

Illustrative calculation. Assumptions and sensitivity are published with the model.

The surplus hold survives a favourable screening value

The fictional commercial rule requires evidence of the unused-supply terms. The following values remain canonical illustrative results and do not satisfy that external condition.

The surplus hold survives a favourable screening value		
Curtailment field	Frozen quantity	Held proposition
Supply quantity	16,000.00 MWh/year	Purchase and delivery obligation.
Annual energy used	10,000.00 MWh/year	Temporal usefulness and applicable charge basis.
Annual energy beyond demand	6,000.00 MWh/year	Permitted use, payment or export treatment.
Package NPV	212,988.09 USD	Value under a convention that charges only energy used.

Canonical curtailment pointers. The original committee hold is a decision rule, not a new app output or financial calculation.

Annotated bill and value-margin bridge

Populate the reference and intervention bills from applicable terms, then reconcile the annual saving and payment timing. Keep H and K separate from charges already included in the screen.

Annotated bill and value-margin bridge		
Bridge element	Evidence to enter	Reconciliation and decision use
Responsive energy charge	Billed quantity, unit price, period and responsive term.	Connect the physical difference to the amount actually released.
Persisting payment	Fixed, minimum or demand payment and its termination condition.	Retain the payment until its obligation changes.
Paid unused supply	Purchase or delivery quantity, unused quantity, price and allowed credits.	Calculate H from the payable quantity; used and paid energy can differ.
Capital and continuing cost	Included charges, upfront interfaces and recurring expenditure.	Remove duplication; identify K and additional recurring cost.
Value margin	Screen NPV, common annuity convention and evidenced additions.	Compare H and K with the margin before accepting commercial terms.
Timing bridge	Commissioning, benefit start, payment dates and funding need.	Use a time-dependent cash schedule when constant annual cash is unsuitable.

Separate numerical sign, detectable change and receiving claims

Exact decimal subtraction and credible measurement answer different questions. Let D be the estimated adjusted reference energy minus project energy, with service and periods reconciled. Suppose the receiving method can justify conservative absolute error bounds for the adjusted reference and project quantities, including adjustment error. Adding those bounds gives a worst-case bound U for their difference. The admissible energy difference lies between D minus U and D plus U . A positive lower bound supports the sign under those stated bounds; an interval spanning zero cannot settle it. No probability or statistical confidence follows from this deterministic construction.

Record where each bound comes from before using that sign test. Instrument specifications, missing-data treatment and model error can have different units and periods; convert them to the same energy comparison before combining them. A bound that excludes a material uncertainty is not conservative for the whole claim. If dependence is known, a justified joint bound can replace the simple sum, but an assumed cancellation should not. The small-positive computational study remains useful: its ratio is mathematically defined even when this applied evidence packet could not establish an observable reduction of that size.

The same discipline applies when transferring an energy interval into an emissions statement. Factors and boundary choices can add another uncertainty or change the proposition entirely. Retain the energy interval separately, name the factor basis and identify whether the intended statement concerns electricity attribution or a wider intervention. Do not select a factor merely because it makes the lower bound favourable. A cash conclusion can meanwhile remain meaningful under a supported bill comparison. The final evidence packet should state which proposition has passed its own test, avoiding a single accepted label that conflates service, savings, cash and emissions.

Annotated sign, claim and transfer record

For each receiving proposition, link the supporting packet and state the accepted comparison domain.

Annotated sign, claim and transfer record		
Receiving proposition	Packet to attach	Interpretation to record
Comparable service	Service coordinate, affected-load map and operating overlap.	State the service domain within which the energy difference is meaningful.
Sign of energy saving	Adjusted reference, project quantity and justified error-bound components.	Use the interval from D minus U to D plus U; retain an unresolved sign when it crosses zero.
Annual extrapolation	Supported periods, unsupported operation and missing-data treatment.	State which part is measured, adjusted, bounded or outside the claim.
Cash release	Bill bridge, paid supply basis and payment timing.	State the charges that change and the obligations that remain.
Emissions statement	Exact wording, audience, boundary, factors and applicable eligibility evidence.	Accept or narrow the particular statement independently of the energy and cash tests.
Transfer and update	Input version, raw evidence references, applied rules and changed-premise triggers.	Identify which result must be reopened when a service, price, factor or method premise changes.

Original receiving instrument. Report the energy interval, bill comparison and emissions statement as separate propositions.

Applied exercise: challenge a percentage with a load map

Choose a proposed measure and a meter boundary. List affected, unaffected, added and supporting loads, with evidence references and a service coordinate. Construct the annual demand change by load before applying any package percentage. Compare the result with the aggregate screen and identify the first scope assumption responsible for a difference. If the load evidence is absent, return a measurement design and a supported bound rather than a completed estimate. Retain the comparison and the evidence required to resolve its scope difference.

Applied exercise: locate the term that consumes value margin

Select an annual screen and assemble its applicable bill terms. Identify any additional annual payment H and omitted upfront interface cost K. Specify the admissible combination under the chosen cash rule and the evidence needed to test it. Write the intended emissions statement and its support separately. A favourable bill comparison does not settle the statement test.

Assemble a packet that can change the next action

Return the service map, observation view, adjustment challenge, bill bridge and receiving record with evidence links and test outcomes. The receiving authority selects the next action under its actual delegation. A service change reopens the physical comparison, paid-unused terms reopen the bill, and a factor or audience change reopens the statement. Retain prior inputs and reasons so the changed proposition is explicit.

The evidence packet can exceed the value of a small decision

Use existing meter records and simple responsive charges when they can answer the commitment's decisive questions. Select packet elements according to unresolved terms capable of changing that decision. Requiring every field regardless of mechanism adds burden; omitting a consequential gap because the intervention is small hides risk. Proportionate use retains explicit tests and can link to evidence already held elsewhere.

These applied instruments contain no project answers

These worksheets contain no raw measurements, fitted adjustment, enforceable bill or actual delegation. Numerical exhibits remain illustrative; interval and value-margin expressions are conditional original algebra. Test the relevant evidence objects before relying on an applied result.

Decision implications

- Test the affected-load and service perimeter before refining a package percentage.
- Expose unsupported operation and missing data through explicit comparison tests.
- Use a bill bridge and separate sign and claim records to identify the next consequential evidence.

PRACTICAL APPENDICES

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Appendix: source editions and transfer conditions

A source-scope and receiving-claim handover record

Published editions answer defined questions

Published guidance and a publisher announcement have different evidential roles. The retained GHG publications support the particular inventory, project or comparative distinctions cited in the relevant chapters. The retained update

announcement establishes that development and harmonisation work is under way. It does not issue a replacement accounting method for this study. A reader should therefore retain the edition actually used, check applicable current requirements before an applied statement and avoid presenting an announced revision as already adopted. This paper makes no prediction about when an organisation will accept a future method.

Evidence and scope

The announcement describes continuing standards development and harmonisation.

Evidence: [GHG Protocol Announces Key Standard Development Updates: FAQ Resource](#)

The FEMP version history likewise has a limited purpose. A publisher page describing an update supports edition identity and the history it expressly states. The retained full guideline supplies the relevant method and responsibility content used elsewhere. Keeping both prevents a page title from standing in for an unread technical document. The case adapts the published questions to an original development protocol. It does not state that Aster Works holds a federal performance contract, satisfies a particular procurement requirement or has verified realised savings.

Evidence and scope

Publisher history identifies the guideline update and its edition.

Evidence: [M&V Guidelines: Measurement and Verification for Performance-Based Contracts, Version 5.0](#)

Match each source to the question it answers. An annual electricity factor does not supply a project counterfactual; a verification method does not show that the operator used it; corporate accounting guidance does not establish credit entitlement; industry opportunity guidance does not calibrate an illustrative efficiency percentage. Retain these distinctions at the cited locator. Publisher authority cannot close the missing operating or entitlement proposition.

A changed claim needs a defined handover

The relevant transfer question is whether the receiving organisation is making the same kind of statement under the same physical, commercial and reporting boundary. An annual electricity balance can be reproducible while the new claim concerns an export sale, a minimum purchase obligation or a verified emissions reduction. Those claims introduce different events and evidence. Retain the earlier case as a conditional illustration, identify the changed object and assign the review

to the owner of that object. Replacing a source edition or changing a meter boundary should not be handled as a routine substitution of one coefficient in every account.

The receiving claim determines the review

An original handover record routes a changed condition to the method and authority needed for it. The entries below state what the present instrument can represent and what remains outside it. They assert no actual entitlement, contract or meter observation.

The receiving claim determines the review		
Changed condition	Current instrument boundary	Required handover object
Purchased supply is billed even when unused.	Energy cash values admitted consumption; it has no minimum-bill or take-or-pay mechanism.	Accepted billing formula, quantities and timing in a suitable commercial model.
Surplus is offered for export.	Supply above demand is unused under the retained annual cap.	Permitted export route, delivered quantity, price and counterparty terms.
Service changes or another load enters the meter.	The supplied demand and measure scope define the electricity comparison.	A consistent service baseline and revised physical comparison.
A demand charge or time-dependent rate becomes material.	The instrument applies flat supplied energy prices.	Required interval loads, billing rules and the appropriate tariff calculation.
A published emissions-accounting edition changes.	The retained attribution factors and cited narrow methods define this illustration.	Applicable adopted edition, reporting purpose and approved factor basis.
An incentive or credit is proposed.	No eligibility determination or incentive-income field is implemented.	Recognised programme method, eligibility evidence and the responsible authority.

Route the changed claim before transferring the result

Before adopting a result, the receiving decision owner states the claim, boundary and governing method. The technical owner identifies any missing carrier, interval or service condition. The commercial owner establishes payment and use obligations. The reporting owner checks the applicable adopted accounting basis. Where the current instrument lacks the governing mechanism, retain a held transfer condition and commission the appropriate analysis. A valid earlier computation stays useful within its earlier perimeter; it should not be enlarged merely because the new organisation finds its headline attractive.

1. Name the receiving claim and accountable owner.
2. Identify the event or boundary that changed.
3. Choose the method that represents the material condition.
4. Retain unresolved terms beside the conditional result.

A later amendment should identify its trigger and dependencies. If an actual tariff includes payment for unused energy, the affected cash comparison requires a suitable revised commercial method. If a factor basis changes, the applicable emissions statement and climate mandate need review, while energy cash may remain unchanged. If service or affected loads change, the physical comparison and counterfactual may need revision. If only typography changes, the numerical instrument need not be altered, but the checked artifact should be identified. These are different events, with different owners and different reasons for reopening a decision.

Reproduction leaves the institutional protocol open to challenge. A committee that changes its objective, combines roles or selects another gate must state the change and trace its consequences. The Aster Works reference mandate is an illustrative choice tied to the supplied case. Its transparent basis lets a reader contest the objective, mandate or next action without disputing the energy identity.

A complete archive cannot settle every scientific or institutional dispute

Retention makes the stated evidence and method inspectable, leaving materiality and institutional adoption open to challenge. A dissenting reviewer can identify an omitted carrier, temporal condition, counterfactual or authority problem and trace the dependency requiring correction. That is the archive's decision use. File completeness supplies no substantive answer to those scientific or institutional questions and cannot justify adopting the fictional rules unchanged.

Edition assurance is bounded by the work actually recorded

Primary-source editions, instrument files and publication receipts identify this candidate. Applied data, real delegated authority and institutional acceptance are absent. The standards-development announcement is contextual history, while the full retained publications support only their cited narrow propositions. Independent publication review remains a separate step. Future source or project changes require a recorded amendment; this edition does not guarantee continued applicability, complete method coverage or any real investment, performance or reporting outcome.

Decision implications

- Transfer the stated mechanism and boundary, rather than an isolated headline result.
- New billing, service or reporting conditions can require a different governing method.
- An announced standards revision does not establish an adopted replacement.

PRIMARY EVIDENCE

References and source scope

wb-finance-issues

World Bank PPP Resource Center. Key Issues in Developing Project Financed Transactions. live guidance, accessed 2026-10-10

Locator: Debt Service Cover Ratio; Loan Life Cover Ratio

Scope: Definitions and financing logic only. Examples of leverage on the page are not current market benchmarks and are not used as such.

<https://ppp.worldbank.org/financing/issues-in-project-financed-transactions>

green-book

HM Treasury. The Green Book. 5 February 2026

Locator: Options appraisal; risk and uncertainty; monitoring and evaluation

Scope: Its social appraisal perspective and public discount conventions do not automatically apply to private finance.

<https://www.gov.uk/government/publications/the-green-book--2/the-green-book-2026>

magenta-book

HM Treasury. Magenta Book: Central Government guidance on evaluation. 15 May 2026

Locator: Evaluation planning; test and learn; benefits management

Scope: A monitoring improvement is not by itself a causal impact estimate. Identification and context remain necessary.

<https://www.gov.uk/government/publications/the-magenta-book/magenta-book-central-government-guidance-on-evaluation-html>

aqua-book

UK Government Analysis Function. The AQUA Book. current edition accessed 2026-10-10

Locator: Quality assurance of analysis

Scope: A quality framework is not a certification of a particular model. Evidence of executed checks is still required.

<https://www.gov.uk/guidance/the-aqua-book>

gao-cost

US Government Accountability Office. Cost Estimating and Assessment Guide. GAO-20-195G, 12 March 2020

Locator: Technical baseline; assumptions; sensitivity; update with actuals

Scope: An earned-value metric cannot repair an invalid baseline or prove the quality of completed work.

<https://www.gao.gov/products/gao-20-195g>

wb-lifecycle

World Bank. Raising economic efficiency in view of life-cycle costs. 22 April 2024

Locator: Quality Infrastructure Investment principle two

Scope: A lifecycle principle supplies no supplier-specific cost data or performance warranty.

<https://www.worldbank.org/en/brief/2024/04/22/qii-2-raising-economic-efficiency-in-view-of-life-cycle-costs1>

ghg-corporate

GHG Protocol, WRI and WBCSD. Corporate Accounting and Reporting Standard. revised edition 2004, current publication page

Locator: Organisational and operational boundaries

Scope: Inventory accounting differs from project avoided-emissions claims. A simple energy model is not a verified corporate inventory.

<https://ghgprotocol.org/corporate-standard>

ghg-scope2

GHG Protocol, WRI and WBCSD. Scope 2 Guidance. 2015 guidance; revision consultation disclosed on current page

Locator: Purchased electricity; location and market basis

Scope: The active revision process is disclosed. This edition does not assume the consultation has replaced the published standard.

<https://ghgprotocol.org/scope-2-guidance>

iea-efficiency-industry

International Energy Agency. Energy Efficiency 2025: Industry. 20 November 2025

Locator: Energy uses; industrial efficiency measures

Scope: Sector descriptions do not establish savings for a particular site. Site balances, baselines and load profiles are needed.

<https://www.iea.org/reports/energy-efficiency-2025/industry>

doe-mv

US Department of Energy, FEMP. Measurement and Verification for Federal Energy Savings Performance Contracts. current publication page accessed 2026-10-10

Locator: Degree of measurement and verification

Scope: US federal contract requirements retain their stated scope; the analytical principle can be adapted without importing legal obligations.

<https://www.energy.gov/cmei/femp/measurement-and-verification-federal-energy-savings-performance-contracts>

doe-mv-options

US Department of Energy, FEMP. Measurement and Verification Options for Federal Energy- and Water-Saving Projects. current publication page accessed 2026-10-10

Locator: Options A, B, C and D

Scope: Measurement boundaries and interactions determine which approach is meaningful. A pre/post total alone is not automatically attributable savings.

<https://www.energy.gov/cmei/femp/measurement-and-verification-options-federal-energy-and-water-saving-projects>

doe-mv-plan

US Department of Energy, FEMP. Measurement and Verification Activities Required in the Energy Savings Performance Contract Process. current publication page accessed 2026-10-10

Locator: M&V plan and baseline conditions

Scope: A baseline must be defended for the actual project. The cited process does not validate illustrative inputs.

<https://www.energy.gov/cmei/femp/measurement-and-verification-activities-required-energy-savings-performance-contract>

doe-mv-v5

US Department of Energy, FEMP. M&V Guidelines: Measurement and Verification for Performance-Based Contracts, Version 5.0. 14 October 2024

Locator: Version and procedure scope

Scope: Guideline adoption and project-specific compliance are separate questions.

<https://www.energy.gov/cmei/femp/articles/mv-guidelines-measurement-and-verification-performance-based-contracts-version-0>

ghg-project

GHG Protocol, World Resources Institute and WBCSD. The GHG Protocol for Project Accounting. 2005, retained published protocol; update disclosed by publisher

Locator: Chapter 5 assessment boundary; Chapter 6 selecting a baseline procedure, printed pages 36 to 37; Chapter 10 monitoring

Scope: Project accounting is distinct from corporate inventory. The protocol does not establish ownership, programme acceptance or credit eligibility for these illustrative measures.

https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf

ghg-avoided

World Resources Institute, GHG Protocol. Estimating and Reporting the Comparative Emissions Impacts of Products. Working paper, January 2019

Locator: Key principles, printed page 3; functional unit, printed page 5

Scope: This is a working-paper framework, not exhaustive detailed guidance or a replacement inventory standard. No product impact is measured here.

https://ghgprotocol.org/sites/default/files/2023-03/18_WP_Comparative-Emissions_final.pdf

epa-egrid

US Environmental Protection Agency. eGRID2023 Technical Guide. January 15, 2025

Locator: Section 2.3 applications, printed page 4; Section 3.1.3.3 emission rates, printed pages 19 to 20

Scope: US historical generation data do not supply a factor for an unspecified facility or an international forecast. No eGRID numerical factor is imported into the fixtures.

https://www.epa.gov/system/files/documents/2025-01/egrid2023_technical_guide.pdf

epa-avert

US Environmental Protection Agency. AVERT User Manual, Version 4.3. April 2024

Locator: Introduction, printed pages 4 to 6; overview of temporally resolved emissions-change modelling

Scope: AVERT retains its US electric-system and methodological scope. This paper does not run AVERT, estimate marginal dispatch or certify a consequential reduction.

<https://www.epa.gov/system/files/documents/2024-04/avert-user-manual-v4.3.pdf>

doe-process-heat

US Department of Energy, Industrial Technologies Office. Process Heat Basics. Live official explanatory page, accessed 2026-10-10

Locator: Opening definition and description of heat transfer to materials

Scope: An explanatory process description does not establish an equipment efficiency, operating duty, temperature requirement or verified fuel-switch benefit.

<https://www.energy.gov/cmei/ito/process-heat-basics>

nist-si

US National Institute of Standards and Technology. The International System of Units (SI), NIST Special Publication 330. 2019 edition

Locator: Section 2.3.4 and Table 4, printed page 15; SI derived units energy and power

Scope: The retained published edition supports the unit distinction. No equipment duty or transition performance parameter follows from a unit definition.

<https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.330-2019.pdf>

ipcc-industry

Intergovernmental Panel on Climate Change. Climate Change 2022: Mitigation of Climate Change, Chapter 11 Industry. AR6 Working Group III, 2022; official readable chapter page

Locator: Sections 11.3.4 Energy Efficiency and 11.3.5 Electrification and Fuel Switching

Scope: The assessment concerns broad mechanisms. No global potential, sector average or cited numerical factor is adopted as a project parameter.

<https://www.ipcc.ch/report/ar6/wg3/chapter/chapter-11/>

ghg-updates

GHG Protocol. GHG Protocol Announces Key Standard Development Updates: FAQ Resource. July 29, 2026 announcement

Locator: Questions on consolidated standard development and separate inventory, contractual and action-impact reporting

Scope: A development announcement is not an issued replacement standard. Current published guidance, future proposals and programme requirements must be distinguished.

<https://ghgprotocol.org/blog/ghg-protocol-announces-key-standard-development-updates-faq-resource>

doe-mv-guidelines

US Department of Energy, Federal Energy Management Program. M&V Guidelines: Measurement and Verification for Performance-Based Contracts. Version 5.0, September 2024 published PDF

Locator: Section 2.1.1, printed pages 3 to 4; Section 3, printed pages 13 to 14; Section 4.1, printed pages 18 to 19; Section 5, printed pages 40 to 43

Scope: The published performance-contract framework informs method and responsibility design. It does not validate fictional inputs, an actual contract or realised savings.

https://www.energy.gov/sites/default/files/2024-10/mv_guide_5_0.pdf

PUBLICATION RECORD

Methods, limitations and review

This edition uses publicly accessible primary sources. All worked numerical examples are illustrative, with frozen inputs and reproducible calculations. They represent no actual client, mandate or operating project.

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